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EVALUATION OF EXISTING STRUCTURES

C. K. Wiegle

Stanford Research Institute

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December 1974

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## EVALUATION OF EXISTING STRUCTURES

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report. Also included is the flow chart developed for a computer program to analyze a building subsystem; i.e., the dynamic response and collapse of all exterior and interior walls on one floor level of a building. An analysis made to determine the blast resistance of basement walls of Emergency Operating Centers is presented. Finally, the report contains a complete listing of all computer programs developed during the project for analyzing the dynamic response and collapse of wall and floor elements.

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## SUMMARY

### Introduction

The objective of this investigation was to develop an evaluation procedure for determining the blast protection afforded by existing NSS-type structures and private residences. The procedure developed consists basically of (1) a method for determining the air blast loading on the structure and structural elements, (2) a method for determining the dynamic structural response up to collapse, and (3) a method for establishing the failure criterion for each structural member of interest. The analytical method used was to establish the resistance function for each wall or floor element by considering the approximate response mode and by assuming that the element was subjected to a uniformly distributed static load. The member was then transformed into an equivalent single-degree-of-freedom dynamic system, and the equation of motion solved on a computer using a numerical integration procedure.

### Background

The primary interest from the inception of this study has been the development of an evaluation procedure for analyzing the dynamic response and collapse of the building system. However, the complexity of a comprehensive evaluation procedure for a building system necessitated that important building elements be treated first. Therefore, the initial effort in the program was directed primarily toward the development of mathematical models to analyze the dynamic response and collapse of various types of one-way action walls. Also, the behavior of window glass and steel-frame connections were examined as part of the initial study.

The analytical procedures were then extended to include two-way walls, and a probability approach was incorporated into the evaluation procedure. Next, mathematical models were developed to analyze dynamically loaded reinforced concrete floor systems of various types, and wood-joist floors. During the conduct of the research program, the evaluation procedure has been used to predict the collapse overpressure of a large number of exterior walls and floors over basement areas for existing NSS buildings. As part of this effort, the relative collapse strength of the exterior walls and frame of a multistory steel-frame building was examined.

A summary of the evaluation procedure for existing structures is contained in this final report. Also included is a flow chart for a computer program to analyze a building subsystem, and an analysis of the blast resistance of basement walls located in areaways of Emergency Operating Centers (EOCs). An appendix of the report contains a complete listing of all computer programs developed during the study to analyze dynamically loaded wall and floor elements.

#### Discussion

The computer programs for the evaluation of existing structures were developed as individual programs to analyze various types of wall and floor elements. Although this approach permitted the analysis of actual structures to be made sooner than would otherwise be possible, as well as being convenient for correlation of analytical models with experimental data, there was a need to develop a computer program to analyze the building system. As the next logical step in the development of an overall building program, a flow chart was developed for a building subsystem. The subsystem selected was all exterior and interior walls on one floor of a building. The report presents the flow chart for a computer program to analyze each wall on a room-by-room basis as the blast wave moves through the building.

The collapse strength of reinforced concrete basement walls was examined to determine the feasibility of retrofitting EOCs with doors to resist the 10-psi blast overpressure level. Although mathematical models have been developed for walls with window openings, the evaluation procedures were not extended to include walls with door openings. Since there was insufficient time to develop a generalized model for calculating the resistance and response of the wall configuration of interest, the following three-phase approach was used:

- (1) A detailed yield-line analysis of several specific reinforced concrete walls with door openings was made to establish the static resistance over a limited range of wall widths.
- (2) The computer program for analyzing the collapse of wall elements, developed by SRI for DCPA, was used to calculate the resistance of walls without door openings. The results were then compared with those obtained from the yield-line analysis for walls with door openings to determine the feasibility of using the existing computer program to simulate the dynamic response of walls with door openings. If the resistances for the two wall types was found to be not comparable, then it would be necessary to hand calculate a resistance function for each wall case.
- (3) An existing finite element computer program was used to analyze the static behavior for a few cases of walls with door openings to determine if shear or stress concentrations could conceivably produce a wall failure not predictable by the other analyses.

The various analyses led to a few general conclusions concerning the collapse of blast loaded reinforced concrete basement walls with door openings and located in areaways. First, for reinforced concrete walls 8-in. thick or thicker, and not over 10-ft high, it is probable that the wall strength of the weakest code-designed wall is sufficient to resist

a 10-psi blast loading if the horizontal distance from the edge of the door opening to the areaway support wall is less than approximately 20 in. ( $L_H = 84$  in.).

Second, for 8-in.-thick walls with horizontal distance between door opening and areaway wall greater than 20 in., it will be necessary to strengthen the wall in the vicinity of the door opening so as to upgrade the wall to the 10-psi blast overpressure level.

Third, for reinforced concrete basement walls 12-in thick or thicker, the blast strength can be expected to be approximately equal to or greater than the 10-psi blast overpressure criterion for all wall conditions.



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## EVALUATION OF EXISTING STRUCTURES

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CIVIL DEFENSE PREPAREDNESS AGENCY  
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## ABSTRACT

The objective of the overall research program is to develop an evaluation procedure applicable to existing NSS-type structures and private homes. Past efforts have been concerned with examining exterior walls; window glass; steel frame connections; applications to actual buildings; reinforced concrete floor systems, including restrained slab, wood-joist floors; and the dynamic inelastic analysis of a steel frame building. Since this is the final report in this effort, a summary of the evaluation procedure for existing structures is presented in the report. Also included is the flow chart developed for a computer program to analyze a building subsystem; i.e., the dynamic response and collapse of all exterior and interior walls on one floor level of a building. An analysis made to determine the blast resistance of basement walls of Emergency Operating Centers is presented. Finally, the report contains a complete listing of all computer programs developed during the project for analyzing the dynamic response and collapse of wall and floor elements.

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## I INTRODUCTION

Under contract to the Defense Civil Preparedness Agency, Stanford Research Institute is developing a procedure for the evaluation of existing structures subjected to nuclear air blast. The objective of the program is to develop an evaluation procedure applicable to existing NSS-type structures and private homes. This report covers the final phase of the program.

### Background

The Defense Civil Preparedness Agency has a number of problem areas in which an evaluation procedure for existing structures can be applied. These include:

- Survival and injury predictions
- Debris prediction
- Damage assessment
- Selection of existing structures that provide the best protection
- Selection of existing structures that have a potential for modification to provide blast shelters.

Even with the availability of high-speed computers, it was apparent that the complexity of an overall building evaluation procedure to meet the needs of DCPA could lead to considerable unwarranted computational effort if care was not exercised in the selection of the methodology. Therefore, relatively simplified air blast loading and room-filling procedures, as well as simplified structural response analytical methods, have been used in the evaluation program.

Although the primary interest from the inception of the program has been in the behavior and collapse of the building system, the complexity

of a comprehensive evaluation procedure necessitated the establishment of a priority for determining which structural element to investigate first. It is apparent that the collapse of the exterior walls of most buildings is important to the casualties produced. This is especially true for large multistory buildings where the collapse of the exterior and interior walls could result in a large number of casualties through ejection from the building, even if the floors and frame remained intact. Since one of the primary uses of a building evaluation procedure is to provide input for prediction of survival of people located in buildings subjected to nuclear blast, the initial research effort was directed towards the development of a method to determine the response and collapse of exterior wall elements.

Subsequent to the development of the wall evaluation procedure, the procedures for analyzing the collapse of floor systems were developed. Although there were insufficient funds in the program to develop a procedure for evaluating the collapse of structural frames, it was possible to use an available elastic and inelastic computer program to analyze the dynamic response of a steel frame building and estimate the frame collapse overpressure. During the final phase of the research, a computer flow diagram was developed for analyzing a building subsystem; i.e., for predicting the time sequence of collapse of all exterior and interior walls on one floor of a building on a room-by-room basis. However, the computer program could not be written within the level of effort of the contract.

Past reports in this program have been concerned with examining exterior walls (Ref. 1),\* window glass (Ref. 2), steel-frame connections (Ref. 3), two-way action walls (Ref. 4), applications to NSS buildings

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\* References are listed after the appendix.

(Refs. 5 and 6), reinforced concrete floor systems (Refs. 7 and 8), and wood-joist floors, and frame analysis (Ref. 8).

#### Report Organization

Since this is the final report on the research effort, a summary of the evaluation procedure is presented in Section II. A flow chart for the analysis of all walls on one floor level of a building (a building subsystem) is presented in Section III "Building System Program." The analysis of basement walls located in areaways is given in Section IV. During the project for evaluation of existing structures, computer programs were developed for analyzing the dynamic collapse strength of three types of wall elements and five types of floor system elements. The listings for the eight programs are included in the Appendix.

#### Acknowledgements

The author gratefully acknowledges the assistance and guidance of G. N. Sisson and M. A. Pachuta of the Defense Civil Preparedness Agency during the conduct of this program. Also acknowledged are J. R. Rempel and J. E. Beck of SRI, and Dr. J. L. Bockholt, consultant to SRI, for their contributions to this effort.

## II EVALUATION OF EXISTING STRUCTURES

### Approach

The overall approach adopted in this study for the evaluation of existing structures subjected to nuclear air blast has been to formulate a procedure for examining the response of a structure over a range of incident overpressure levels to determine the overpressure at which collapse will occur. Basically, the procedure consists of (1) a method for determining the air blast loading on the structure and structural elements, (2) a method for determining the dynamic structural response up to collapse, and (3) a method for establishing the failure criterion for each structural member of interest. An iterative process is employed in which the structural response can be examined for various levels of incident overpressure and compared with a failure criterion to predict the overpressure level at which collapse of each member will occur.

### Wall and Floor Evaluation Procedure

#### Introduction

The analytical method used in the research study was to establish the resistance function for each wall or floor element of interest by considering the approximate response mode and by assuming that the element was subjected to a uniformly distributed static load. The member was then transformed into an equivalent single-degree-of-freedom dynamic system by the use of the transformation factors for the load, resistance, and mass. The equation of motion was then solved on a computer using the numerical integration procedure described in Ref. 9. Although the approach has been

to use established analytical procedures wherever possible, it has been necessary to modify and adapt current procedures, as well as develop new methods, for specific uses.

The method followed in developing the wall and floor evaluation procedure was to (1) develop a mathematical model for each element of interest, (2) prepare the computer program, and (3) verify the analytical predictions with the available published test information on the dynamic response and collapse of wall and floor elements.

Although the mathematical models were formulated by using established analytical procedures, as noted in the referenced reports on the evaluation procedure for existing structures, the available published test data were adequate for correlation with only some of the analytical models. However, for other cases\* there was a lack of definitive experimental information that adequately described the load-response relationship up to collapse. Although all mathematical models could not be correlated sufficiently with appropriate experimental data, the use of probability functions i. e. the procedures for predicting the incipient collapse overpressure of the elements makes the use of precise resistance functions less critical than would otherwise be the case.

For the evaluation of existing structures, failure implies collapse or disintegration of the structural element. Furthermore, the predicted collapse overpressures calculated are for the incipient collapse of the element, which is defined as that point in the response where the wall or floor can be considered as on the threshold of collapse. The incipient collapse overpressure is just sufficient in magnitude to cause a collapse of the element.

---

\* For example, the inelastic response up to collapse of a two-way lightly reinforced concrete wall with a window opening and with vertical in-plane forces acting on the wall.

### Wall Analysis

The three basic types of exterior walls considered in the evaluation procedure are unreinforced concrete or masonry unit walls without arching, unreinforced concrete or masonry unit walls with arching, and reinforced concrete walls. The details of the development of the wall evaluation procedures are presented in Ref. 1 for one-way action walls and Ref. 4 for two-way walls.

For unreinforced masonry unit walls without arching and for reinforced concrete walls, resistance functions were developed for the following type of wall support conditions:

- Two-way, simply supported on four edges
- Two-way, fixed on four edges
- Two-way, fixed on vertical edges; simply supported on horizontal edges
- Two-way, simply supported on vertical edges; fixed on horizontal edges
- One-way, simply supported on opposite edges
- One-way, fixed on opposite edges
- One-way propped cantilever
- One-way, cantilever.

For unreinforced walls with arching, resistance functions were developed for one- and two-way action walls with rigid supports.

### Floor System Analysis

One of the interests of DCPA has been the possible use of basements of existing NSS structures as blast shelter areas, and therefore the research effort was primarily concerned with developing methods for predicting the collapse of various types of reinforced concrete floor systems.

However, the resistance function for wood-joist floors was also developed. The details of the floor system evaluation procedures are presented in Refs. 7 and 8.

The types of floor elements included in the evaluation procedure are as follows:

- One- and two-way reinforced concrete solid slabs
- Two-way restrained reinforced concrete solid slab
- Reinforced concrete support beam (including T-beam and joist)
- Structural steel support beam (including composite action)
- Reinforced concrete flat slab
- Reinforced concrete flat plate
- Wood-joist floor

#### Probability Considerations

The analysis of actual building elements subjected to nuclear air blast requires the assumption of values for many of the physical properties of the structure that are unknown and cannot be measured without an unwarranted amount of effort. Similarly, assumptions are also required in the determination of the parameters defining the load acting on the building element. Since precise values cannot usually be specified for many of the parameters that influence the collapse of actual structures, a probabilistic approach was formulated to provide a realistic evaluation of existing structures subjected to nuclear air blast (Ref. 4).

It is apparent that the determination of the incipient collapse overpressure for a given wall or floor depends on a number of variables, at least some of which must be considered to be randomly distributed. Although the probability distribution of these random variables may be determined fairly easily, at least as approximations, the extension of this step to determine the probability distribution of the resulting

collapse overpressure is not so easy. Since it was not possible to obtain an exact distribution, it was decided to use Monte Carlo, or simulation, techniques to determine the probability distribution for the incipient collapse overpressure.

This technique uses a set of mathematically simulated wall or floor elements, each of which possesses the characteristics of some real wall or floor to determine an approximate distribution of the incipient collapse overpressure. This set of simulated walls or floors is prepared by selecting the parameters to be varied and determining the values of these parameters by randomly sampling their corresponding probability distribution functions. Each simulated wall or floor is then analyzed by using the deterministic equations developed previously. The results of these analyses provide a probability distribution of the incipient collapse overpressure. It should be noted that the collapse overpressure of a wall or floor element can also be calculated deterministically.

#### Air Blast Loading

An important factor in the evaluation of existing structures subjected to nuclear air blast is the determination of the pressure-time function on each structural element of interest. This is a complex problem, since, even before the blast wave interacts with the structure, the blast wave is influenced by many factors, such as weapon yield and location, weather conditions, terrain, surface type, and blast shielding. Even if it were assumed that the free-field, pressure-time relationship were known for a blast wave incident on the side of a building, the determination of the loading function on a wall or floor element is difficult because of the interaction processes. The primary difficulty arises because the structural element responds to the differential or net loading, which requires a knowledge of the loading on both the front and back surfaces.

For the evaluation of existing structures subjected to nuclear air blast, it was assumed that the blast wave before interacting with the structure was an ideal Mach waveform propagating radially outward over an ideal reflecting surface. It was also assumed that the duration of positive phase of the dynamic overpressure was equal to that of the side-on overpressure and that the negative phase could be neglected for structural response calculations. The method used to determine the pressure-time function of an exterior wall is presented in detail in Ref. 4, and involves the calculation of an exterior, interior, and net loading.

To calculate the average load-time history on the exterior wall, the conventional air blast loading scheme for a closed rectangular block is used (Ref. 10). For the front face of a building with window openings, the conventional scheme is modified by using the weighted average clearing distance presented in Ref. 11. To calculate the interior pressure build up resulting from the air blast entering the building through openings, the room-filling procedure presented in Ref. 12 is used. For each specific problem, the net wall loading is obtained by a simple summation of the exterior and interior pressure-time histories.

In addition to the ideal air blast loading, the evaluation procedure for exterior walls includes the following loading schemes:

- Triangular load
- Rectangular load
- URS shock tunnel load
- Arbitrary load.

For the dynamic analysis of floor systems subjected to nuclear air blast, two load-time functions were included in the evaluation procedure. The first load type was equal to the free-field blast overpressure, except with a rise time equal to the travel time of the wave front across the floor panel. The second load type was equal to the room-filling pressure

resulting from the interaction of an ideal air blast wave with a structure with window openings. In addition, the floor evaluation procedure includes an arbitrary load shape.

It should be noted that although the net load-time function resulting from a nuclear air blast is calculated so as to analyze the dynamic response of a wall or floor element, a description of the net load-time function is not too meaningful for comparing collapse predictions for elements of various structures. Therefore, the predicted collapse overpressures given in this study are the peak incident overpressures of the free-field blast wave that results in collapse of the element.

#### Applications

As part of an integrated program to develop a survey procedure for all nuclear weapon effects, Research Triangle Institute (RTI) made an initial on-site field survey during November 1970 of five NSS buildings in Detroit, Michigan. The survey was conducted primarily to obtain a complete structural description of buildings that would be adequate for predicting building damage and casualties. The results of the field survey were recorded on forms and included sketches and photographs. A complete copy of this information, together with the building plans, was provided to SRI for analysis of the buildings. The results of the dynamic analysis of the exterior walls of the five Detroit buildings are presented in Ref. 5.

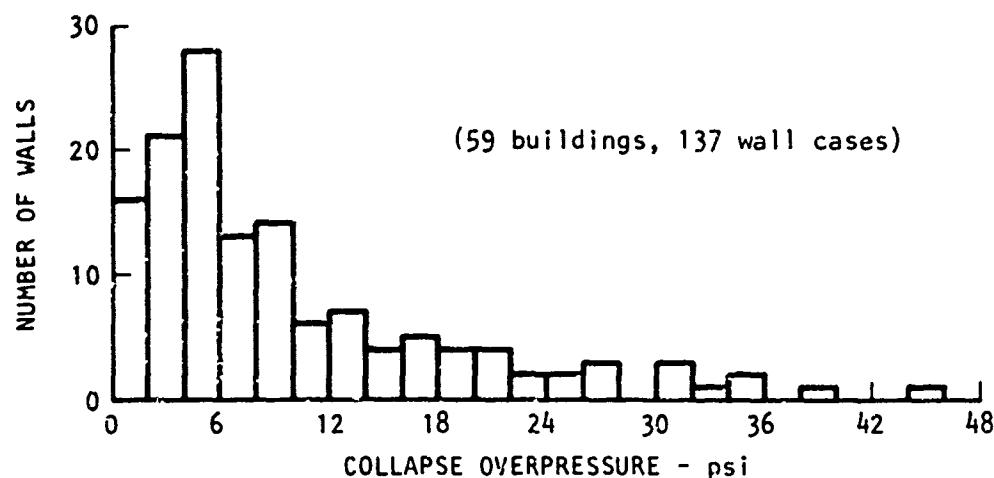
To provide additional input information for the development of the all-effects survey, RTI made a second on-site field survey in July 1971 of five buildings in the vicinity of Greensboro, North Carolina. As in the analysis of the Detroit buildings presented in Ref. 5, two dynamic analyses were made of each of the Greensboro buildings. The first analysis was made using the data obtained during the RTI on-site survey.

A second analysis of the same building was then made independently using data obtained from the actual building plans. This procedure provided a check on the adequacy of the survey technique and the proposed field survey data form, and emphasized areas of possible improvement. The results of the dynamic analysis of the exterior walls of the five Greensboro-High Point buildings are presented in Ref. 6.

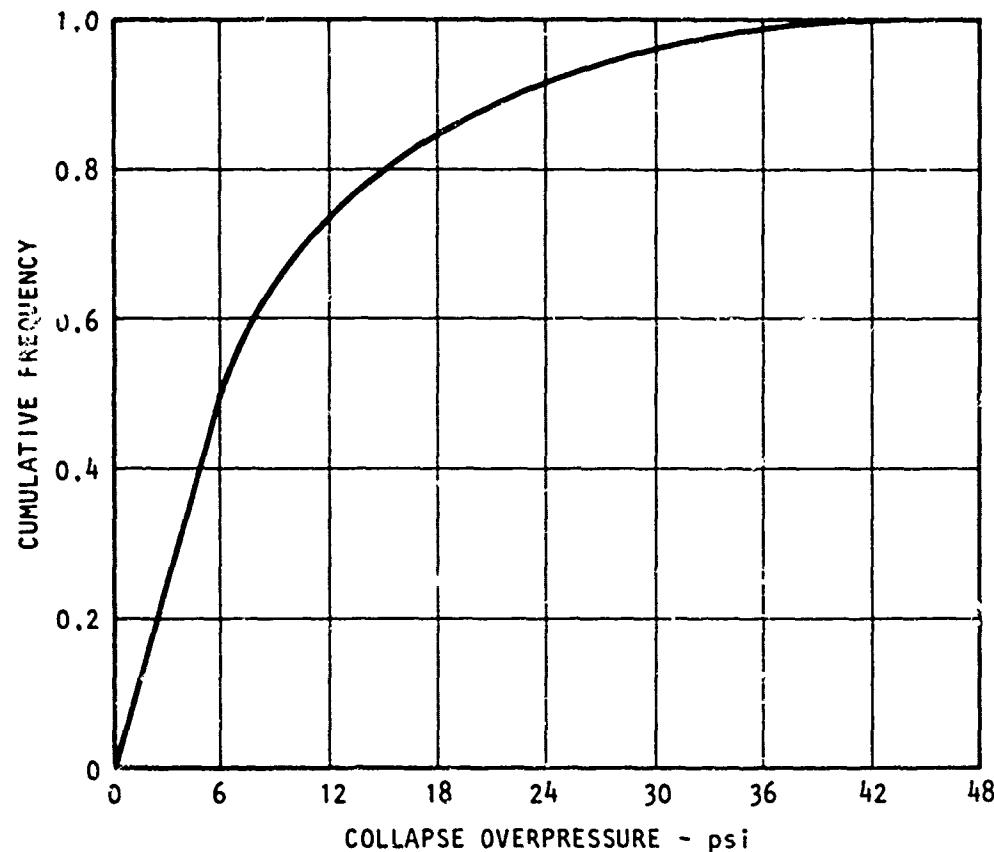
In addition to the two research studies to develop an all-effects shelter survey procedure, RTJ also collected data on a national sample of NSS buildings for the Engineering Directorate of DCPA (Ref. 13). Of the 219 NSS buildings comprising the national sample, the SRI evaluation procedure was used to predict the collapse overpressure of the exterior walls for 50 of the buildings and of floors over basement areas for 36 of the buildings. Since the results of the dynamic analyses of the walls and floors of actual buildings are of interest to the evaluation of existing structures program, a short summary of the findings are presented in this report.

#### Walls

The collapse predictions for the exterior walls of NSS buildings required the dynamic analysis of 137 wall cases. These walls represent 59 NSS buildings, which can be categorized as 15 load-bearing wall buildings, 23 structural steel frame buildings, and 21 reinforced concrete frame buildings. Figure 1 shows a histogram and cumulative frequency distribution of the mean collapse overpressure for the 137-wall population. The data indicate that for the 59 sample buildings, 50 percent of the exterior walls are predicted to have a mean collapse overpressure of 6 psi or less, and 90 percent are predicted to have a mean collapse overpressure of 22 psi or less.



(a) Histogram for all wall cases



(b) Cumulative frequency distribution for all wall cases

FIGURE 1 HISTOGRAM AND CUMULATIVE FREQUENCY DISTRIBUTION OF THE MEAN COLLAPSE OVERPRESSURE FOR THE EXTERIOR WALLS OF 59 BUILDINGS

The effect of the type of frame on the collapse strength of exterior walls is indicated by the cumulative frequency distributions for the wall collapse overpressures shown in Figure 2 for the three major building frame categories. Although the data are considered as insufficient to establish quantitatively the effect of frame type on wall collapse overpressure level, the trends in the data are apparent. The mean values of the collapse overpressures for walls are about 4.5 psi for load-bearing wall buildings, 6 psi for reinforced concrete frame buildings, and 10 psi for steel frame buildings.

#### Floors

The collapse predictions for the floor systems over basement areas of NSS buildings required the dynamic analysis of 82 floor cases, which represent 36 buildings. Figure 3 shows a histogram and cumulative frequency distribution of the collapse overpressures for all floors. As noted on the figure, the collapse overpressure for floors over basement areas ranged from about 2 to 55 psi, with 50 percent of the floors predicted to collapse at 7 psi or less and 90 percent predicted to collapse at 18 psi or less.

#### Frame Analysis

A continuing concern in evaluating the collapse overpressure of existing buildings has been the relative blast strength of the exterior walls and frames of multistory buildings. To predict the collapse overpressure of the exterior walls for the existing NSS buildings discussed in the previous subsection, it was assumed that the structural frame did not collapse at a lower overpressure than that predicted for the exterior walls. For weak-walled buildings, such an assumption is reasonable. In fact, it is often assumed for the analysis of blast loaded frame buildings that the exterior walls can be considered as frangible,

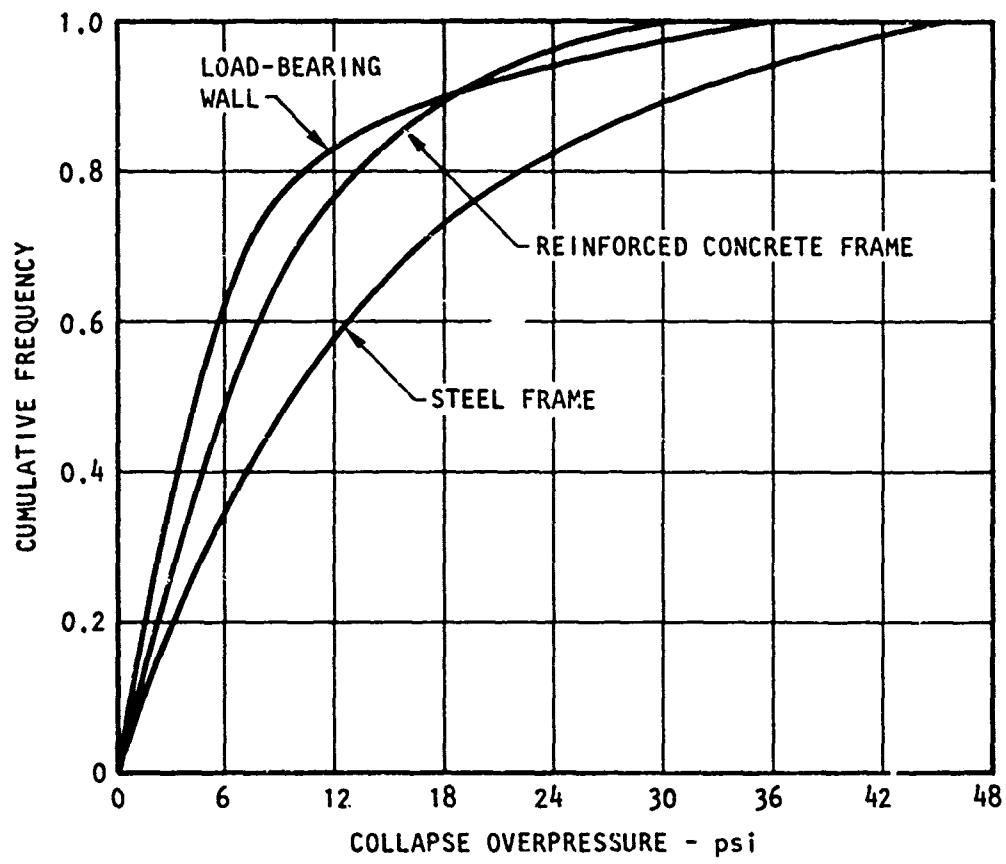


FIGURE 2 COMPARISON OF THE CUMULATIVE FREQUENCY DISTRIBUTIONS OF THE MEAN COLLAPSE OVERPRESSURE FOR EXTERIOR WALLS BY THE TYPE OF BUILDING FRAME

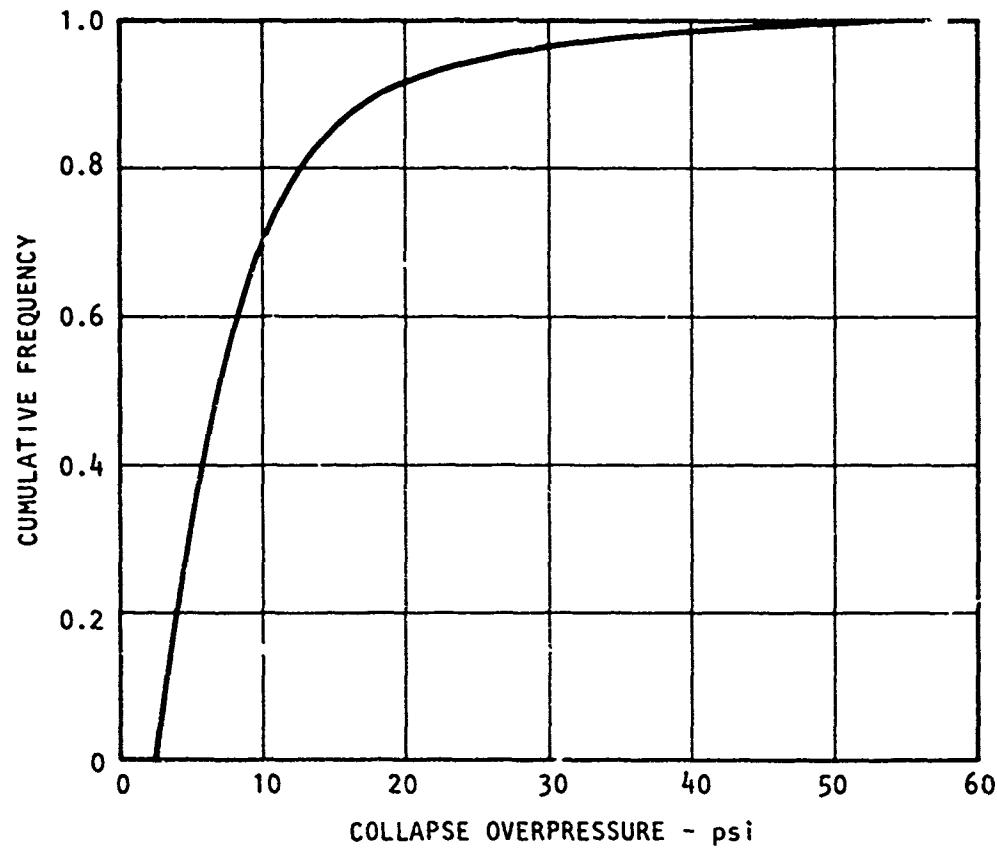
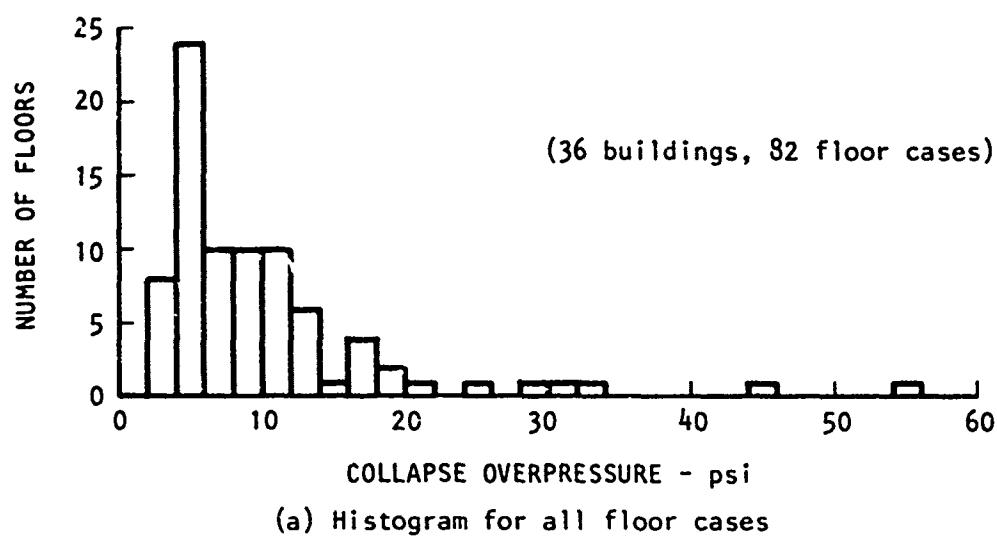


FIGURE 3 HISTOGRAM AND CUMULATIVE FREQUENCY DISTRIBUTION OF THE MEAN COLLAPSE OVERPRESSURE FOR THE FLOORS OVER BASEMENT AREAS OF 36 BUILDINGS

and therefore, that the wall loading transferred to the frame can be approximated by an impulse loading. However, for many of the actual buildings analyzed, the strength of the exterior walls under blast loading was sufficiently high to make it doubtful that the frame could survive at the overpressure level required to collapse the walls. For example, Figure 1 shows that 50 percent of the walls of the NSS buildings analyzed were predicted to collapse at an overpressure level greater than 6 psi. The strength of the exterior walls is important in calculating the collapse of the frame, since, for a given overpressure level, the blast loading on the total wall area can be much more severe than the blast loading on the frame alone plus an impulse loading from a frangible-type wall.

To investigate the relative strength of the exterior walls and frame of a building would require a comprehensive computer program that includes inelastic response under dynamic loading as well as realistic frame collapse mechanisms. Since such a program was not available, a computer program for analyzing the elastic and inelastic dynamic response of two-dimensional structural frames was used (Ref. 14). Although the program does not include frame collapse mechanisms, it was felt that the results would provide a basis for estimating the possible collapse strength of a building frame relative to the strength of the exterior walls.

The building selected for analysis was the North Carolina National Bank, Greensboro, North Carolina. The building has a structural steel frame, and consists of eight stories, with a height of about 110 ft, and plan dimensions of 50 ft by 115 ft. A complete description of the bank building and the results of the analysis of the exterior walls are given in Ref. 6. The exterior walls on the upper stories consist of a 4-in.-thick brick veneer, which is continuous over the frame members, and an 8-in.-thick terra cotta backing wythe, which is inset in the frame and parged to the brick veneer.

Three different types of frame analyses were performed: (1) an elastic analysis to determine the strength of the inset walls on the ends of the building acting as shear walls, (2) elastic frame analyses at various overpressure levels, and (3) inelastic frame analyses at various overpressure levels. The exterior walls of the building were previously found to have an incipient collapse overpressure (50 percent probability) of 15.7 psi (Ref. 6), and therefore the blast loading for the frame analyses are calculated for a box-type building with nonfailing exterior walls with window openings.

The results of the analyses provide an estimate of the collapse strength of the structural steel frame of the bank building under blast loading, even though the computer program used cannot predict frame collapse. The results of the first analysis, for the shear wall building, indicated that the cracking of the exterior walls acting as shear walls occurs at an incident overpressure level of less than 2 psi, since the moment ratios (computed moment/yield moment) for the shear walls are above 35 for a 2-psi incident overpressure level. Therefore, it was assumed for the other two types of analyses that the inset end walls acting as shear walls contributed negligible resistance to the frame, so that the analysis of the frame acting alone should adequately model the building behavior under lateral load.

An elastic analysis of the frames for 16 psi, which approximated the incipient collapse overpressure of the exterior walls, indicated a maximum stress ratio (computed stress/stress at yield) of about 20. Since the elastic analysis is much simpler than the inelastic analysis, the frames were then analyzed for elastic behavior at 5-, 4-, and 3-psi overpressures to obtain an estimate of the frame strength. The results of the elastic analyses indicated that the strength of the frames was in the range of the lower overpressures examined, and therefore the inelastic frame analyses were run at 3-, 4-, and 5-psi overpressure levels.

The inelastic analyses indicated maximum ductility ratios at 3 psi of 13.4 for the beams and 20.6 for the columns, and maximum moment ratios of about 1.64 for the beams and columns. At the 4-psi overpressure level, the maximum ductility ratios were 29.5 in the beams and 42.2 in the columns, and the maximum moment ratios were in excess of 2. A simplified hand calculation indicated that the P- $\Delta$  effect, which is not included in the computer program, would increase some of the moment ratios by over 50 percent. The calculated lateral deflection of the top story of the building was about 21 ft for the 3-psi overpressure level, and 47 ft for the 4-psi level. If it is assumed that the frame would collapse at a ductility ratio of about 50, then the estimated collapse overpressure is between 3-, and 4-psi incident overpressure level. The actual blast strength could be much less, since the effect of the axial column load (P- $\Delta$  effect) and frame collapse mechanisms, such as column buckling or instability, are not accounted for in the analytical procedure.

It should be noted that the frame of the North Carolina National Bank building appears to be constructed of relatively light structural shapes that may not necessarily be typical of most NSS structures. In any event, however, the analysis indicated that the blast resistance of the frame of the building was much less than (possibly only one-fourth) that of the exterior walls. This, of course, is an important consideration in predicting either building damage or casualties.

#### Building System Computer Program

Since the inception of the evaluation project, the intention has been to develop a procedure for the analysis of a building system that would be applicable to various requirements of DCPA. For predicting damage to NSS structures in this program, it was assumed that each wall analyzed could be treated as though it were the "front face" of the building with an ideal blast wave advancing at normal incidence to it.

The time-sequence of collapse of various building elements, or the effect of the engulfment of the building by the blast wave, is not directly accounted for in the current computer programs. For example, to use the computer codes for predicting the collapse of all exterior walls of a building (i.e., front, side, and back) for the blast approaching from one direction it is necessary to use engineering judgment in providing realistic input data. Such a procedure was used to correlate analytical predictions with nuclear field tests of brick load-bearing-wall houses (Ref. 4).

In order to systematize the building evaluation procedure, a flow diagram was prepared during the current effort that outlines the computer analysis of all wall elements on one story of a building. The results are presented in Section III.

### III BUILDING SYSTEM PROGRAM

The purpose of this phase of the research was to examine a method for systematizing the collapse predictions for blast loaded buildings. Since the inception of the existing structures evaluation project, the intention has been to develop a procedure for the analysis of a building system that would be applicable to various requirements of DCPA, such as damage assessment, survival and injury predictions, and debris predictions. Because of the complex nature of analyzing the response and collapse of buildings under dynamic loading, as well as the difficulty of calculating precise blast loadings on each element in a complex building geometry, the approach has been to establish a sound technical basis for the analysis of each building element. It has been necessary to derive realistic mathematical response models before computer codes could be prepared for the various structural elements of interest. Although the original intent was to develop subroutines for each element for the eventual incorporation into a single computer program, the need to analyze existing buildings preceded the completion of a building system program. Instead, relatively complete computer programs, as opposed to building element subroutines, were prepared for each building element; i.e., for each element the computer code consists of a main routine, a subroutine to calculate the resistance function, a subroutine to calculate transformation factors, subroutines to calculate the exterior and interior blast pressures and net load on the element, and a subroutine for calculating the probability of collapse. The development of these individual element programs diverted some effort from the development of a building system program; however, the individual programs permitted analyses of existing

buildings to be performed much sooner than would otherwise have been possible. Also, the availability of individual element programs was convenient for the correlation of experimental data with analytical models.

Essentially, the building element computer programs were developed as research tools for use in developing realistic analytical prediction models, and for performing limited analyses of buildings rather than for performing a large number of analyses of existing buildings. However, as originally intended, it has become apparent that a computer program for analyzing a building system, or at least a building subsystem, would be useful. Therefore, during this phase of the research effort, the feasibility of incorporating the previously developed computer programs for wall analysis into a program for the analysis of a subsystem of the overall building system was examined. Specifically, a relatively detailed flow diagram was prepared that outlines the procedure for analyzing all exterior and interior walls on one story of a building. During this phase, the computer flow chart was prepared, but the computer program was not written.

A subsystem analysis approach was chosen as the most expedient and logical next step in the development of an overall building evaluation procedure. Figure 4 shows a macroscopic organizational flow chart of the proposed program to be used. The subsystem is one floor level of a building that can be oriented at any angle to the blast wave front. For a given free-field overpressure level, the net loading on each wall element will be computed and the wall response calculated on a room-by-room basis as the blast wave moves through the building.

At the present time the evaluation procedure has the capability of calculating the exterior pressure-time environment resulting from an interacting blast wave, and can compute the resulting interior pressure

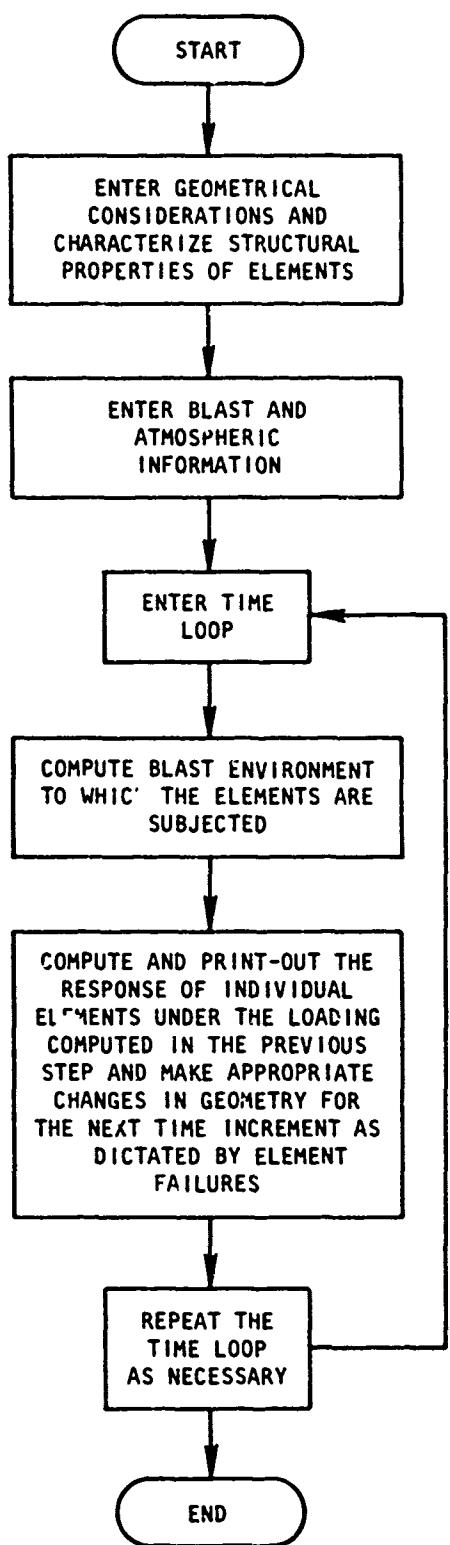


FIGURE 4 BUILDING SUBSYSTEM PROGRAM MACROSCOPIC ORGANIZATIONAL FLOW CHART

build-up to a single room. For the subsystem program, it will be necessary only to extend the capability to calculate the interior pressure in a multiroom complex by the method presented in Ref. 12. Also, as discussed previously, the mathematical models for predicting the response and collapse of walls are available. The remaining task consists of combining the loading and response models into a single subsystem program that includes the geometry of the floor of a building.

Figure 5 shows a detailed organizational flow chart of the proposed subsystem program. Table 1 is a list of abbreviations used in the flow chart.

Table I

ABBREVIATIONS USED  
IN FLOW CHART

<u>Abbreviation</u>	<u>Word Represented</u>
EXT	EXTERIOR
INT	INTERIOR
OPNG	OPENING
FLR	FLOOR
PR	PAIR
ARVD	ARRIVED
RM	ROOM
NRST	NEAREST

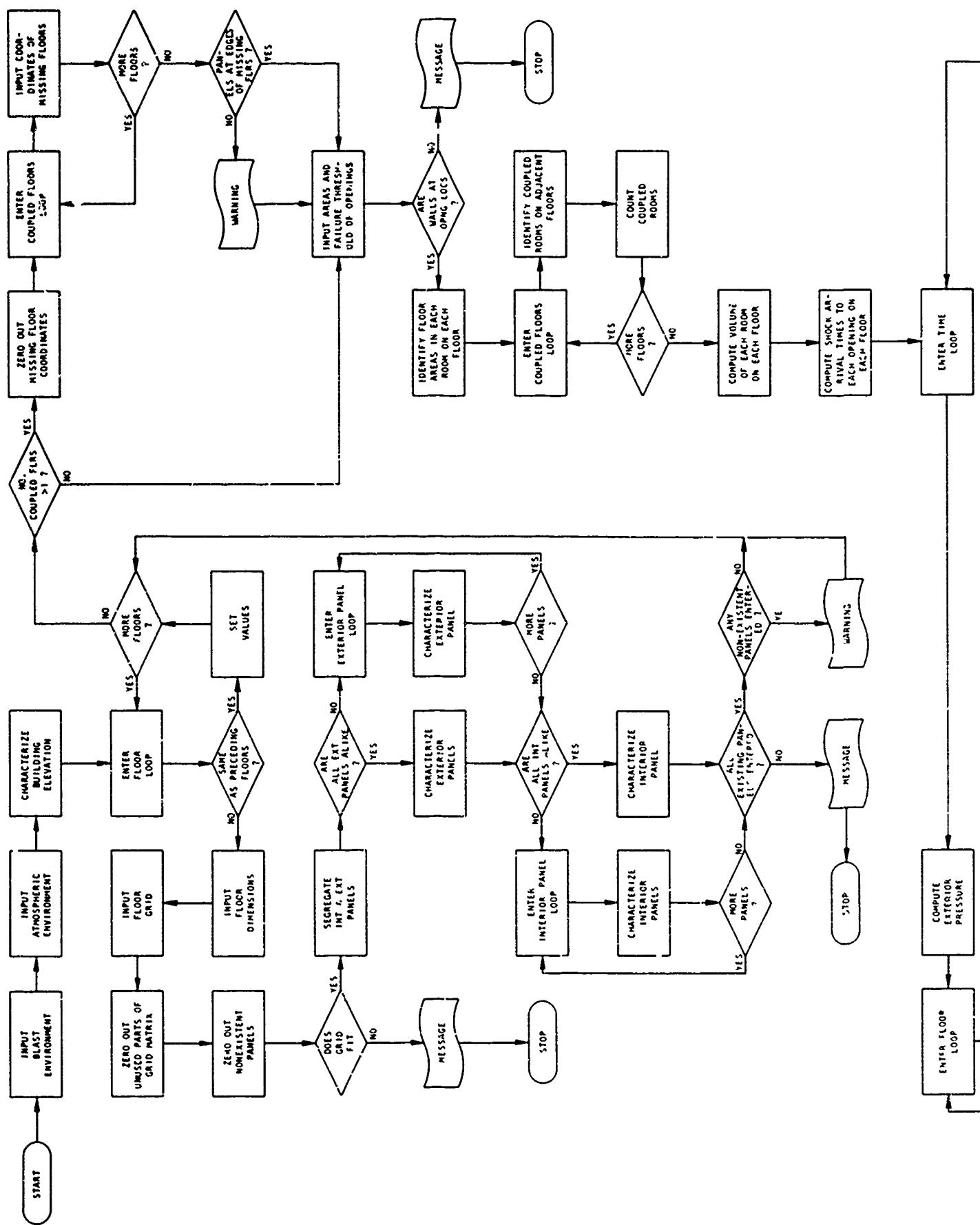
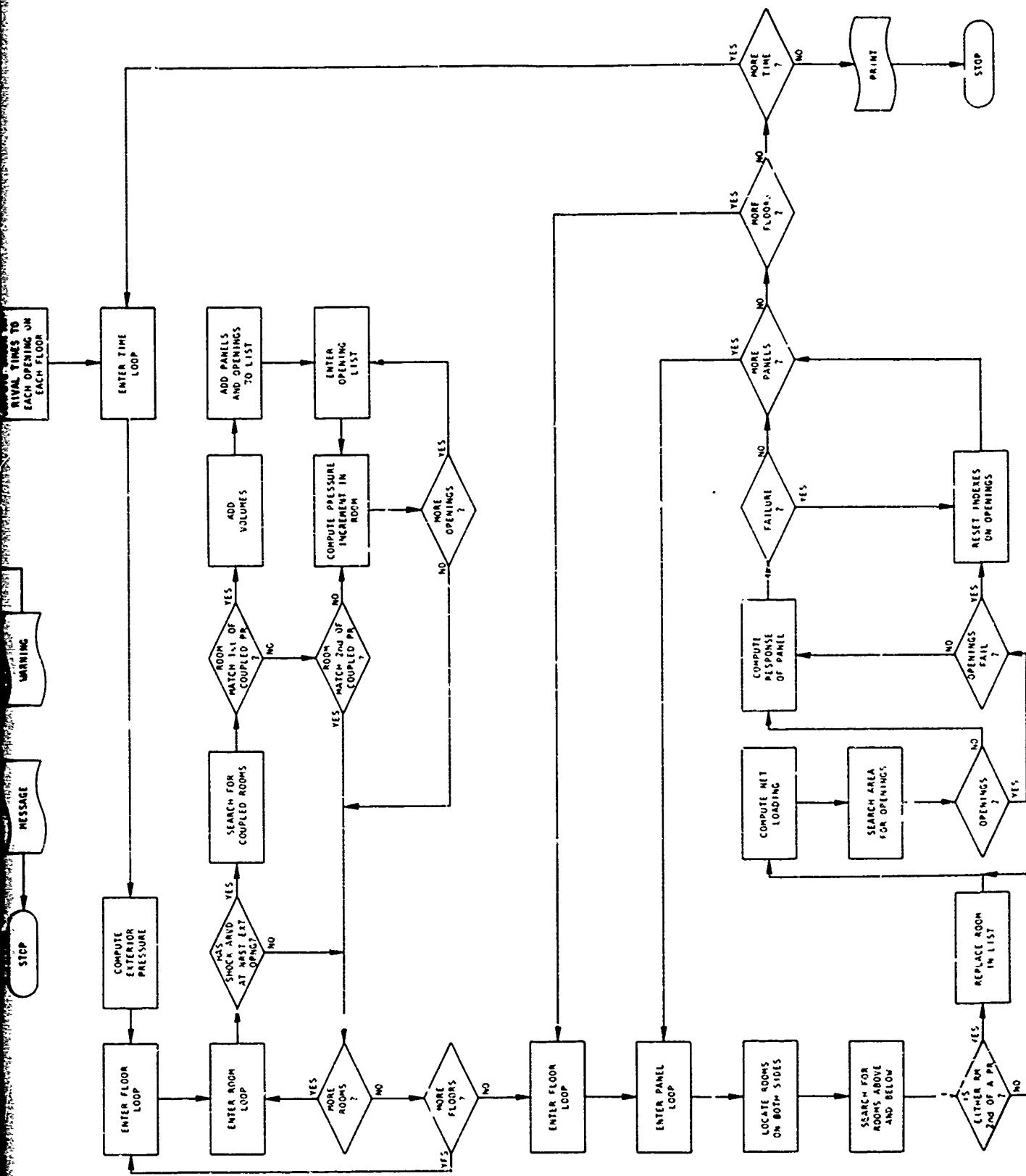


FIGURE 5 BUILDING SUBSYSTEM ORGANIZATIONAL FLOW CHART



#### IV ANALYSIS OF BASEMENT WALLS

The objective of this phase of the effort was to examine the blast resistance of exposed, reinforced concrete basement walls with door openings to determine the feasibility of retrofitting EOCs with blast doors. The primary purpose was to determine if reinforced concrete basement walls located in areaways of existing buildings could resist 10-psi blast overpressure.

##### Approach

In past studies, the collapse strength of blast loaded walls of existing buildings has been determined for various types and configurations of walls. Although mathematical models have been developed for walls with window openings, the procedures were not extended to include walls with door openings. Since there was insufficient time and funds to develop a generalized model and computer program for calculating the resistance and collapse of the wall configuration of interest, the following three-phase approach was used:

(1) A detailed yield-line analysis of several specific reinforced concrete walls with door openings was made to establish the static resistance over a limited range of wall widths.

(2) The computer programs developed for the building evaluation procedure for DCPA for analyzing the collapse of wall elements was used to generate resistance functions for walls without door openings. The results were then compared with those obtained from the yield-line analysis for walls with door openings to determine the feasibility of using the existing computer programs to simulate the dynamic response and

collapse of walls with door openings. If the resistances for the two wall types was found to be not comparable, then it would be necessary to hand calculate a resistance function for each wall case.

(3) An existing finite element computer program was used to analyze the static behavior for a few wall cases with door openings to determine if shear or stress concentrations could conceivably produce a wall failure not predictable by the other analyses.

#### Wall Design

The basement wall considered in this study was located in an open areaway such that the wall and door are fully exposed to the air blast effects. For simplicity, a standard door opening of 3 ft 8 in. wide by 6 ft 8 in. high was adopted; this is a two-unit-of-exit-width door opening as specified in Ref. 15. It was also assumed that the door was closed for all analyses and that it did not fail. The general layout of the basement wall analyzed is shown in Figure 6. As noted in Figure 6, it was assumed that the wall was bounded at the top and bottom by the first story and basement floors, and on the sides by the vertical areaway walls. The basement wall was continuous at the areaway wall intersection, and no interior walls abutted the basement wall in the vicinity of the areaway. The soil backfill adjacent to the areaway and basement walls extended to the first story level.

Since specific wall details were not provided, it was assumed that the basement walls were designed according to the 1963 ACI code (Ref. 16). Pertinent requirements of the code applicable to basement walls are:

- Area of horizontal reinforcing steel is not less than 0.0025 times the area of the reinforced section of the wall.
- Area of vertical reinforcing steel is not less than 0.0015 times the area of the reinforced section of the wall.

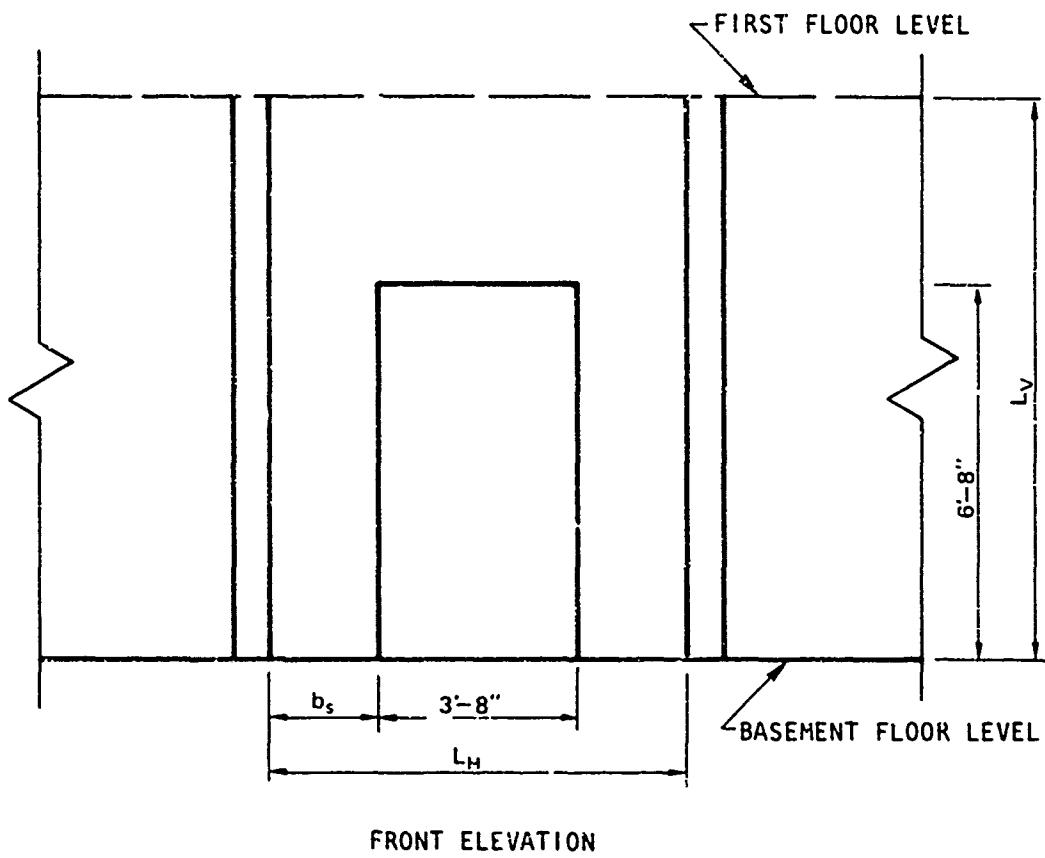
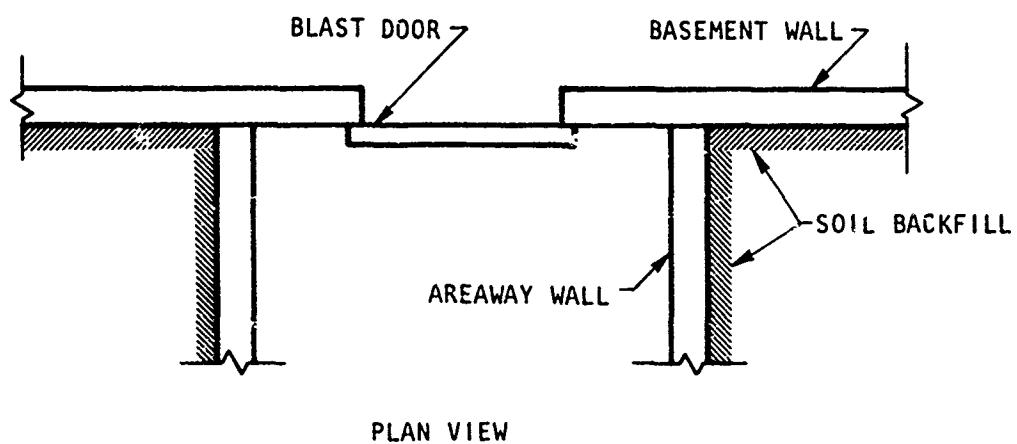


FIGURE 6 PLAN VIEW AND FRONT ELEVATION OF BASEMENT WALL USED IN THE ANALYSIS

- In addition to the above, two No. 5 bars are required around the door opening, and extending a distance of 24 in. beyond the opening.
- Minimum bar size is No. 3 at 18 in., center-to-center.
- Basement wall is assumed to be anchored to the floors and areaway walls with reinforcement equal to that in the wall.
- Minimum basement wall thickness is 8 in.

In addition, since the most efficient use of the reinforcing steel for the basement walls with soil backfill would dictate that the reinforcement be placed near the inside face of the wall, it was assumed that the reinforcement for the basement wall located in the areaway was also near the inside face.

Since it was assumed that the basement wall in the areaway was identical to that with soil backfill, the strength of a basement wall with minimum code reinforcement and with soil backfill was checked for adequacy as follows:

The lateral static soil pressure against the wall is

$$p_h = K_c h \sigma,$$

where  $K_c$  = lateral soil coefficient (assumed as 0.30 for well-drained soil)

$h$  = soil depth

$\sigma$  = unit weight of soil.

For height of wall,  $L_y = 10.0$  ft,

$$p_h = (.3)(10)(100) = 300 \text{ psf (bottom of wall)}.$$

The maximum applied moment for a one-way wall simply supported at the top and bottom and with a triangular load function is

$$M = 0.1283 P_t L_y^2,$$

where  $P_t$  = total applied load.

Therefore, the applied moment is equal to

$$M = (.1283)(300 \times \frac{10}{2})(10) = 1925 \text{ ft-lb/ft} .$$

For a reinforced concrete section with tensile reinforcement only, the ultimate bending moment of the section is

$$M_u = \phi \left[ A_s f_y \left( d - \frac{a}{2} \right) \right]$$

$$\text{where } a = \frac{A_s f_y}{0.85 f'_c b} .$$

For a reinforced concrete basement wall with minimum thickness,  $t_w = 8 \text{ in.}$ , the area of vertical reinforcement is

$$A_s = (8)(12)(.0015) = 0.144 \text{ sq in./ft of wall},$$

$$A_s = \text{No. 3 @ 9 in.},$$

and

$$d = 8 - (\frac{3}{4} + \frac{1}{2} \times \frac{3}{8}) = 7.06 \text{ in.}$$

For  $f'_c = 3000 \text{ psi}$  and  $f_y = 33,000 \text{ psi}$

$$a = \frac{(.144)(33,000)}{(.85)(3000)(12)} = 0.1553,$$

and with a coefficient of flexure  $\phi = 0.90$ , the ultimate bending moment is therefore

$$M_u = (.90) \left[ (.144)(33,000)(7.06 - \frac{.1553}{2}) \right] = 29,862 \text{ in.-lb/ft}$$

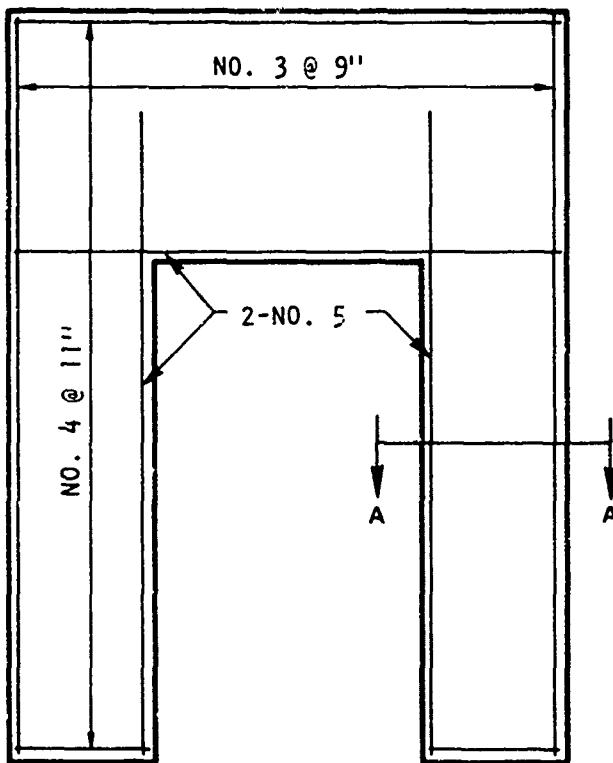
or

$$M_u = 2489 \text{ ft-lb/ft} .$$

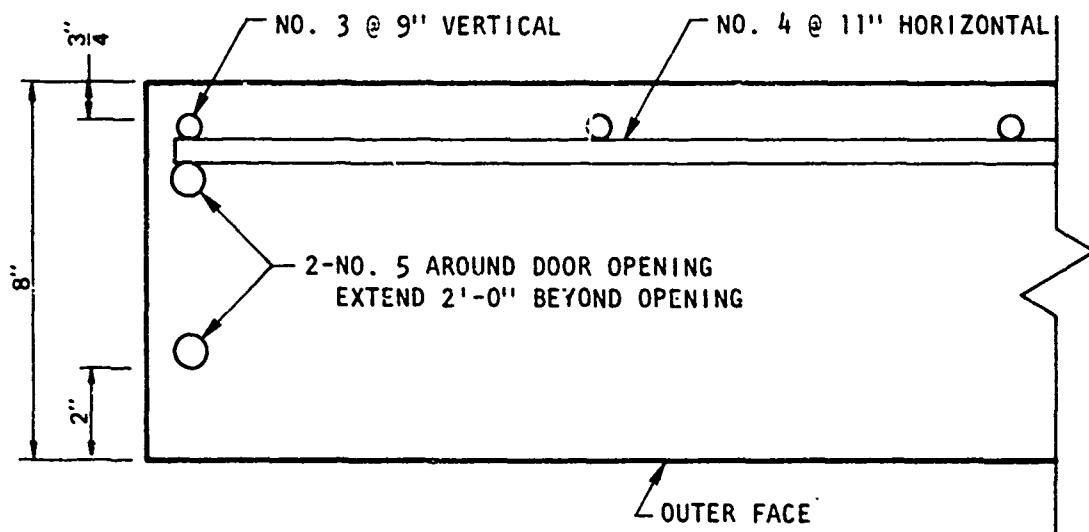
Since  $M_u > M$ , a fully buried, 10-ft-high by 8-in.-thick reinforced concrete basement wall with minimum code reinforcement is adequate to resist the pressure from a well-drained soil. Figure 7 illustrates the reinforcing steel details assumed for the 8-in.-thick basement wall used in the analysis.

### Analysis

Various types of analyses were performed because a mathematical model that adequately represented the dynamic behavior and collapse of



ELEVATION OF BASEMENT WALL



SECTION A-A

FIGURE 7 REINFORCING STEEL DETAILS FOR 8-INCH THICK CONCRETE BASEMENT WALL USED IN ANALYSIS

basement walls with door openings had not been developed previously. The object was to use the available analytical tools to estimate with a good degree of confidence the collapse strength of basement walls in area-ways without actually expending the time and effort required to develop a realistic mathematical model and writing the computer code.

#### Wall With Door Opening

The work-energy method from the yield-line theory for reinforced concrete slabs was used to calculate the flexural resistance for reinforced concrete walls with door openings. The method is outlined in Ref. 4, and will not be repeated here. The purpose of performing a limited number of yield-line analyses was to compare the resistance of walls with door openings with that of walls without door openings. If the resistance values for the two wall types were found to be approximately the same, then the available dynamic computer programs for wall elements could be used to provide interim collapse predictions for a variety of wall cases. However, if the resistances for the two wall types were found to be different, then the resistance values calculated for the walls with door openings could be used to perform a limited number of dynamic analyses.

The reinforcing steel details used for the analysis are shown in Figure 7. Since the calculation of the yield-line moments is a relatively tedious hand calculation requiring trial and error solutions, a minimum number of wall cases was considered. Therefore, only an 8-in.-thick wall with a height of 120 in. was treated; walls were analyzed with widths, L, of 92 in., 116 in., and 140 in. The calculated yield lines and resistance values for the three walls are shown in Figure 8.

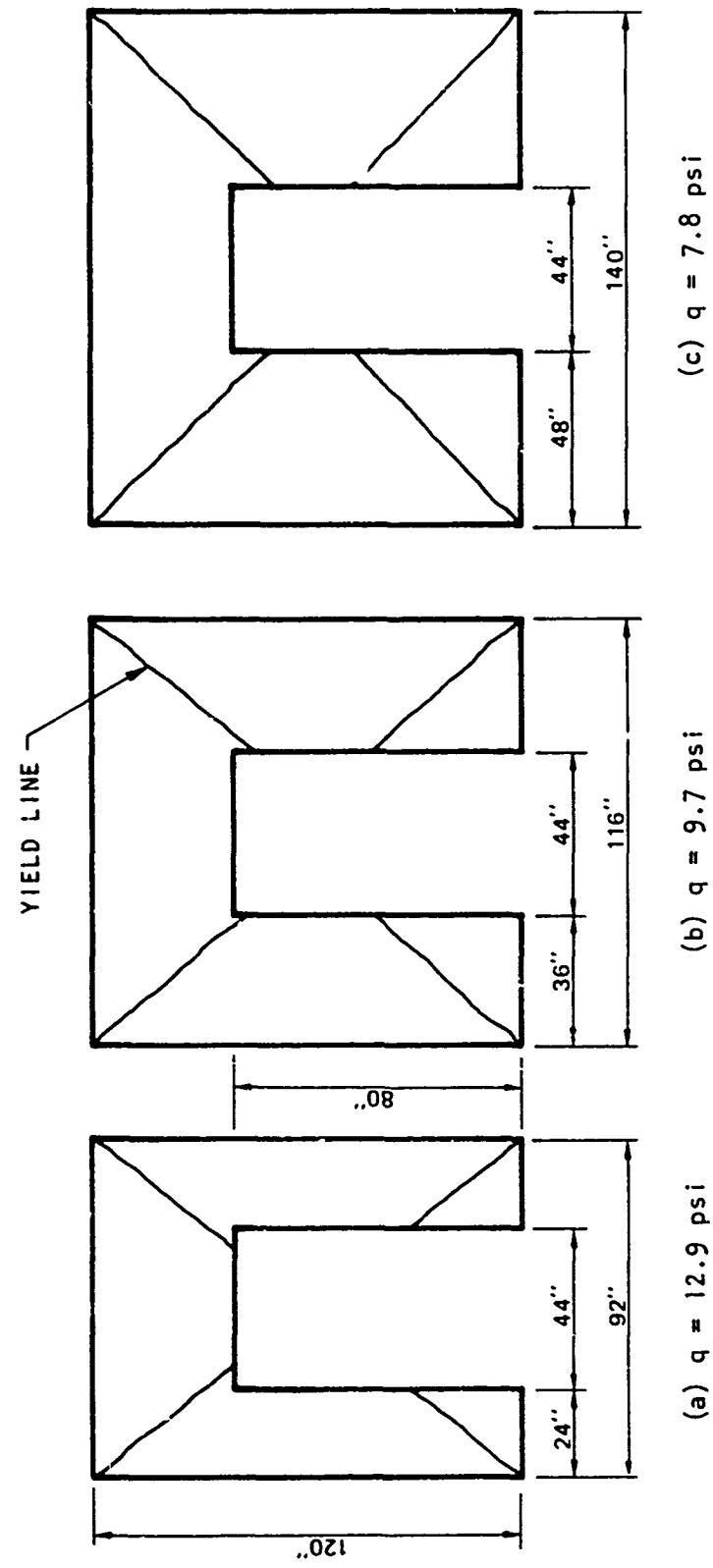


FIGURE 8 YIELD LINES AND RESISTANCE VALUES FOR REINFORCED CONCRETE WALLS WITH DOOR OPENING

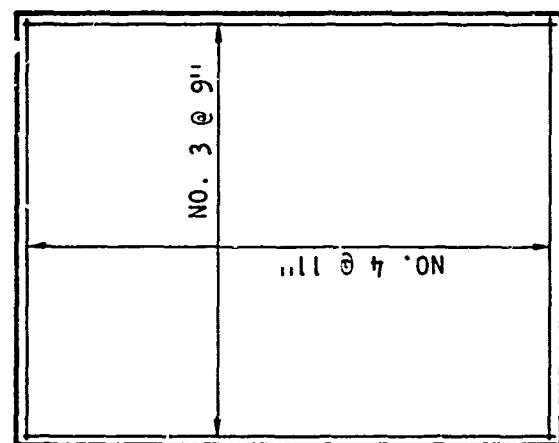
### Wall Without Door Opening

A series of computer runs was made using the SRI programs developed previously for two-way action reinforced concrete walls (Ref. 4). The vertical load,  $P_v$ , in the plane of the wall was assumed to be zero; i.e., the wall was considered as a panel wall that did not carry any loads from the floor levels above. The horizontal and vertical reinforcement for the walls without door openings was the same as that for walls with door openings, except that for walls without door openings the two No. 5 bars around the opening shown in Figure 7 were deleted, as shown in Figure 9.

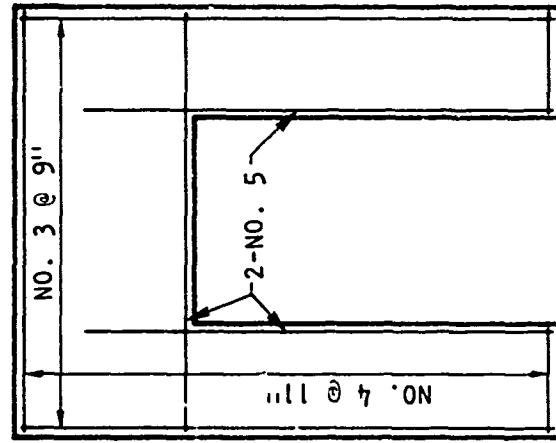
The values of the resistance for walls without door openings are plotted in Figure 10, where they are compared with the resistances calculated by the yield-line theory for walls with door openings. From the figure, it is apparent that the maximum resistance,  $q$ , for the two wall cases is approximately equal for the range of wall widths considered. Based on this limited study, it was assumed for the purpose of performing preliminary dynamic collapse predictions for reinforced concrete basement walls that the flexural resistances of wall with and without a door opening, and reinforced as shown in Figure 9, were equal.

To estimate the collapse of blast loaded basement walls with door openings, dynamic analyses were performed for a range of wall widths, two wall thicknesses, and two wall heights. The results of these analyses are shown in Figure 11. It should be noted that, since it was assumed that the basement walls were panel walls with  $P_v = 0$ , and did not arch, the curves can be considered as lower bound predictions for each wall type shown.

The collapse criterion adopted for walls in the evaluation procedure was based on the collapse of the wall in flexure; as discussed in Ref. 4, collapse is predicted as a result of excessive steel strain, instability, or an excessive ductility ratio. From studies made during the development



(a) Solid Wall Without Door Opening



(b) Wall With 3'-8" x 6'-8" Door Opening

FIGURE 9 WALLS ASSUMED AS EQUIVALENT FOR ANALYSIS PURPOSES

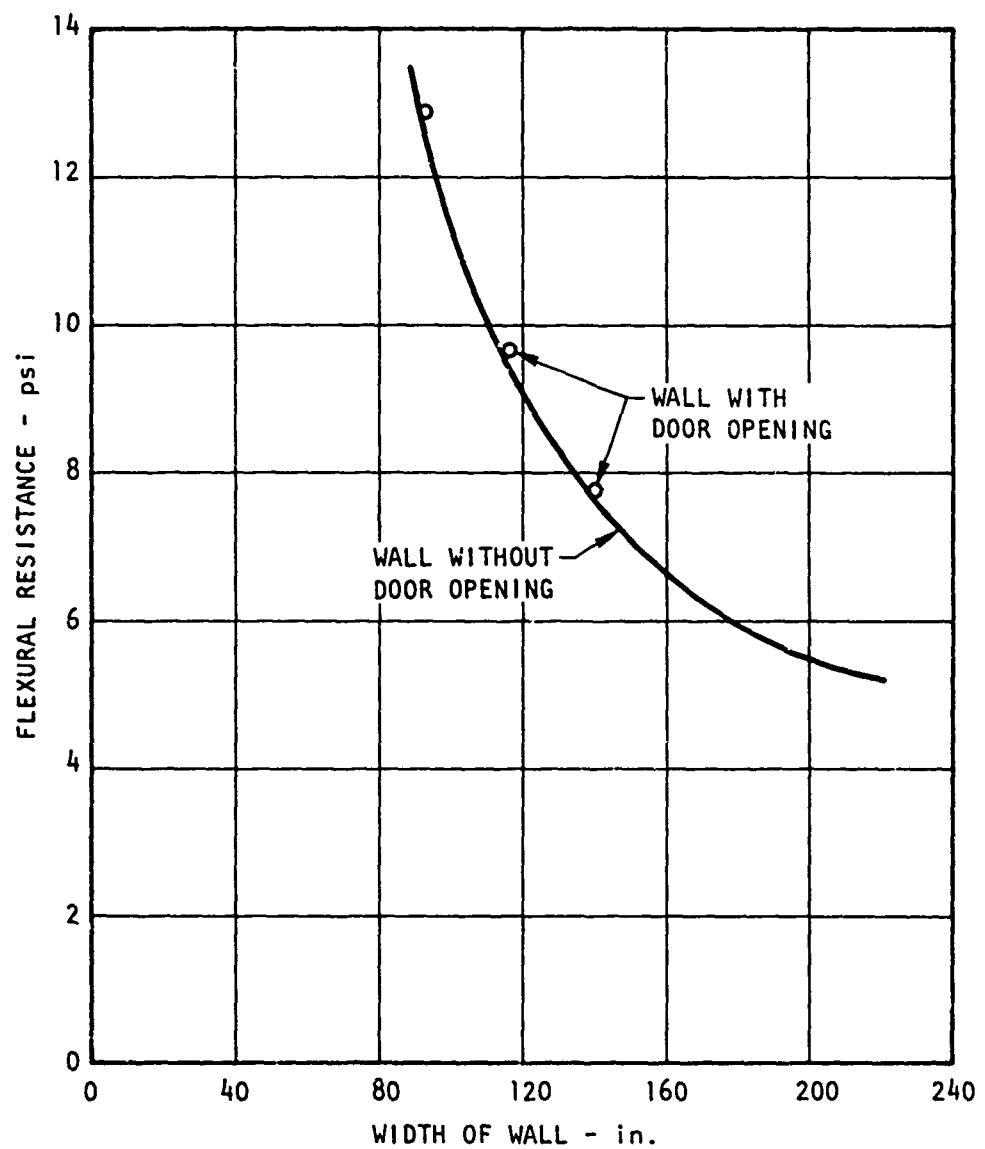


FIGURE 10 COMPARISON OF RESISTANCE VALUES FOR WALLS WITH AND WITHOUT A DOOR OPENING

WALL PARAMETERS

$L_v = 96$  in. and 120 in.  
 $L_h = 92$  in. to 240 in.  
 $t_w = 8$  in. and 12 in.  
 $f'_{dc} = 3,750$  psi  
 $f'_{dy} = 44,000$  psi  
 $p = 0.0025 A_c$  (horizontal)  
 $p = 0.0015 A_c$  (vertical)  
 $\gamma = 145$  pcf  
 $A_w = 0$   
Door opening: 3'-8" x 6'-8"  
Support case: fixed four edges

LOAD PARAMETERS

$W = 1$  Mt  
 $P_v = 0$   
 $S = 6.7$  ft

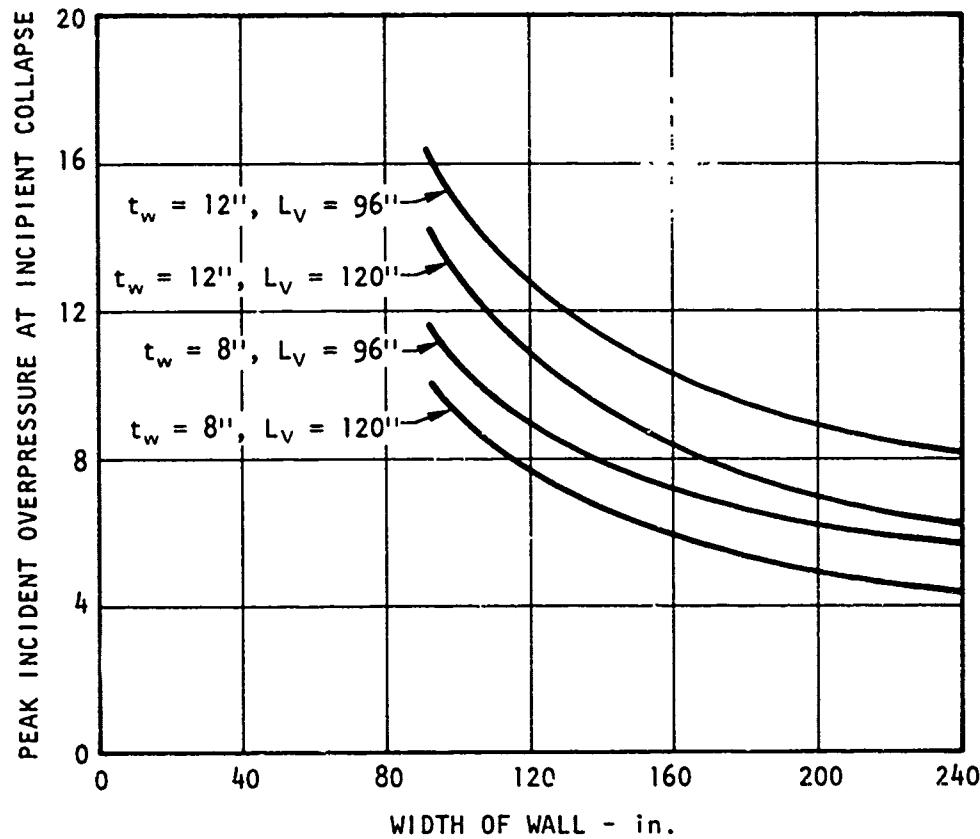
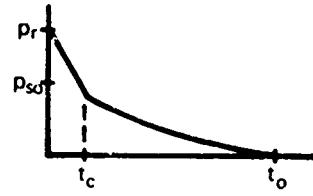
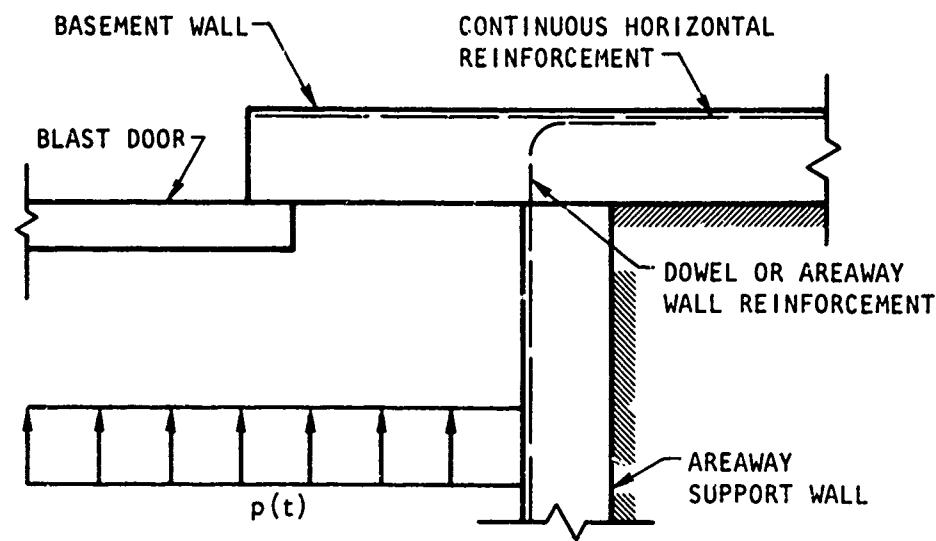


FIGURE 11 PEAK INCIDENT OVERPRESSURE AT INCIPIENT COLLAPSE VERSUS WALL WIDTH

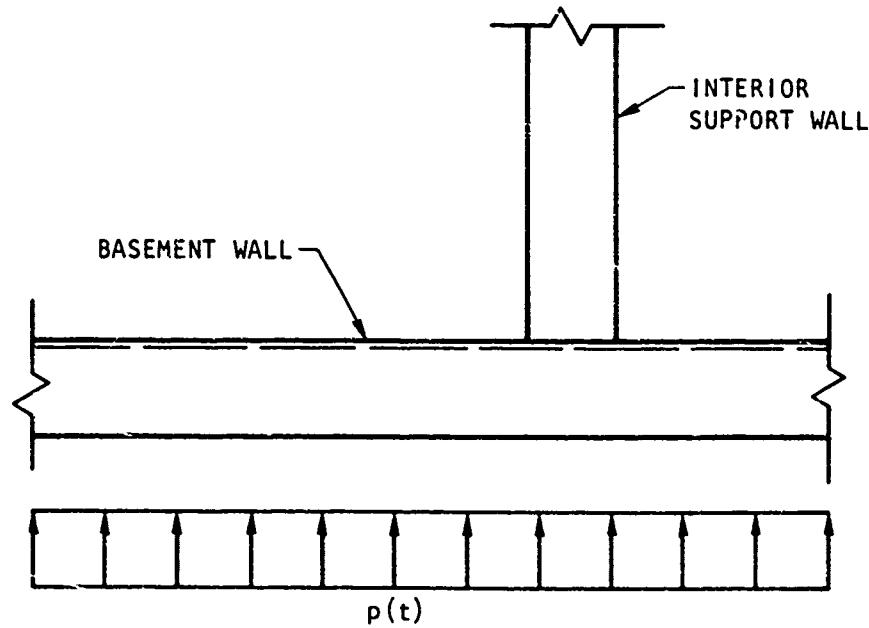
Two-Way Reinforced Concrete Basement Wall In Areaway

of the original wall evaluation procedure, it was determined that for lightly reinforced members with the usual type of supports, a shear failure would not be expected to occur, and if it did, it would not be expected to result in collapse of the wall. However, for the basement walls considered in this study, there were two factors that could influence the collapse mechanism assumed in the original procedure. First, the door opening could produce both higher local shears and stress concentrations than found in solid walls. Second, the reaction of the basement wall at the construction joint between the basement wall and the areaway support wall is opposite in direction to that usually encountered. That is, the reaction places the joint between the basement and areaway walls in tension; the areaway wall provides lateral support to the basement wall only through development of tensile forces in the reinforcing steel continuous through the joint shown in Figure 12a. This, of course, is opposite to the usual case where the lateral load on the wall forces the member to bear directly against its support as shown in Figure 12b.

There are two important implications as a result of the type of lateral support provided by the areaway walls that could influence the collapse predictions of the basement walls shown in Figure 11. First, the reinforcing steel between the basement and areaway walls could fail in tension, which would result in one-way wall action between floor levels rather than two-way action as assumed in the analysis. Second, under the lateral blast load the basement wall cracks along all supports at small elastic deflections as a result of the negative moment developed. As illustrated in Figure 13a, the reinforcing steel is near the inside surface of the basement wall and the effective depth of the steel for resisting this negative moment is measured from the inside wall surface; for the assumed wall this distance,  $d$ , would be only 1-3/8 in. Because of the cracks at the support, the thickness of the concrete available for resisting the shear force is only equal to  $d$ , and therefore a shear

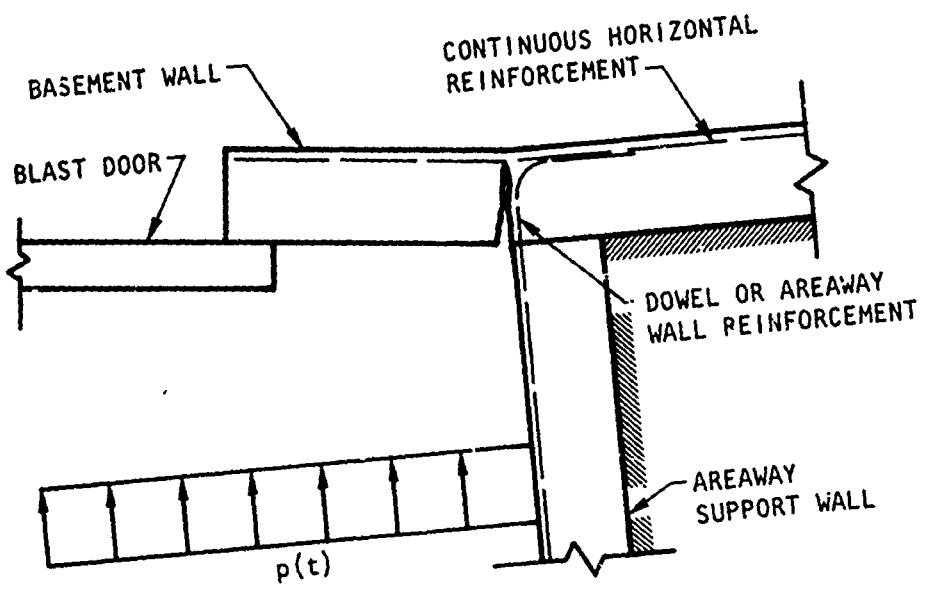


(a) Basement Wall in Areaway

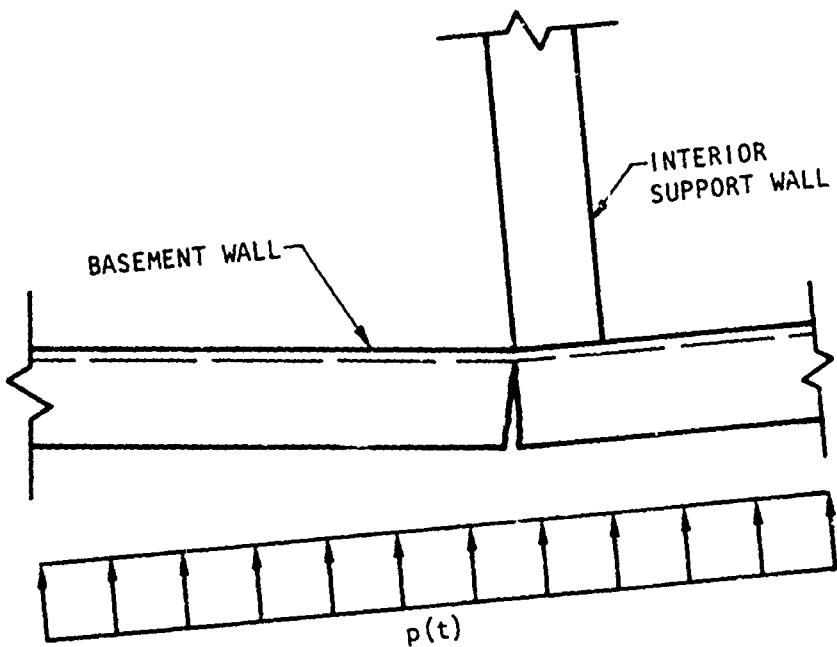


(b) Basement Wall With Interior Support Wall

FIGURE 12 PLAN VIEW OF CONSTRUCTION JOINT AT INTERSECTION OF BASEMENT AND SUPPORT WALLS



(a) Basement Wall in Areaway



(b) Basement Wall With Interior Support Wall

FIGURE 13 PLAN VIEW SHOWING CRACK AT CONSTRUCTION JOINT AT THE INTERSECTION OF BASEMENT AND SUPPORT WALLS

failure could occur early in the wall response. For the type of walls considered when developing the evaluation procedure, the reaction was assumed to act against the lateral interior support wall and a shear failure was not considered as a wall collapse mechanism. That is, a shear failure at the lateral support wall would precipitate a tensile membrane mode of response in the basement wall, rather than a wall collapse, and the reactive forces would be transferred to the support by tensile action of the continuous reinforcement; this is illustrated in Figure 13b. For a basement wall located in an areaway, a shear failure in the wall at the construction joint between the basement and areaway walls would result in rupturing of the concrete and tearing out of the continuous reinforcing steel in the basement wall; the small concrete cover over the reinforcement shown in Figure 13a could not be expected to resist the reactive forces of the basement wall.

Since the mathematical models developed for the evaluation procedures could not be used to investigate the details of localized internal stresses and reactions for the complex door opening wall geometry, an available static finite element computer program was used to estimate probable failure modes.

#### Finite Element Wall Program

Although the available finite element program is a powerful analytical tool, it is limited to static, elastic structural systems. Therefore, the primary value of the results for this study was to provide a basis for estimating possible collapse mechanisms; the results were of only limited quantitative value. The two basic wall configurations analyzed are illustrated in Figure 14; because of symmetry, it was only necessary to consider one-half the wall. The wall model consisted of an assemblage of plate elements, and only the support nodes are numbered on the figure. The useful output information included the deflections, internal loads,

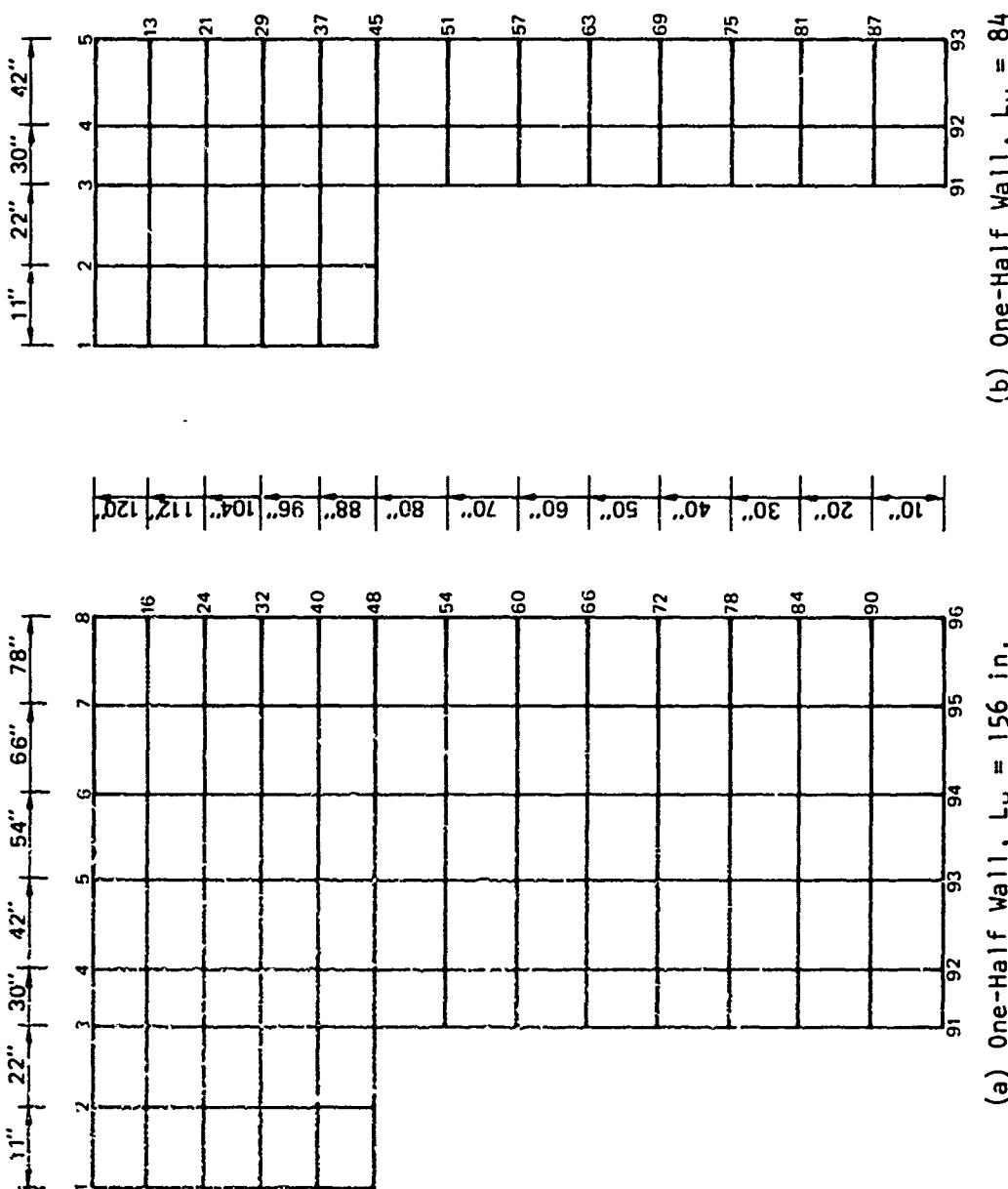


FIGURE 14 WALL WITH DOOR OPENING SHOWING FINITE PLATE ELEMENTS AND NODES

and extreme fiber stresses in the plates, and the reactions at each support node. For this exercise, only an 8-in.-thick wall with a 120-in. height was considered. The walls were analyzed for a static lateral load of 10 psi applied uniformly to the wall and door; the door load was distributed to the wall nodes adjacent to the opening.

The primary reason for conducting the finite element analysis was to provide more detailed information about the reactions at the construction joint formed by the intersection of the basement and areaway walls than was available from the other analyses. For the wall with  $L_w = 156$  in., the following values for the basement wall reactions at the basement/areaway wall joint were obtained for the nodes shown in Figure 11:

<u>Node</u>	<u>Reaction, lb</u>
16	1,904
24	2,915
32	3,801
40	-3,165
48	11,785
54	6,125
60	6,079
66	6,027
72	5,684
78	5,081
84	1,194
90	2,680

The maximum reaction predicted is 11,785 lb at node 48; next is 6,125 lb at node 54. Since the actual wall had continuous support rather than point support at each node, it is appropriate to average the reaction between two adjacent nodes. Therefore, the maximum average applied shear along the basement/areaway wall joint is

$$V = \frac{11,785 + 6,125}{(2)(10)} = 896 \text{ lb/in.}$$

To determine whether this magnitude of applied shear would result in a shear failure in the basement wall, it was necessary to calculate the shear resistance of the wall. From Ref. 7, the unit shear resistance at the support of a reinforced concrete member is

$$(v_c)_s = \frac{2.28\sqrt{f'_c}}{1-2d/L} + \frac{3000p}{1-d/L} \leq \frac{3.5\sqrt{f'_c}}{1-2d/L}$$

For the basement wall, the horizontal reinforcement is

$$A_s = 0.240 \text{ sq in./ft},$$

and  $d = 1.38$  in. for a raked concrete section, therefore

$$p = \frac{0.240}{(12)(1.38)} = 0.01449.$$

Substituting these quantities into the above equation, the unit shear is

$$(v_c)_s = \frac{2.28\sqrt{3000}}{1-(2)(1.38)} + \frac{(3000)(.01449)}{1-\frac{1.38}{156}} = 171 \text{ psi.}$$

Since the total shear resistance at the support would be

$$(V_c)_s = (v_c)_s bd,$$

then

$$(V_c)_s = (171)(1)(1.38) = 236 \text{ lb/in.}$$

This value is, of course, much less than the shear force of 896 lb/in. resulting from a uniform static load of 10 psi. For estimating purposes only, if it is assumed that the dynamic shear resistance is 25 percent greater than the static, and that a dynamic load factor (DLF) of 1.15 is appropriate for the load type, then a rough estimate of the level of the blast load that would result in a shear failure in the wall would be

$$p_{sf} \approx \frac{(236)(1.25)(10)}{(1.15)(896)} \approx 2.9 \text{ psi.}$$

For the basement wall with  $L_w = 84$  in., two wall cases were considered; (1) simply supported on four edges, and (2) fixed on four edges. The values of the reactions along the basement/areaway wall joint for the simply supported wall with a 10-psi static load were as follows:

<u>Node</u>	Reaction, <u>1b</u>
13	1,520
21	2,318
29	3,087
37	-3,839
45	7,764
51	3,924
57	3,820
63	3,976
69	4,027
75	3,904
81	3,531
87	2,467

Using the same method as before for two adjacent nodes, the predicted maximum average shear along the basement/areaway wall joint is

$$V = \frac{776.4 + 3924}{(2)(10)} = 58.4 \text{ lb/in.}$$

Again, a rough estimate of the blast overpressure that would result in a shear failure in the basement wall would be

$$p_{ss} \approx \frac{(236)(1.25)(10)}{(1.13)(58.4)} \approx 4.4 \text{ psi.}$$

Based on the above rough estimates for 8-in.-thick reinforced concrete walls with door openings, it could be concluded that a shear failure will occur at blast overpressures less than 5 psi if the horizontal distance from the edge of the door opening to the areaway wall is greater than about 18 in., i.e., for  $L_d \geq 80$  in. However, since this estimate is based on a cracked concrete section, it is of interest to examine the effect on the strength of the wall of the concrete cracking along the supports.

As the exposed horizontal distance between the edge of the door opening and the areaway support wall is increased, the probability of a shear failure occurring in the basement wall is also increased. For example, if the horizontal distance is equal to the wall thickness,

$t_w = 8$  in. ( $L_w = 60$  in.), then the full thickness of the concrete wall section is effective in resisting the applied shear force because the modulus of rupture of the concrete has not been exceeded and the concrete section is uncracked. Since the shear resistance for this case is much greater than the applied shear, the wall would not be expected to experience a shear failure. As the width of the wall is increased to 84 in., the values of the reactions and moments along the basement/areaway joint for an 8-in.-thick concrete wall fixed on four edges and with a 10-psi static load are as follows:

<u>Node</u>	<u>Reaction, lb</u>	<u>Moment in.-lb</u>
13	-26	1,149
21	1,187	10,813
29	1,738	20,043
37	2,726	37,845
45	5,031	55,746
51	3,786	49,166
57	4,076	52,550
63	4,267	54,022
69	4,329	52,165
75	4,103	45,468
81	3,125	31,006
87	167	7,190

The maximum moment predicted for two adjacent nodes is 52,550 in.-lb for node 57; next is 54,022 in.-lb for node 63. Therefore, the maximum average moment along the basement/areaway wall joint is

$$M = \frac{52,550 + 54,022}{(2)(10)} = 5329 \text{ in.-lb/in.}$$

To estimate if the wall cracks under the applied moment, it is necessary to calculate the resisting moment for the uncracked wall section. For a linear relationship between stress and strain across the section of the wall, the maximum resisting moment is equal to

$$M_u = \frac{f_u b t_w^3}{6} .$$

For

$$f_r = 8\sqrt{f'_{c_e}},$$
$$M_u = \frac{(8)\sqrt{3750}(1)(8)^2}{6} = 5226 \text{ in.-lb/in.},$$

which is approximately equal to the applied moment. Therefore, an 8-in.-thick concrete wall with a horizontal distance between the edge of the door and the areaway support wall of about 20 in. ( $L_u = 8.4$  in.) would be expected to crack and experience a shear failure along the basement/areaway wall joint at a blast overpressure level somewhat less than 10 psi. This, of course, indicates a much greater blast strength for the un-cracked wall case than was estimated above for the cracked wall case.

#### One-Way Reinforced Concrete Wall (Without Arching)

As discussed in the previous subsection, under dynamic load the initial shear failure in an 8-in.-thick, two-way reinforced concrete basement wall located in an areaway would occur at the points of maximum shear along the joint between the basement and areaway walls at relatively small wall deflections. The shear failure would result in the initiation of one-way wall action (i.e., the lateral support of the areaway wall would be lost) at a time shortly after arrival of the blast wave. However, as noted in the above tabulations for the nodes shown in Figure 14, the shear forces developed as a result of a 10-psf uniform static load decreased in magnitude from a maximum in the center portion of the wall to a minimum near the top and bottom supports; in particular, the shear forces at the nodes above the level of the door opening are much less than the maximum shear values. It is therefore reasonable to assume that under blast loading the one-way action wall without arching will have an effective span somewhat less than the total height of the basement wall. Therefore, for this study, the effective wall height for

for one-way action was assumed equal to the height of the door opening. The collapse overpressure was obtained for walls with the following properties and load conditions:

$L_v$  = 80 in.  
 $L_w$  = 92 to 360 in.  
 $t_w$  = 8 in.  
 $f'_{ac}$  = 3,750 psi  
 $f_{sy}$  = 44,000 psi  
 $p$  = 0.0015  $A_e$  (vertical)  
 $\gamma$  = 145pcf  
 $P_v$  = 0  
Support case: one-way propped cantilever  
 $S$  = 6.7 ft  
 $W$  = 1 Mt

The collapse of these basement walls is predicted to occur at a blast overpressure of approximately 4.5 psi for all wall widths from  $L_w$  = 92 in to 360 in. For comparison, the collapse overpressure was also obtained for a 12-in.-thick reinforced concrete basement wall with the same properties as for the above 8-in. wall. The predicted collapse overpressure for the 12-in.-thick wall was found to be 9.2 psi for the same range of wall widths.

#### One-Way Concrete Wall (With Arching)

For a frame structure, it is possible that one-way arching, rather than one-way flexure, may occur in the basement wall subsequent to a shear failure at the basement/areaway wall construction joint. Therefore, calculations were performed to determine the blast strength of one-way arching walls. Since arching walls develop considerable more resistance than similar nonarching walls, it was felt to be more meaningful to use

the full height of arching walls in the analysis, rather than the height of the door opening as was done for nonarching walls. The collapse overpressure was obtained for a wall with the following properties and load conditions:

$$L_t = 120 \text{ in.}$$

$$L_u = 92 \text{ to } 360 \text{ in.}$$

$$t_w = 8 \text{ in.}$$

$$f'_s = 3,750 \text{ psi}$$

$$\gamma = 1.45 \text{ pcf}$$

Support case: one-way arching

$$S = 6.7 \text{ ft.}$$

$$W = 1 \text{ Mt}$$

The collapse of these basement walls is predicted to increase from a blast overpressure level of 6.9 psi for  $L_u = 92$  in. to 10.1 psi for  $L_u = 360$  in. The results of the analyses for both the one-way concrete walls with arching and without arching are shown in Figure 15.

#### Summary and Discussion

The primary purpose of this effort was to examine the dynamic response of conventional reinforced concrete basement walls located in areaways, and determine if such walls can resist a 10-psi blast overpressure. Since an adequate analytical model for predicting the collapse of basement walls with door openings was not available, it was necessary to perform several types of analyses so as to make a realistic estimate of the collapse strength of the walls. To provide uniformity for the various analyses, a standard basement wall with door opening was designed in accordance with the 1963 ACI code for reinforced concrete.

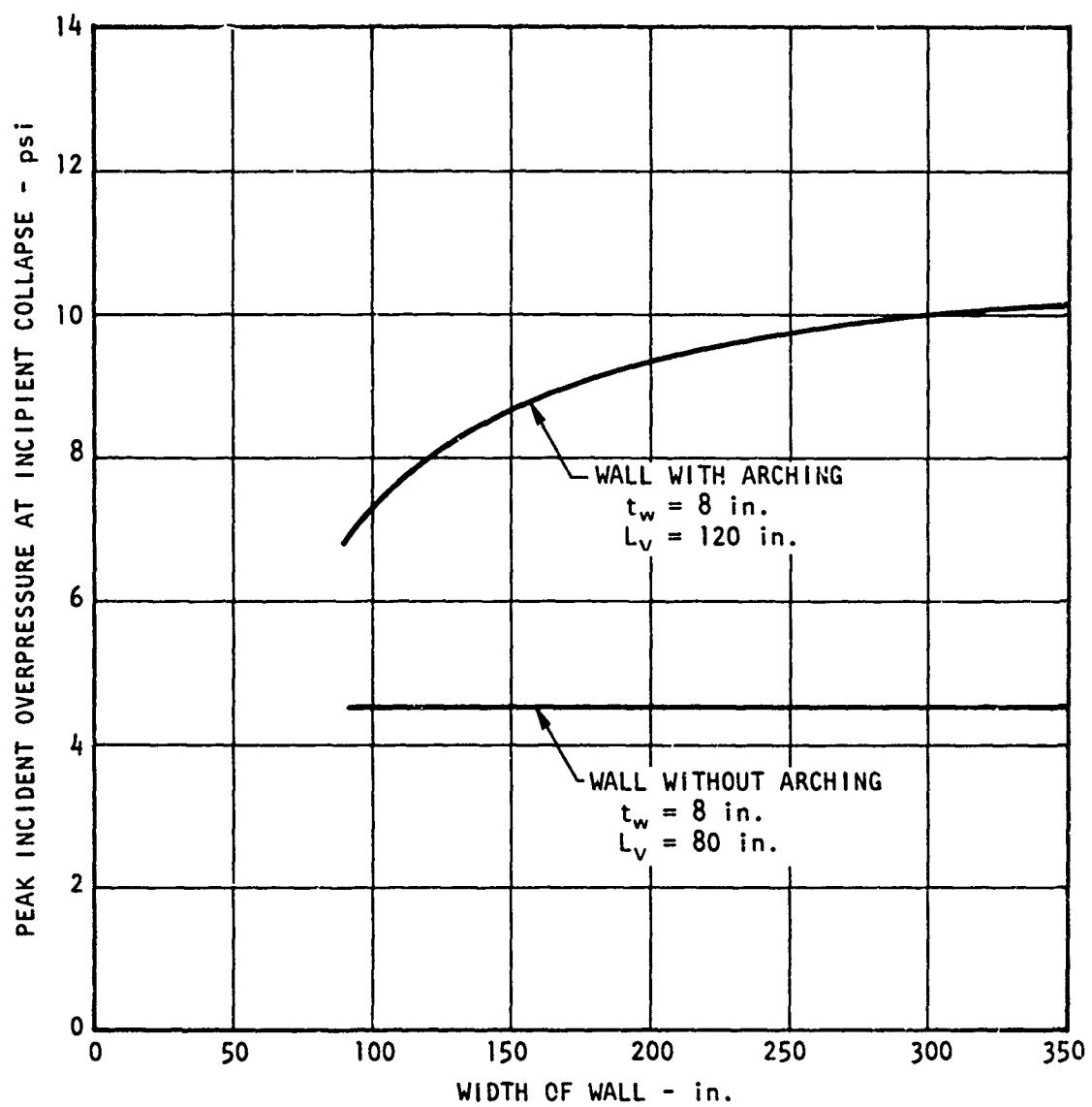


FIGURE 15 PEAK INCIDENT OVERPRESSURE AT INCIPIENT COLLAPSE  
VERSUS WALL WIDTH

One-Way Reinforced Concrete Basement Wall Without Arching  
One-Way Concrete Basement Wall With Arching

An initial static analysis was made to compare the flexural resistances of two-way reinforced concrete walls with and without door openings. The results of this analysis (Figure 10) indicated that the flexural resistances of the two walls shown in Figure 9 were approximately equivalent. It was therefore warranted to use an available computer program to perform dynamic analyses of walls without door openings, and then to use these results for estimating the collapse overpressure of basement walls with door openings. The predicted collapse overpressures for two-way walls without door openings are shown in Figure 11 for 8- and 12-in.-thick reinforced concrete walls with wall heights of 96 and 120 in.

However, although the results of this analysis appeared reasonable, there was some concern because the available analytical model could not provide sufficient detailed information on the effect of the complex door opening geometry on the response of the wall. Therefore, an available static finite element computer program was used to analyze an 8-in.-thick two-way wall. The results for a 10-psi uniform lateral static load indicated that a shear failure was probable at the construction joint between the basement and areaway walls shown in Figure 12a. From the analysis of two walls with different widths, it was concluded that a shear failure would occur at relatively low overpressure levels if the areaway wall was located greater than about 20-in. horizontal distance from the edge of the door opening. However, a shear failure in the basement wall at the basement/areaway wall joint does not necessarily result in collapse of the basement wall, since the wall may still resist the applied blast forces through one-way flexural or arching action between top and bottom supports subsequent to the shear failure and loss of side supports.

To determine the effect of a shear failure at the basement/areaway wall joint on the collapse strength of two-way walls, dynamic analyses

were performed for one-way basement walls, both with and without arching. The results of the analyses are indicated in Figure 15, where it can be noted that 8-in.-thick reinforced concrete basement walls without arching are predicted to collapse at less than 5-psi blast overpressure. Although the predicted collapse overpressure for arching walls is much greater than for nonarching walls, for most of the wall widths examined the strength of arching walls is less than the 10-psi blast overpressure criterion. It should be mentioned that these results apply to the minimum thickness reinforced concrete basement wall, which has the minimum area of steel reinforcement permitted by the 1963 ACI building code for reinforced concrete.

### Conclusions

From the various analyses performed, a few general conclusions can be made concerning the collapse of blast loaded reinforced concrete basement walls with door openings and located in areaways. First, for reinforced concrete walls 8-in. thick or thicker, and not over 10-ft high, it is probable that the wall strength of the weakest code-designed wall is sufficient to resist a 10-psi blast loading if the horizontal distance from the edge of the door opening to the areaway support wall is less than approximately 20 in. ( $L_{\text{u}} = 84$  in.).

Second, for 8-in.-thick walls with horizontal distance between door opening and areaway wall greater than about 20 in., it will be necessary to strengthen the wall in the vicinity of the door opening so as to upgrade the wall to the 10-psi blast overpressure level.

Third, for reinforced concrete basement walls 12-in. thick or thicker, the blast strength can be expected to be approximately equal to or greater than the 10-psi blast overpressure criterion for all wall conditions.

Appendix A  
LISTINGS OF COMPUTER PROGRAMS

## Appendix A

### LISTINGS OF COMPUTER PROGRAMS

#### Introduction

This appendix contains a printout of the listing for each program developed for DCPA for analyzing the dynamic response and collapse of walls and floor systems of existing buildings.

The programs were coded in FORTRAN and run on United Computing Systems, Inc., commercial time-sharing CDC 6400 computer (System UCS-VI); running on other systems may require minor modifications to the programs. For convenience and ease of use during the research effort, as well as by others later, the programs were written in an interactive or conversational mode.

To reduce the size of the computer central memory required, and thereby reduce the cost of running the programs, the Link Mode or chaining technique was used for the larger programs. Chaining has the advantage of reducing the overall cost of running programs, but a slightly more complicated technique is required to compile the programs in preparation for execution. Half of the programs were developed as chained programs.

Also included in this appendix are short summaries describing the function of each of the following eight programs:

- UNREINF, Unreinforced masonry wall without arching, see page 63
- ARCHING, Unreinforced masonry wall with arching, see page 81
- RCWALL, Reinforced concrete wall,\* see page 95

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\* Link Mode or chained program.

- RCSLAB, Reinforced concrete slab,\* see page 115
- RESTRAN, Restrained reinforced concrete slab, see page 133
- RCBEAM, Reinforced concrete support beam,\* see page 147
- STBEAM, Steel support beam,\* see page 165
- FLAT, Flat slab or flat plate, see page 181.

Following the summaries are the listings of the programs.

#### Summary of Computer Programs

##### Program UNREINF

Analyzes one-way and two-way unreinforced masonry walls (exterior or interior) without arching for a given load, or solves for incipient collapse load. Window openings may be included. Load types include: idealized blast loading (front, side, or rear face) with or without room filling; triangular load; rectangular load; URS tunnel loading; arbitrary load shape. Modulus of rupture and clearing distance may be randomly varied (normal distribution).

Subroutine:	Main Routine	COEF
	FORCE	TRANS
	FILL	WINDOW
	RESIST	RANDOM

##### Program ARCHING

Analyzes one-way and two-way unreinforced masonry walls (exterior or interior) with arching for a given load, or solves for incipient collapse load. Window openings may be included. Load types include: idealized blast loading (front, side, or rear face) with or without room filling; triangular load; rectangular load; URS tunnel loading; arbitrary load shape. Ultimate compressive strength, modulus of elasticity, and clearing distance may be randomly varied (normal distribution).

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\* Link Mode or chained program.

Subroutines:	Main Routine	RESIST
	FORCE	WINDOW
	FILL	RANDOM

Program RCWALL

Analyzes one-way and two-way reinforced concrete walls (exterior or interior) for a given load, or solves for incipient collapse load. Window openings may be included. Load types include: idealized blast loading (front, side, or rear face) with or without room filling; arbitrary load shape. Dynamic yield strength of reinforcement steel and clearing distance may be randomly varied (normal distribution).

Subroutines:	RCWALL1	RESIST
	WINDOW	MOMENT
	RCWALL2	COEF
	FORCE	TRANS
	FILL	RANDOM

Program RCSLAB

Analyzes one-way and two-way reinforced concrete floor slabs for a given load, or solves for incipient collapse load. Tensile membrane resistance may be included. Dynamic reactions may be output to a data file for use in analyzing support beams. Load types include: idealized blast loading (top face) with rise time equal to time required for blast wave to travel across short span; room filling pressure resulting from idealized blast loading; arbitrary load shape. Dynamic yield strength of reinforcement steel and clearing distance (for room filling load) may be randomly varied (normal distribution).

Subroutines:	RCSLAB1	RESIST
	COEF	MOMENT
	RCSLAB2	TRANS
	FORCE	RANDOM
	FILL	

Program RESTRAN

Analyzes two-way reinforced concrete floor slabs with edges restrained against lateral movement for a given load, or solves for incipient collapse load. Both compressive and tensile membrane behavior are included. Load types include: idealized blast loading (top face) with rise time equal to time required for blast wave to travel across short span; room filling pressure resulting from idealized blast loading; arbitrary load shape. Yield strength of reinforcement steel, concrete compressive strength, and clearing distance (for room filling load) may be randomly varied (normal distribution).

Subroutines:	Main Routine	MOMENT
	FORCE	TRANS
	FILL	RANDOM
	RESIST	

Program RCBEAM

Analyzes reinforced concrete beams (rectangular or T-beam) for a given load, or solves for incipient collapse load. Tensile membrane resistance may be included. Load types include: dynamic reactions from slab analysis (see RCSLAB); idealized blast loading acting on beam and area of slab supported by the beam with rise time equal to time required for blast wave to travel length of the beam; room filling pressure resulting from idealized blast loading acting on beam and area of slab supported by the beam; arbitrary load shape. Dynamic yield strength of reinforcement steel and clearing distance (for room filling load) may be randomly varied (normal distribution).

Subroutines:	RCBEAM1	RESIST
	RCBEAM2	MOMENT
	FORCE	COEF
	FILL	TRANS
		RANDOM

Program STBEAM

Analyzes structural steel beam (wide flange may include bottom steel cover plate and/or composite action with slab) for a given load, or solves for incipient collapse load. Load types include: dynamic reactions from slab analysis (see RCSLAB); idealized blast loading acting on beam and area of slab supported by the beam with rise time equal to time required for blast wave to travel length of the beam; room filling pressure resulting from idealized blast loading acting on beam and area of slab supported by the beam; arbitrary load shape. Dynamic yield strength of structural steel, dynamic yield strength of reinforcement steel (composite beam), and clearing distance (for room filling load) may be randomly varied (normal distribution).

Subroutines:	STBEAM1	RESIST
	STBEAM2	COEF
	FORCE	TRANS
	FILL	RANDOM

Program FLAT

Analyzes reinforced concrete flat slab floor system or flat plate floor system for a given load, or solves for incipient collapse load. Tensile membrane resistance may be included. Load types include: idealized blast load (top face) with rise time equal to the time required for blast wave to travel across span (slab assumed to be square); room filling pressure resulting from idealized blast loading; arbitrary load shape. Dynamic yield strength of reinforcement steel and clearing distance (for room filling load) may be randomly varied (normal distribution).

Subroutines:	Main Routine	RESIST
	FORCE	MOMENT
	FILL	RANDOM

UNREINF

Unreinforced Masonry Wall Without Arching

PROGRAM UNREINF

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01000 PROGRAM JIMRAC(INPUT,OUTPUT,TAPE1=3,PUTPUT)
01010C: THIS ROUTINE IS THE CONTROLLING ROUTINE FOR THE PROGRAM USED
01020C: IN THE ANALYSIS OF ONE-WAY OR TWO-WAY ACTION WALLS.
01030C
01040 COMMON Y(100),YU,YFAIL,D,DU,AREA,ZL4,VH1,VH2,VV1,VV2
01050 CMM3N <WALL,<IVC,<RF,<RAND,I,ICASE,FJ,VFAIL,FR,FP4,EM,FDY
01060 CMM3N FDC(4),LDTYPE,PEXT,PF,PS3,PDB,PC,TC,T0,P3,TIME,L,S
01070 CMM3N /RAND/ TIMEC,IWALL
01080 DIMENSION A(100),V(100),T(100),VV(100),VH(100),
01090+ PEX(100),PIV(100),PV(100)
01100C
01110C: READ TITLE AND CONTROL PARAMETERS
01120 S PRINT 67
01130 READ 68,TITLE
01140 PRINT 95
01150 READ,<WALL <IVC,LDTYPE,<RF,<RAND
01160 DELAY=0
01170 VFAIL=1E10
01180 CALL RESIST(1)
01190 CALL F3RCE(1)
01200 IF(<RF.EQ.0)GOT 12
01210 CALL FILL(PINT,1)
01220 12 IF(<WALL.EQ.0)GOT 14
01230 PRINT 96
01240 READ,DELAY
01250 DELAY=DELAY/1000.0
01260 14 IF(<RAND.NE.1)GOT 35
01270 CALL F3RCE(4)
01280 CALL RANDM(1)
01290 34 CALL RANDM(2)
01300 35 CALL RESIST(3)
01310C
01320C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
01330C: WHERE THE LOAD CAUSING INCIPIENT COLLAPSE IS TO BE FOUND
01340 13 IF(<IVC.EQ.0)GOT 23
01350 PF=0.0
01360 PFMAX=0
01370 PFMIN=PF/2.0
01380 GOT 20
01390 16 PF=(PFMIN+PFMAX)/2.0
01400 20 CALL F3RCE(2)
01410 23 IF(<RF.EQ.0)GOT 24
01420 CALL FILL(PINT,2)
01430C
01440C: INITIALIZE VALUES FOR BETA METHOD (BETA = 1/6) AND COMPUTE VALUE
01450C: FOR FIRST TIME INTERVAL ASSUMING WALL INITIALLY AT REST
01460 24 I=1
01470 TIME=0
01480 T(1)=0$ V(1)=0$ Y(1)=0
01490 DELTA=0.001
01500 GOT 29
01510 27 IF(TIME.GE.(DELAY-0.00001))GOT 29
01520 TIME=TIME+DELTA
01530 CALL FILL(PINT,3)
01540 GOT 27
01550 PIV(1)=PINT
01560 TPNET=AREA*PIV
01570 28 PIV(1)=PINT
01580 TPNET=AREA*PIV
01590 T(1)=TIME
01600 GOT 30
01610 29 CALL F3RCE(3)
01620 PEX(1)=PEXT
01630 TPNET=AREA*PEXT
01640 30 PV(1)=PEXT
01650 CALL RESIST(2)
01660 A(1)=TPNET/(2*MASS*Z(L4))
01670 VV(1)=VV1*TPNET
01680 VH(1)=VH1*TPNET
01690C: PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
01700 1 I=I+1
01710 IF(I.LT.101)GOT 11
01720 PRINT 98,TIME
01730 98 FORMAT(/,*,I=101: TIME =,,F6.3,,*) WALL ASSUMED TO NOT FAIL*
01740 GOT 6

```

PROGRAM UNREINF (CONTINUED)

```

01750 11    TIME=TIME+DELTA
01760    T(I)=TIME
01770    A(I)=A(I-1)
01780    .L FORCE(3)
01790    -PEX(I)=PEXT
01800    IF((<WALL.EQ.1)GOTO 10
01810    IF((KRF.EQ.0)GOTO 3
01820    CALL FILL(PINT,3)
01830    PIN(I)=PINT
01840    TPNET=AREA*(PEX1-PINT)
01850    GOTO 2
01860  3    TPNET=AREA*PEXT
01870    GOTO 2
01880  10   CALL FILL(PINT,3)
01890    PIN(I)=PINT
01900    TPNET=AREA*PINT
01910  2    PV(I)=TPNET/AREA
01920    DO 9 JJ=1,10
01930    Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
01940    CALL RESIST(2)
01950    QT=Q*AREA
01960  4    ANEW=(TPNET-QT)/(2455423L4)
01970    ADELTA=ANEW-A(I)
01980    A(I)=ANEW
01995  IF(ANEW.EQ.0)PRINT *19454, TIME, TPNET, QT, QRES, /Q(L4,Y(I),A(I-1))
02000    IF(ARCS(ADELT,A/(ANEW+1.0E-10)),LT.0.0)GOTO 9
02000  4    CONTINUE
02010    A(I)=ANEW-ADELTA/2.0
02020    WRITE(1,90) TIME, PFA(I), Y(I)
02030  9    CONTINUE
02040    Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
02050    V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
02060    VV(I)=VV1+TPNET+VV2*QT
02070    VH(I)=V41+TPNET+V42*QT
02080    IF(VV(I).GT.VFAIL)GOTO 7
02090C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE OF WALL
02100C: IF MAX DEFLECTION REACHED, WALL DID NOT FAIL
02120    IF(Y(I).LE.Y(I-1).AND.PV(I).LE.PV(I-1))GOTO 6
02130    IF(Y(I).LT.0)GOTO 6
02140    IF(TIME-DELAY.GE.0.01)DELTA=0.002
02150    IF(Y(I).LT.YJ)GOTO 1
02160    IF(TIME-DELAY.GE.0.02)DELTA=0.005
02170    IF(TIME-DELAY.GE.0.10)DELTA=0.010
02180    IF(TIME-DELAY.GE.0.50)DELTA=0.050
02190C: IF FAILING DEFLECTION REACHED, WALL FAILED
02200    IF(Y(I).GE.YFAIL)GOTO 7
02210    GOTO 1
02220C: INTERVAL HALVING PROCEDURE TO DETERMINE L340 CAUSING INCIDENT
02240C: COLLAPSE FOR CASES WHERE DESIRED
02250C: WALL DID NOT FAIL - SET PFAIV TO PF
02260  6    CONTINUE
02270    IF((KRF1.EQ.1)GOTO 36
02280    IF((<INC.EQ.0)GOTO 19
02290  36   PFAIV=PF
02300    IF(PFA4K.GT.0)GOTO 17
02310    PF=2.0*PF
02320    GOTO 20
02330C: WALL FAILED - SET PFA4K TO PF
02340  7    CONTINUE
02350    T4EC=TIME
02360    IF((KRF1.EQ.1)GOTO 37
02370    IF((<INC.EQ.0)GOTO 19
02380  37   PFA4K=PF
02390C: CHECK TO SEE IF L340 RANGE IS WITHIN DESIRED ACCURACY
02400  17   IF((PFA4K-PFAIV)/PFAIV.GT.0.01)GOTO 16
02410    IF((KRF1.NE.1)GOTO 18
02420    CALL RAND34(3)
02430    GOTO 34
02440C: INPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
02450C: INSURANCE FOR A NON-FAILING WALL IN THE TIME AND VELOCITY
02460C: AT COLLAPSE FOR A FAILING WALL. INTERVAL INPUT IS THE

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PROGRAM UNREINF (CONTINUED)

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02490C: ENTIRE BEHAVIOR TIME-HISTORY OF THE WALL.
02490C
02500C: INPUT/L3AD DATA
02510 19 CALL FORCE(4)
02520C
02530C: OUTPUT FINAL RESULTS
02540 IF(Y(1).LT.YFAIL)WRITE(1,70)Y(1),T(1)
02550 IF(Y(1).GE.YFAIL)WRITE(1,71)T(1),V(1)
02560C
02570C: CHECK T3 SEE IF ENTIRE TIME-HISTORY OF WALL IS DESIRED
02580 WRITE(1,72)
02590 READ*,I
02600 IF(I.EQ.0)GOTO 25
02620 IF(<WALL.EQ.1)GOTO 32
02630 IF(<RF.EQ.0)GOTO 26
02640 WRITE(1,75)(T(J),PE(J),PIN(J),PH(J),Y(J),V(J),VH(J),J=1,I)
02650 GOTO 25
02660 26 WRITE(1,76)(T(J),PE(J),AC(J),VC(J),Y(J),V(J),VH(J),J=1,I)
02670 GOTO 25
02680 32 WRITE(1,76)(T(J),PIN(J),AC(J),VC(J),Y(J),V(J),VH(J),J=1,I)
02690 25 WRITE(1,77)
02700 GOTO 5
02710C
02720 67 F3R4AT(/<INPUT TITLE*,*)
02730 68 F3R4AT(AS9)
02740 70 F3R4AT(/<WALL DID NOT FAIL - MAX. DEFLECTION 3F*E6.?
02750* * IN. REACHED AT*F7.3,* SEC*)
02760 71 F3R4AT(/<WALL FAILED AT*F7.3,* SEC (FINAL VELOCITY ==*
02770* F7.2* IN./SEC)*)
02780 72 F3R4AT(/<IS TIME HISTORY OF WALL DESIRED (YES=1, NO=0)*)
02800 75 F3R4AT(/<IN*,*PRESSURE IN WALL*/< TIME EXTERIOR *
02810* *INTERIOR VEL DISPLACEMENT VV VH*/
02820* (F6.3,F10.3,F12.4,F11.0,FR.0))
02830 76 F3R4AT(/< TIME PRESSURE ACCELERATION VELOCITY *
02840* *DISPLACEMENT VV VH*/
02850* (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0,FR.0))
02860 77 F3R4AT(/<,7(*-----*))
02870 99 F3R4AT(/<ACCELERATION NOT CONVERGING AT TIME ==,FS.3,
02880* * SEC (PF ==,F7.3,* PS*)/* A(J) SET EQUAL T3*/,
02890* FR.1,* (AVG OF LAST 2 ITERATIONS)/* Y(J) ==,
02900* FR.4,* IN.*)
02910 95 F3R4AT(/<INPUT <WALL(0=EXT,I=INT),<INC,<LDTYPE,<RF,<RAND*,
02920* *(I=3AND94)*)
02930 96 F3R4AT(/<INPUT DELAY TIME (MS) T3 INITIAL L3ADING 3F*,
02940* * INTERIOR WALL*)
02950C
02960 999 STOP
02970 EVD
10000 SUBROUTINE FORCE(ENTRY)
10010C THIS SUBROUTINE INPUTS THE L3AD PARAMETERS AND DETERMINES
10020C THE LOAD AT A GIVEN TIME FOR THE FOLLOWING L3AD TYPES:
10030C 1. IDEALIZED BLAST L3AD (FRONT OR SIDE FACE)
10080C
10090 C3M43V Y(100),YIJ,YFAIL,0,0U,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
10100 C3M43V <WALL,<INC,<RF,<RAND,I,ICASE,FU,VFAIL,FR,FP4,EM,FDY
10110 C3M43V FDC,D(4),LDTYPE,P,PR,PS0,PD0,PC,TC,TO,PB,TIME,LL,S
10140C
10150 G3T3(100,200,300,4),IENTRY
10160C
10170C INPUT LOAD PARAMETERS
10190 100 IF(<RAND.EQ.0)GOTO 102
10192 W=1000 S PB=14.7 S CD=1120.0 S L3C=1
10194 RETURN
10196 102 PRINT 600
10200 READ,W,PR,CD,I,OC,S
10210 IF(L3C.EQ.1)GOTO 105
10220 PRINT 605
10230 READ,ZLEV,CD
10240 105 IF(<INC.EQ.1)RETURN
10250 PRINT 630
10260 READ,PS0
10270 PR=2.0*PS0*(7.0*PB+4.0*PS0)/(7.0*PB+PS0)
10280 GOTO 215
11000C

```

PROGRAM UNREINF (CONTINUED)

```

11010C CALCULATE LOAD PROPERTIES FOR GIVEN PEAK PRESSURE
11030 200 G3T3(205.210),L3C
11040 205 PS0=(PR-14.0*P3+SQRT(196.0*P3*P3+196.0*P3*PR+PR*PR))/16.0
11050 G3T3 215
11060 210 PS3=PR
11070 215 PD3=2.5*PS0*PS3/(7.0*P3+PS3)
11080 U=C3*SQRT(1.0*(6.0*PS3)/(7.0*P3))
11090 T0=U**0.333**2/(2.2399+0.1886*PS3)
11100 G3T3(220,' .3C
11110 220 TC=3.0*
11120 PC=PS3*(1-TC/T0)*EXP(-TC/T0)+PD3*(1-TC/T0)**2*EXP(-2*TC/T0)
11130 CD=1.0
11140 RETURN
11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2T0=TA2/T0
11180 PA=PS3*(1-TA2T0)*EXP(-TA2T0)+CD*PD3*(1-TA2T0)**2*EXP(-2*TA2T0)
11190 RETURN
12000C
12010C CALCULATE LOAD DATA
12030 300 G3T3(305.310),L3C
12040 305 TT0=TIME*T0
12050 IF(TIME.GT.TC)G3T3 320
12060 P=PC*(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TT0=(TIME-TA2)/T0
12090 IF(TIME.GT.TA)G3T3 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TT0.GE.1.0)G3T3 330
12130 P=PS3*(1-TT0)*EXP(-TT0)+CD*PD3*(1-TT0)**2*EXP(-2*TT0)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C PRINT LOAD DATA
13020 4 IF(K14C.EQ.0)G3T3 400
13030 PRINT 640,LDTYPE
13040 G3T3 410
13050 400 PRINT 645,LDTYPE
13060 410 CONTINUE
13070 415 G3T3(420,425),L3C
13080 420 PRINT 650
13090 G3T3 430
13100 425 PRINT 655
13110 430 PRINT 660,W,P3,C3
13120 IF((RAND.NE.0)RETURN
13130 G3T3(435,440),L3C
13140 435 PRINT 665,S,TC,PR
13150 G3T3 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,U,T0,CD,PS3,PD3
13180 RETURN
14000C
14010 600 FORMAT(/>INPUT W,P3,C3,L3C,S*,*)
14020 605 FORMAT(/>INPUT L,CD*,*)
14060 630 FORMAT(/>INPUT PS0*,*)
14070 640 FORMAT(/>LOAD CAUSING INCIPIENT FAILURE IS AS FOLLOWS:*,*
14071*,*,5X,4L3AD TYPE NUMBER,[2])
14080 645 FORMAT(/>PROPERTIES OF LOAD ACTING ON WALL ARE AS FOLLOWS:*,*
14081*,*,5X,4L3AD TYPE NUMBER,[2])
14090 650 FORMAT(RX,*(<FRONT FACE)>)
14100 655 FORMAT(RX,*(<SIDE FACE)>)
14110 660 FORMAT(10X,*W ==,F6.1,* FT P0 ==,F6.2,* PSI C3 ==,
14111*,*,F7.1,* FPS*)
14120 665 FORMAT(10X,*S ==,F6.1,* FT TC ==,F6.3,* SEC PR ==,
14121*,*,F7.3,* PSI*)
14130 670 FORMAT(10X,*L ==,F6.1,* FT TA ==,F6.3,* SEC PA ==,
14131*,*,F7.3,* PSE*)
14140 675 FORMAT(10X,*U ==,F7.1,* FPS TO ==,F6.3,* SEC CD ==,
14141*,*,F5.1,* /,R3,*PS0 ==,F7.3,* PSI PD3 ==,F7.3,* PSI*)
15000 END

```

PROGRAM UNREINF (CONTINUED)

```

20000 S:INITIATIVE FILL(P3,IENTRY)
20010C1 C3MPUTES AVERAGE AIR PRESSURE IN R304 DUE TO BLAST WAVE
20020C1 .VCIIDENT HEAD-24 UPON FRONT WALL.
20030C
20040 C3MM24 Y(100),YU,YFAIL,0,0U,AREA,ZMASS,ZKL4,VH1,VH2,VV1,VV2
20060 C04404 <WALL,<INC,<RF,KRAVD,II,ICASE,FU,VFAIL,FR,FPY,EM,FDY
20070 C3MM24 FDC,D(4),LTYPE,PEXT,PR,PS0,PD0,PC,TC,TO,P0,TIME,L,S
20080 DIMENS13V AA(5,2),VV(8)
20090 L3GICAL L1,L2,L3
20100 G0T0(10,13,11),IENTRY
20110 10 PRINT 700
20115 RH00=0.076 $ L1=.FALSE.
20120 READ,VW1,V3
20125 AT=0$ AFR0NT=0$ ASIDE=0
20130 D0 18 I=1,VW1
20140 PRNT '10,I
20150 READ,AA(1,1),VV(1),AA(1,2)
20160 AA(1,2)=AA(1,2)/1000.0
20161 AT=AT+AA(1,1)
20162 M=VV(1)$ G0T0(12,14,14),4
20163 12 AFR0NT=AFR0NT+AA(1,1)
20164 G0T2 18
20165 14 ASIDE=ASIDE+AA(1,1)
20170 19 C3VTIVUE
20175 AFR0NT=AFR0NT/ATS ASIDE=ASIDE/AT
20180 700 F0RMAT(*INPUT VW1 AND R004 VOLUME (CF)*,*)
20200 7:0 F0RMAT(*INPUT AREA (SQ FT),LOCATION CODE & DELAY(MSEC)*
20210+ * F0R W1ND0W*,I2,?)
20230 G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3 $ G5=G+1.
20240 G6=2.*G/G5 $ G7=(G-1.)/G5
20250 PP2=.1912
20260 C=SQRT(0*P0*32.*144./RH00)
20270 TAU=2.*((V2*(1./3.))/C
20280 NSTEP=4
20290 DT=TAU/NSTEP
20300 RETURN
20310C
20320 13 P30=P0
20330 TT=0. $ T0=0.
20340 RH030=RH00
20350 L2=.FALSE. $ L3=.FALSE.
20360 RETURN
20370C
20380 11 IF(L1)G0T0 52
20385 IF(L2,A,L3)G0T0 9
20390 S2 DDT=(TIME-T0)*0.5
20395 IST0P=2
20400 S3 IF(DDT.LT.DT)G0T0 51
20410 S0 DDT=0.5*DDT
20415 IST0P=2*IST0P
20420 G0 T0 S3
20430 S1 C3VTIVUE
20440 D0 99 I=1,IST0P
20450 TT=T0+I*DDT
20460 IF(TT.GT.T0)G0 T0 99
20470 DM=0. $ HH=0. $ VV=0
20480 D0 500 I=1,VW1
20490 M=VV(K)$ DLY=AA(<,2)+0.000001
20500 IF(DLY.GE.TT)G0 T0 500
20510 G0T0(15,16,16),4
20520 15 CDF=1.0
20530 IF(TT-TC)20,20,21
20540 20 P11=(TC-TT)*(PR-PC)/TC+PC
20550 P11=P11+P0
20560 G0 T0 30
20570 16 CDF=-0.4
20600 21 R=TT/TO $ RR=1.-R
20610 PD=PD0*RR*RR*EXP(-2.*R)
20620 PS=PS0*RR*EXP(-R)
20630 P11=PS+CDF*PD
20640 P11=P11+P0
20650 30 RH01=RH00*((P11/P0)**G2)
20660 IF(P11-P30)36,36,37
20670 36 JSI(N=-1

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PROGRAM UNREINF (CONTINUED)

```

20680 L2=.TRUE.
20770 303 P2=P11
20780 RH02=((P2/P33)**G2)*RH033
20790 X=P33/RH033
20800 G0 T0 38
20810 37 JSIGN=+1
20820 306 P2=PP2*P11
20830 RH02=((P2/P11)**G2)*RH01
20840 X=P11/RH01
20850 39 U22=G4*(X-P2/RH02)*32.*144.
20860 IF(U22<40,39,39
20870 40 PRIVT,*U22 NEGATIVE*,U22
20880 STOP
20890 39 U2=SQRT(U22)*JSIGN
20900 DD4=U2*RH02*AA(K,1)*DDT
20910 D4=D4+DD4
20920 WW=WW+P11*DD4/(G3*RH01)
20930 500 CONTINUE
20940 P30=P30+(G-1.)*WW/V3
20950 RH030=RH030+D4/V3
20960 99 CONTINUE
20970 T0=TT
20980 P3=P30-P3
20982 IF(TIME.GE.TC)L3=.TRUE.
20983 RETURN
20984 9 R=TIME/TO S RR=1.0-R
20985 PD=P08*RR*RR*EXP(-2.0*R)
20986 PS=PS9*RR*EXP(-R)
20987 P3=PS*PD*(AFR7NT-0.4*ASIDE)
20990 999 RETURN
21020 END
30000 SUBROUTINE RESIST (IENTRY)
30010C
30020C THIS SUBROUTINE DETERMINES THE RESISTANCE FUNCTION FOR AN
30030C UNREINFORCED MASONRY WALL WITH JR WITHOUT OPENINGS. CASES
30040C 1-4 ARE TWO-WAY WALLS AND CASES 5-7 ARE ONE-WAY WALLS
30050C
30060 C9M43N Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKL4,VH1,VH2,VV1,VV2
30070 C9M43N <WALL,<INC,<RF,<RAND,I,[CASE,FU,VFAIL,FR,FFM,EM,FDY
30080 C9M43N FDC,D(4),LDTYPE,PEXT,PF,PSA,P03,PC,TC,TO,P3,TIME,L,S
30095 C9M43N /RAND TIMEC,IWALL
30090 REAL <1,<2,<3,<4,<5,<6,<7,<8,<9,<10,<11,<12,<13,M4,MPS0
30100 REAL <S,<F,<EP,<ED,<U,WU
30110C
30120 G0T0(5,500,262),IENTRY
30130C
30140C INPUT WALL PARAMETERS
30150 S WRITE(1,600)
30160 READ(ZLV,ZLH,TW,PV,E,FR,[CASE,ZLVW,ZLHW,G444A
30170 WRITE(1,670)
30180C
30190C DETERMINE ELASTIC DEFLECTION AND MOMENT COEFFICIENTS FOR
30200C TWO-WAY WALLS WITHOUT INPLANE FORCES
30205 IWALL=1
30210 R=ZLH/ZLV
30220 ALP=1.0/R$ ALP2=ALP*ALP
30230 IF([CASE.LE.4]G0T0 11
30240 R=0$ ALP=0$ ALP2=0
30250 11 AWALL=ZLV*ZLH
30260 AWIN=ZLHW*ZLH
30270 AREA=AWALL-AWIN
30280 ZMASS=G444A*AREA*TW/(396.07*1728.0)
30290 R=0.5*(ALP*SQRT(3.0+ALP2)-ALP)
30300 LG=TW*3/12.0
30310 CALL COEF ([CASE,R,ASS,RSS,AF,RF,IG,ZLV,ZLH,PV,VX,CF,E,1)
30320 CALL TRAVS (B,ZLV,ZLH,[CASE,0,ZLM,ZLMSE,ZLMFE,ZLMP,VH1,S,
30330+ VH2S,VV1S,VV2S,VH1F,VH2F,VV1F,VV2F,VH1P,VH2P,VV1P,VV2P)
30340C
30350C DETERMINE MODIFICATION FACTOR FOR WALL WITH WINDOWS
30360C
30370 290 OMULT=1.0
30380 IF(AWIN.NE.0)CALL WIVD3W (OMULT,ZLV,ZLH,ZLVW,ZLHW,AWIN,AWALL,
30391+ R,[CASE])
30390 WRITE(1,620)[CASE,ZLV,ZLH,ALP,TW,FR,E,PV,G444A,ZLVW,ZLHW,OM,LT

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PROGRAM UNREINF (CONTINUED)

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30410 RETURN
30420C
30430C: DETERMINE MAXIMUM RESISTANCE DURING DECAYING PHASE
30440C
30450 262 MM=(FR+PV/TW)*TW=TW/6.0
30460 W=ZLV*TW GAMMA/1728.0
30470 IF(ICASE.GT.4) GOTO 274
30480 QEZER0=12.0*TW*(2.0*PV+W)*(1.0+0.5*ALP2/R)/(ZLV*ZLV*(3-2*B))
30490 GOTO 279
30500 278 QEZER0=8.0*TW=(PV+0.25*W)/(ZLV*ZLV)
30510 279 CONTINUE
30520 YFAIL=TW
30530 KEQ=QEZERO/TW
30540C
30550C: DETERMINE MAXIMUM RESISTANCE DURING INITIAL (FLEXURAL) PHASE
30560 QU=M/(BSS*ZLV*ZLV)
30570 KS=E*IG/(ASS*ZLV**4)
30580 YU=QU/KS
30590 IF(ICASE.EQ.1.OR.ICASE.EQ.5) GOTO 280
30600C
30610C: CASES 2,3,4
30620 Q1=MM/(BF*ZLV*ZLV)
30630 KF=E*IG/(AF*ZLV**4)
30640 Y1=Q1/KF
30650 KEP=(QU-Q1)/(YU-Y1)
30660 GOTO 280
30670C
30680C: DETERMINE WHETHER BENDING OR EQUILIBRIUM RESISTANCE IS LARGER
30690C
30700 280 IF(QU.LE.QEZERO) GOTO 285
30710C
30720C: QU>QEZERO
30730 Y2=YU
30740 Q2=QEZERO*(1.0-Y1/TW)
30750 GOTO 295
30760C
30770C: QEZERO>QU
30780 285 Y2=QEZERO/((KS*(FO)
30790 Q2=KS*Y2
30800 295 CONTINUE
30810C
30820C: MODIFY RESISTANCE VALUES BY APPROPRIATE FACTOR
30830 310 Q1=Q1*QMULT
30840 Q2=Q2*QMULT
30850 QU=QU*QMULT
30860 KS=KS*QMULTS <F=KF*QMULTS <EP=KEP*QMULTS <EO=KEO*QMULTS
30870C
30880C: OUTPUT LOAD-DEFLECTION CURVE
30890 IF(<RAVD.EQ.1) GOTO 325
30900 PRINT 650
30910 IF(ICASE.EQ.1.OR.ICASE.EQ.5) GOTO 320
30920 WRITE(1,660) Q1,Y1
30930 320 XXXXX=0.0
30940 WRITE(1,660) QU,Y1,Q2,Y2,XXXXX,YFAIL
30950 325 RETURN
30960C
30970C: DETERMINE THE RESISTANCE (PER UNIT AREA) OF THE WALL AS
30980C: A FUNCTION OF Y(I)
30990C
31000 500 IF(Y(I).GT.Y2) GOTO 520
31005 IF(Y(I).GT.YU) GOTO 502
31010 GOTO(502,510,510,510,502,510,510),ICASE
31020C
31030C: ELASTIC PHASE -- CASE 1
31040 S02 Q=Y(I)*KS
31050 S05 ZKLW=ZKL4SE
31060 VH1=VH1SS VH2=VH2S
31070 VV1=VV1SS VV2=VV2S
31080 RETURN
31090C
31100 510 IF(Y(I).GT.Y1) GOTO 515
31110C
31120C: ELASTIC PHASE -- CASES 2,3,4
31130 Q=Y(I)*KF

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PROGRAM UNREINF (CONTINUED)

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31140 ZKL4=Z-L4FF
31150 VH1=VH1FS VH2=VH2F
31160 VVI=VV1FS VV2=VV2F
31170 RETURN
31180C
31190C *ELASTO-PLASTIC PHASE (CASES 2,3,4)
31200 S15 Q=01+ $\epsilon$ P*(Y(I)-Y1)
31210 G3T3 S05
31220C
31230C SECONDARY (EQUILIBRIUM) PHASE
31240 S20 IF(Y(I).GT.TW)G3T3 S25
31250 Q= $\epsilon$ E0*(TW-Y(I))
31260 ZKL4=Z-L4P
31270 VH1=VH1PS VH2=VH2P
31280 VVI=VV1PS VV2=VV2P
31290 RETURN
31300C
31310C WALL COLLAPSED -- NO RESISTANCE (TO AVOID DIFFICULTIES
31320C FOR CERTAIN CASES SET RESISTANCE EQUAL TO VERY SMALL VALUE)
31330 S25 Q=1E-10
31340 RETURN
31350C
31360C
31370 600 FORMAT(*INPUT LV,LH,TW,PV,E,FR,ICASE,LVW,LHW,GAMMA*)
31380 620 FORMAT(*WALL PROPERTIES -- SUPPORT TYPE VJ..*12/
31390* * LV =*,F6.1,* IV. LH =*,F6.1,* IV. LV/LH =*,F6.1,* IV.
31400* * TW =*,F6.1,* IV. FR =*,F7.1,* PSI*,SX*
31410* * E =*,F10.1,* PSI*/*,PV =*,F6.1,* LR/IV.,*,SK*
31420* * GAMMA =*,F6.1,* PCF*/*,LW =*,F6.1,* IV. LHW =*,F6.1,* IV.
31425* F6.1,* IV. OMUL =*,F6.3)
31430 650 FORMAT(*LVAD-DEFLECTION CURVE*,/3X,*Q (PSI)*,4X,*Y (IV.)*)
31450 660 FORMAT(F9.2,F12.4)
31460 670 FORMAT(1H )
31480C
31490 END
40000 SUBROUTINE COEF(ICASE,R,ASS,BSS,AF,BF,I,ZLV,ZLH,PV,VX,CF,
40010* E,IENTRY)
40020C THIS SUBROUTINE DETERMINES MOMENT AND DEFLECTION COEFFICIENTS
40030C FOR 3-WAY (CASES 5-7) AND TW-WAY (CASES 1-4) WALLS
40040C
40050      REAL I,MPR,MPSQ,VII
40060      IF(IENTRY.EQ.2)G3T3 200
40070      VX=1
40080      IF((ICASE.GT.4)G3T3 50
40090C
40100      R2=R*R
40110      R3=R*R2
40120      R4=R2*R2
40130      ASS=-.007030+.013990*R-.003456*R2+.000296*R3
40140      BSS=-.05R332+.139314*R-.035609*R2+.003016*R3
40150 8      G3T3(41,20,30,40),ICASE
40160C
40170C CASE 2. FIXED 3V FOUR SIDES
40180 20      VX=3
40190      AF=-.003430+.007327*R-.003365*R2+.0006646*R3-.00004766*R4
40200      BF=-.101150+.260975*R+.138992*R2+.034677*R3-.004016*R4
40210*     -.000170**5
40220      CF=-.1674+.3554*R+.1714*R2+.0286*R3
40230      G3T3 41
40240C
40250C CASE 3. FIXED 3V SHORT SIDES, SIMPLY SUPPORTED ON LONG SIDES
40260 30      VX=4
40270      AF=.004513-.017525*R+.023095*R2-.010325*R3+.002187*R4
40280*     -.0002208*R**5 + .000004408*R**6
40290      BF=-.122149+.313445*R-.153979*R2+.036192*R3-.004015*R4
40300*     *.0001646*R**5
40310      CF=.2.1953-.7.7564**4+.10.8376**42-.7.2495*R3+.2.344*R4
40320*     -.2954*R**5
40330      G3T3 41
40340C
40350C CASE 4. SIMPLY SUPPORTED ON SHORT SIDES, FIXED ON LONG SIDES
40360 40      VX=3
40370      AF=-.002765+.008652*R-.005695*R2+.001829*R3-.0002859*R4
40380*     *.00001739*R**5

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PROGRAM UNREINF (CONTINUED)

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40390      BF=-.060320+.256515*R-.175648*R2-.57928*R3-.009227*R4
40400+   +.000569*R**5
40410  CF=5.8987*R-1.6669-7.9398*R2+5.3142*R3-1.7623*R4+.2313*R**5
40420C
40430  41  IF(R.GT.2.0)CF=1.0/12.0
40440  IF(PV.EQ.0)RETURN
40450  ARATI9=AF/ASSS  BRATI9=BF/BSS
40460  BF0=BF3  CF0=CF
40470  G0T0 220
40480C
40490  50  IF(PV.NE.0)G0T0 300
40500C: CASE 5. ONE-WAY SIMPLY SUPPORTED WALL
40510  ASS=5.0/384.0
40520  BSS=0.125
40530  G0T3(270:270,270,270,270,60,70),ICASE
40540C
40550C: CASE 6. ONE-WAY FIXED END WALL
40560  60  AF=1.0/384.0
40570  BF=1.0/12.0
40580  CF=1.0/12.0
40590  NX=3
40600  RETURN
40610C
40620C: CASE 7. ONE-WAY PREPEARED CANTILEVER WALL
40630  70  AF=1.0/185.0
40640  BF=0.125
40650  CF=0.125
40660  NX=3
40670  RETURN
40680C
40690  200  IF(ICASE.GT.4)G0T0 300
40700C: DETERMINE ELASTIC DEFLECTION AND MOMENT COEFFICIENT FOR
40710C: TWO-WAY WALL WITH INPLANE FORCES
40720  220  PI=3.14159165
40730  VU=0.3
40740  PE=4.0*PI*PI*E*I/(ZLV*ZLV*(1.0-VU*VU))
40750  BV=0
40760  230  AV=0
40770  PPE=PV/PE
40780  TERM6=4.0*PI*PI*R*SORT(PPE)
40790C
40800C: SERIES SOLUTION USED TO DETERMINE COEFFICIENTS
40810  09  250  N=1,7,2
40820  MPR=M*PI*R
40830  MPRSQ=MPR**2
40840  EMSQ=MPRSQ+2.0*MPR*PI*SORT(PPE)
40850  EMSH=MRSQ-2.0*MPR*PI*SORT(PPE)
40860  TERM5=M*PRSQ*(MRSQ-4.0*PI*PI*PPE)
40870  CASHM2=0.5*(EXP(0.5*SORT(EMSQ))+EXP(-0.5*SORT(EMSQ)))
40880  IF(EMSQ.LT.0)G0T0 240
40890  CASHEM2=0.5*(EXP(0.5*SORT(EMSQ))+EXP(-0.5*SORT(EMSQ)))
40900  G0T0 245
40910  240  CASHEM2=CASH(0.5*SORT(-EMSQ))
40920  245  AV=AV+(1.0+(EMSQ/CASHM2-EMSQ/CASHEM2)/(N*TERM6))
40930+  *(-1)**((N-1)/2)*TER15
40940  BV=BV+(MRSQ*(VU*EMSQ-MPRSQ)/CASHM2-E450*(VU*EMSQ
40950+  -MPRSQ)/CASHM2)/(N*TERM6))*(-1)**((N-1)/2)/TERMS
40960  250  CONTINUE
40970C
40980C: CASE 1
40990  AVSS=AV*(1.0-VU*VU)+R4*4.0/PI
41000  BVSS=BV*R2*4.0/PI
41010  IF(ICASE.EQ.1)G0T0 260
41020C
41030C: CASES 2, 3, AND 4
41040  AVF=AVSS*ARATI3
41050  BVF=BVSS*BRATI3
41060  CF=CF0*BVF/BFA
41070  254  AF=AVF
41080  BF=BVF
41090  260  ASS=AVSS
41100  BSS=BVSS
41110  270  RETURN

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PROGRAM UNREINF (CONTINUED)

```

4 120C
41130C: ONE-WAY WALLS
41140 300 EIPV=2*I/PV
41150 U=ZLV/SORT(EIPV)
41160 U2=0.5*U
41170 TERM1=1.0/COS(U2)-1.0
41180C
41190C: CASE 5. ONE-WAY SIMPLY SUPPORTED WALL
41200 RSS=TERM1/U**2
41210 ASS=(RSS-0.125)/U**2
41220 G0T0(270,270,270,270,310,320),1CASE
41230C
41240C: CASE 6. ONE-WAY FIXED END WALL
41250 310 VX=3
41260 BF=(1.0-U2/TAN(U2))/U**2
41270 AF=-BF+RSS+ASS
41280 RETURN
41290C
41300C: CASE 7. ONE-WAY PROPPED CANTILEVER WALL
41310 320 VX=3
41320 BF=TAN(U)*TAN(U2)/(U*TAN(U)-U2)
41330 AF=(BF*(0.5+SIN(U2)/TAN(U)-COS(U2))-(SIN(U2)/TAN(U)
41340 -COS(U2)-SIN(U2)/SIN(U)+0.125*(J+I+1.0)/U**2)/U**2
41350 RETURN
41350 999 END
50000 SUBROUTINE TRANS (R, ZLV, ZLH, 1CASE, XRAK, ZKL1, ZKLSE, ZLMFE,
50010* ZLMFP, VL1S, VL2S, VS1S, VS2S, VL1F, VL2F, VS1F, VS2F, VL1P, VL2P,
50020* VS1P, VS2P)
50030C
50040C: THIS SUBROUTINE DETERMINES LOAD AND MASS TRANSFORMATION FACTORS
50050C: AND DYNAMIC REACTION COEFFICIENTS FOR TWO-WAY WALLS.
50060C
50070C: DETERMINE LOAD AND MASS TRANSFORMATION FACTORS
50080 R2=B*B
50090 R3=B*B2
50100 R4=B2*B2
50110 R5=B2*B3
50120 R6=B3*B3
50130C
50140C: CASES 1 & 5 -- ELASTIC RANGE
50150 330 ZK4SE1=20.48*B3*(1./12.-B2/7.5+P3/21+B4/14-B5/18+B6/90)
50160 ZK4SE2=0.503B-0.7066*B
50170 ZKLSE1=6.4*B2*(1./6.-B2/10.+B3/30.)
50180 ZKLSE2=0.64-0.5134*B
50190 BARS1=B*(1./12.-B2/15.+B3/42.)/(1./6.-B2/10.+B3/30.)
50200 BARS2=(0.127083-0.194524*B)/(0.4-0.503333*B)
50210 ZK4SE=ZK4SE1+ZK4SE2
50220 ZKLSE=ZKLSE1+ZKLSE2
50230 IF(XRAK.EQ.1) G0T0 335
50240C: CRACK PATTERN 4
50250 CVS=0.5*B
50260 CVL=0.5*(1.0-B)
50270 XP=ZLH*B/3.0
50280 XBARS=BARS1*ZLH
50290 ZP=ZLV*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
50300 ZBARS=BARS2*ZLV
50310 XBARP=0.5*B*ZLH
50320 ZBARP=ZLV*(1./24.-9/16.)/(1./8.-B/6.)
50330 G0T0 338
50340C: CRACK PATTERN 5
50350 335 CVS=0.5*(1.0-B)
50360 CVL=0.5*B
50370 XP=ZLH*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
50380 XBARS=BARS2*ZLH
50390 ZP=ZLV*1.3.0
50400 ZBARS=B1*(1.0-ZLV
50410 XBARP=ZLH*(1./24.-9/16.)/(1./8.-B/6.)
50420 ZBARP=1.5*B*ZLV
50430 338 ZKLSE=ZK4SE/ZKLSE
50440 ZKL4=ZLMSE
50450 G0T0(390,340,310,360,350,340,470),1CASE
50460C
50470C: CASES 2, 3, 4 & 4 -- ELASTIC RANGE
50480 350 IF(XRAK.EQ.1) G0T0 365

```

PROGRAM UNREINF (CONTINUED)

```

50490    G0T3 340
50500 360 IF(<RA4,.E0.0>)G0T3 365
50510C: CASES 2A, 2B, 3A, 4B, 4 6
50520 340 ZK4FE1=512.0*35*(1./0.30.-B/10.)*3.*R2/28.+R3/18.+B4/90.+
50530    ZKLFE1=32.0*3*(1./12.-B/10.)*92/30.+
50540    BARF1=B*(.05-B/15.+R2/42.)*(1./12.-B/10.+R2/30.+
50550    G0T3(370,365,370,370,370,365),ICASE
50560C: CASES 2A, 2B, 3B, 4A, 4 6
50570 365 ZK4FE2=0.4065*0.6144*B
50580    ZKLFE2=0.5344*0.7329*B
50590    BARF2=(.091667-.139095*B)/(.266 -.366667*B)
50600    G0T3(375,360,375,375,375,360),ICASE
50610C: CASES 2A & 2B
50620 368 ZK4FE=ZK4FE1+ZK4FE2
50630    ZKLFE=ZKLFE1+ZKLFE2
50640    G0T3 380
50650C: CASES 3A & 4B
50660 370 ZK4FE=ZK4FE1+ZK4SE2
50670    ZKLFE=ZKLFE1+ZKLSE2
50680    G0T3 380
50690C: CASES 3B, 4A, 4 6
50700 375 ZK4FE=ZK4SE1+ZK4FE2
50710    ZKLFE=ZKLSE1+ZKLFE2
50720 380 ZKLFE=ZK4FE/ZKLFE
50730    ZKL4S=ZLMFE
50740    G0T3 390
50750C: CASE 7
50760 470 ZKL4FE=0.78
50770C
50780C: ALL CASES -- PLASTIC RANGE
50790 390 ZK4P=(1.0-B)/3.0
50800    ZKL_P=0.5-B/3.0
50810    ZKL4P=ZK4P/ZKL_P
50820C
50830C
50840C: DETERMINE DYNAMIC REACTIV CDF "CIENTS FOR SHORT (VS) AND
50850C: LONG (VL) EDGES
50860C
50870    IF(ICASE.LT.5)G0T3 395
50880    XBARS=1E-10$ BARF1=1E-10$ XBARP=1E-10
50890 395 CONTINUE
50900    G0T3(450,400,400,420,450,400,445),ICASE
50910 400 IF(<RA4,.E0.1>)G0T3 410
50920    XBARF=BARF1*ZLH
50930    IF(ICASE.E0.3)G0T3 430
5094C 405 ZBARF=BARF2*ZLV
50950    G0T3 440
50960 410 XBARF=BARF2*ZLH
50970    IF(ICASE.E0.3)G0T3 435
50980 415 ZBARF=BARF1*ZLV
50990    G0T3 440
51000 420 IF(<RA4,.E0.1>)G0T3 425
51010    XBARF=BARF1*ZLH
51020    G0T3 405
51030 425 XBARF=BARF2*ZLH
51040    G0T3 415
51050 430 ZBARF=BARF2*ZLV
51060    .18 440
51070 4. ZRF=BARF1*ZLV
51080 440 CONTINUE
51090C
51100C: CASES 2, 3, 4, & 6 -- ELASTIC RANGE
51110    VS1F=CVS*(1.0-XP/XBARF)
51120    VS2F=CVS*(XP/XBARF)
51130    VL1F=CVL*(1.0-ZP/ZBARF)
51140    VL2F=CVL*(ZP/ZBARF)
51150    VS1=VS1F
51160    VL1=VL1F
51170    G0T3 450
51180C
51190C: CASE 7 -- ELASTIC RANGE
51200 445 VS1F=0
51210    VS1=0
51220    VL1F=0.459

```

PROGRAM UNREINF (CONTINUED)

```

51230      VL1=VL1F
51240      VL2F=0.165
51250C
51260C: CASE 1 & 5 -- ELASTIC RANGE
51270 450  VS1S=CVS*(1.0-XP/XBARS)
51280      VS2S=CVS*(XP/XBARS)
51290      VL1S=CVL*(1.0-ZP/ZBARS)
51300      VL2S=CVL*(ZP/ZBARS)
51310      G3T3(455,460,460,460,455,460,460),1CASE
51320 455  VS1=VS1S
51330      VL1=VL1S
51340C
51350C: ALL CASES -- PLASTIC RANGE
51360 450  VS1P=CVS*(1.0-XP/XBARP)
51370      VS2P=CVS*(XP/XBARP)
51380      VL1P=CVL*(1.0-ZP/ZBARP)
51390      VL2P=CVL*(ZP/ZBARP)
51400      RETJRV
51410      END
6000C SUBROUTINE WINDAW(MULT,ZLV,ZLH,ZLW,ZLH%AWIN,AWALL,R,1CASE)
60010C
60020C: THIS SUBROUTINE DETERMINES THE STRUCTURAL
60030C: MODIFICATION FACTOR FOR WALLS WITH WINDWS
60035 IF(ICASE.GT.4.AND.1CASE.NE.10)G3T3 320
60040 RWWS=ZLW/ZLV
60050 RWWL=ZLHW/ZLH
60060 RAREA=AWIN/AWALL
60070 IF(R.LE.1.5)G3T3 300
60080 IF(RWWS.GT.0.7)G3T3 300
60090 IF(RWWL.LT.0.5)G3T3 300
60100 IF(RWWS.EQ.RWWL)G3T3 300
60110C
60120C: CASE WHERE LV/LH >= 1.5, LW/LV <= 0.7, AND LH/LH >= 0.5
60130C: (BUT LV/LV NOT EQUAL TO LH/LH)
60140 ?MULT=-5.85461-12.6644*RARFA+4.37652*RWWS+0.94943*RWHL
60150+ -0.223*R-1.07269*(?LW/ZLHW)+0.9+6.59942*EXP(RAREA)
60160 G3T3 315
60170C
60180C: CASE WHERE ONE OR MORE OF ABOVE CONDITIONS IS NOT MET
60190 300 ?MULT=0.62022-2.23415*RAREA*(RWHL**4)-0.79461*RWHL**2
60200+ -2.27663*RWHL+0.62522*RWHL/RAREA**0.3
60210+ +2.63043*EXP(RAREA)-0.0268*RWWS
60220 315 CONTINUE
60230 RETURN
60240C
60250C ONE-WAY ACTION WALLS
60260 320 ?MULT=(AWALL-ZLV*ZLHW)/(AWALL-AWIN)
60270 RETURN
60280 END
70000      SUBROUTINE RAND34 (IENTRY)
70010C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
70020C VARIABLES, GENERATES RANDOM VALUES, AND CONTROLS REQUIRED
70030C NUMBER OF CASES TO BE RUN, AND OUTPUTS FINAL RESULTS AND SUMMARY
70040C
70050      C3443N Y(100),Y1,YFAIL,F,SPS3,ZMASS,ZLM,VH1,VH2,VV1,VV2
70060      C3443N /VALL,C1NC,C1PC,C1RD,1,1CASE,F,1,UFAIL,FR,FP4,F4,FDY
70070      C3443N FDC,D(4),LDTYPE,PEXT,PF,PS3,PUJ,PC,TC,T0,P3,TIME,L,S
70080      C3443N /RAND/,TIMEC,IWALL
70090      C3443N CH1975(7),CH1975(7),TDIST(7)
70100C
70110C VALUES FOR 97.5% (F=19.24,29.34,39.44,47)
70120      DATA CH1975/4689.5167,5533.7925,6055,6267,6440/
70130      D/ 4 CH1975/1.7235,1.5402,1.5766,1.5214,1.4903,1.4591,1.4331/
70140      DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
70150C
70160      G3T3(5,50,70),IENTRY
70170      S XDI444=Y43RM1(-1.0,0.0,1.0)
70180C INITIALIZE RANDOM NUMBER GENERATOR
70190      PRINT/,"INPUT VRAND=",
70200      READ(VRAND)
70210      D3 47 I=1,VRAVD
70220      XDI444=Y43RM1(0.0,0.0,1.0)
70230      47 CONTINUE
70240      I955=0$ SPS3=0$ SSPS3=0

```

PROGRAM UNREINF (CONTINUED)

```

70250  ICHECK=2
70260C INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
70280  PRINT 97
70290  READ, S4EAV, FSD
70300  G3T3(10,20),1 WALL
70310C UNREINFORCED 1.1 WALLS WITHOUT ARCHING
70320  10 PRINT 94
70330  READ, FRMEAN, FRSD
70340  PRINT 94
70350  RETURN
70360C UNREINFORCED WALLS 1.1 ARCHING
70370  20 PRINT 95
70380  READ, FFM4EAV, FPM4SD
70390  PRINT 95
70400  RETURN
70460C GENERATE RANDOM VALUES
70480  50 G3T3(S2,54),1 WALL
70490  52 FR=XV3RM1(0.0,FRMEAN,FRSD)
70500  IF(FR.LF.0)G3T3 52
70510  G3T3 58
70520  54 FPM=XV3RM1(0.0,FPM4EAV,FPM4SD)
70530  IF(FPM.LF.0)G3T3 54
70540  55 ALPHA4=XV3RM1(0.0,1.0,0.3)
70550  IF(ALPHA4.LT.0.4.22.ALPHA4.GT.1.6)G3T3 55
70555  EM=1000.0*ALPHA4*FPM
70585  58 IF(S4EAV.EQ.0)G3T3 65
70590  60 S=XV3RM1(0.0,S4EAV,SSD)
70600  IF(S.LE.0)G3T3 60
70610  65 INDEX=INDEX+1
70620  RETURN
70630C SUM VALUES OF PS0 AND PS0**2 FOR USE IN STATISTICAL ANALYSIS
70640  70 SPS0=SPS0+PS0
70650  SSPSS0=SSPSS0+PS0*PS0
70660C
70670C OUTPUT FINAL RESULTS
70680  G3T3(72,74),1 WALL
70690  72 PRINT 90,FR,S,PS0,TIMEC
70700  G3T3 90
70710  74 PRINT 91,FPM,EM,S,PS0,TIMEC
70720  G3T3 80
70740  80 IF(INDEX.LT.ICHECK)RETURN
70750C
70760C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PS0
70770  ZN8=INDEX
70780  Z4EAV=SPS0/ZN8
70790  SD=SORT((SSPSS0-ZN8*Z4EAV*Z4EAV)/ZN8)
70800  SDERR=SD/(SQR(ZN8-1))
70810C CHECK IF MAXIMUM OF 50 PS0 SAMPLES RETAINED
70820  IF(INDEX.EQ.50)G3T3 62
70830C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PS0 VALUE IS
70840  IF(STDERR*TDIST((INDEX-15)/5)/Z4EAV.GT.0.10)G3T3 61
70850C
70860C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
70870C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
70880C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
70890  62 SDU=SD/(SQR(CHI25((INDEX-15)/5)))
70900C CHECK IF MAXIMUM OF 50 PS0 SAMPLES RETAINED
70910  IF(INDEX.EQ.50)G3T3 53
70920C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
70930C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
70940  IF(((SDU-SD)/Z4EAV).GT.0.10)G3T3 61
70950C
70960C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
70970C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES RETAINED
70980C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
70990,
71000C AND 10% AND 90% PROBABILITY VALUES
71010  53 Z4EAVL=Z4EAV-STDERR*TDIST((INDEX-15)/5)
71020  Z4EAVU=Z4EAV+STDERR*TDIST((INDEX-15)/5)
71030  SDL=SD/(SQR(CHI95((INDEX-15)/5)))
71040  Z1_1=Z4EAV-1.292*SD
71050  P_0L=Z4EAV-1.292*SDU

```

PROGRAM UNREINF (CONTINUED)

```

71060      P10U=ZMEAN+1.242*SD
71070      P90=ZMEAN+1.282*SD
71080      P90L=ZMEAN+1.242*SD
71090      P90U=ZMEAN+1.282*SD
71100      P90UH=ZMEAN+1.242*SDH
71110      P90UZ=ZMEAN+1.242*SDU
71120C
71130C 34 INPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
71140      PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
71150*      P90,P90L,P90U
71160      PRINT 105,INDEX,STDERR
71170      GOTO 999
71180C
71190C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND SD
71200B
71210C VALUES -- THEREFORE ABTAIN 5 ADDITIONAL SAMPLES
71220      61 ICHECK=ICHECK+5
71230      RETURN
71240C
71250  34 F3RMAT(/INPUT MEAN AND STANDARD DEVIATION FOR FR*,*)
71260  RS F3RMAT(/INPUT MEAN AND STANDARD DEVIATION FOR F'M*,*)
71270  R7 F3RMAT(/INPUT MEAN AND STANDARD DEVIATION FOR S*,*)
71280  90 F3RMAT(F9.2,F11.2,F10.2,F14.3)
71290  91 F3RMAT(F9.1,F15.1,F12.2,F10.2,F14.3)
71300  94 F3RMAT(//,SX,*FR*,10X,*S*,HX,*PS3*,6X,*COLLAPSE TIME*)
71310  95 F3RMAT(//,SX,*FPM*,11X,*EM*,12X,*S*,HX,*PS3*,6X,
71320*      *COLLAPSE TIME*)
71330  100 F3RMAT(//,11X,*STATISTICAL PROPERTIES OF INCIPIENT PS3*,
71340*      //,34X,*95% CONFIDENCE LIMITS*,//,1X,*ITEM*,14X,
71350*      *VALUE    LOWER    UPPER*,//,0 MEAN*,P29.2,
71360*      *F12.2,/,0 STANDARD DEVIATION*,F15.2,2F12.2,/,
71370*      * 10% PROBABILITY VALUE*,3F12.2,/
71380*      * 90% PROBABILITY VALUE*,3F12.2)
71390  105 F3RMAT(//,5A,*4148ER OF RESERVATIONS ==,13,/,5X,
71400*      *STANDARD ERROR ==,FS.2)
71410C
71420  999 STOPS END
71430 FUNCTION XNORM1(X,A,B)
71440 10 X0=RANF(-1.0)
71450 20 X1=RANF(0.0)
71460 X2=RANF(0.0)
71470 Y=SQRT(-2.0*ALOG(X1))*(COS(6.283184*X2))
71480 XNORM1=A+Y*B
71490 RETURN
71500 END

```

ADDITION TO PROGRAM UNREINF TO INCLUDE LOAD TYPES 2 THROUGH 5:

```

10040C      2. TRAVN(6,32,1,34)
10050C      3. STEP 2 E,42
10060C      4. FIRE SHACK TUNNEL L740
10070C      5. ARBITRARY L740 SHAPE
10120 214EN(L74,TTC01,P0(2))
10150 GOTO(1,2,3,4),1 ENTRY
11130 1 GOTO(100,110,110,120,130),L0 TYPE
10290 110 PRINT 610
10300 READ,TR,T1,T0
10310 GOTO 125
10320 120 PRINT 615
10330 READ,TR,T1,T0
10340 125 IF((INC.L0,1)NE 1)
10350 PRINT 620
10360 READ,PS1
10370 RETURN
10390 130 PRINT 620
10400 READ,NPRINT,(1:T1),P0(1),I=1,NPRINT

```

**PROGRAM UNREINF (CONCLUDED)**

ARCHING

Unreinforced Masonry Wall With Arching

## PROGRAM ARCHING

```

01000 PROGRAM JIMBOC(INPUT,OUTPUT,TAPE1,BUTPUT)
01010C: THIS ROUTINE IS THE CONTROLLING ROUTINE FOR THE PROGRAM USED
01020C: IN THE ANALYSIS OF ONE-WAY OR TWO-WAY ACTION WALLS.
01030C
01040      COMMON Y(100),YU,YFAIL,Q,QU,ANFA,ZKLM,VH1,VH2,VV1,VV2
01050      COMMON KWALL,KINC,KRF,KRAND,I,ICASE,FU,VFAIL,FR,FFM,EM,FDY
01060      COMMON FDC,D(4),LDTYPE,PEXT,PF,PS0,P00,PC,TC,TO,PP,TIME,L,S
01070      COMMON /RAND/ TIMEC,IWALL
01080      DIMENSION A(100),V(100),T(100),VV(100),VH(100),
01090+         PEX(100),PIN(100),PN(100)
01100C
01110C: READ TITLE AND CONTROL PARAMETERS
01120 5   PRINT 67
01130   READ 68,TITLE
01140   PRINT 85
01150   READ,KWALL,KINC,LDTYPE,KRF,KRAND
01160   DELAY=0
01170   VFAIL=1E10
01180   CALL RESIST()
01190   CALL FORCE()
01200   IF(KRF.EQ.0)GOTO 12
01210   CALL FILL(PINT,1)
01220 12  IF(KWALL.EQ.0)GOTO 14
01230   PRINT 86
01240   READ,DELAY
01250   DELAY=DELAY/1000.0
01260 14  IF(KRAND.NE.1)GOTO 35
01270   CALL FORCE(4)
01280   CALL RANDOM(1)
01290 34  CALL RANDOM(2)
01300 35  CALL RESIST(3)
01310C
01320C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
01330C: WHERE THE LOAD CAUSING INCIPIENT COLLAPSE IS TO BE FOUND
01340 13  IF(KINC.EQ.0)GOTO 23
01350   PF=0.0
01360   PFMAX=0
01370   PFMIN=PF/2.0
01380   GOTO 20
01393 16  PF=(PFMIN+PFMAX)/2.0
01400 20  CALL FORCE(2)
01410 23  IF(KRF.EQ.0)GOTO 24
01420   CALL FILL(PINT,2)
01430C
01440C: INITIALIZE VALUES FOR BETA METHOD (BETA = 1/6) AND COMPUTE VA U
01450C: FOR FIRST TIME INTERVAL ASSUMING WALL INITIALLY AT REST
01460 24  I=1
01470   TIME=0
01480   T(1)=0.0 V(1)=0.0 Y(1)=0
01490   DELTA=0.001
01520   IF(KWALL.EQ.0)GOTO 29
01530 27  IF((TIME.GE.(DELAY-0.00001))GOTO 28
01540   TIME=TIME+DELTA
01550   CALL FILL(PINT,3)
01560   GOTO 27
01570 28  PIN(1)=PINT
01580   TPNET=AREA*PINT
01590   T(1)=TIME
01600   GOTO 30
01610 29  CALL FORCE(3)
01615   PEX(1)=PEXT
01620   TPNET=AREA*PEXT
01630   PN(1)=PEXT
01640 30  CALL RESIST(2)
01650   A(1)=TPNET/(ZMASS+ZKLM)
01660   VV(1)=VVI+TPNET
01670   VH(1)=VHI+TPNET
01680C
01690C: PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
01700 1   I=I+1
01710   IF(I.LT.101)GOTO 11
01720   PRINT 98,TIME
01730 98  FORMAT(1,1,I=101, TIME ??,F6.3,0) WALL ASSUMED TO NOT FAIL()
01740   GOTO 6

```

PROGRAM ARCHING (CONTINUED)

```

01750 11  TIME=TIME+DELTA
01760      T(I)=TIME
01770      A(I)=A(I-1)
01780      CALL FORCE(3)
01790      PEX(I)=PEXT
01800      IF(KWALL.EQ.1)GOTO 10
01810      IF(KRF.EQ.0)GOTO 3
01820      CALL FILL(PINT,3)
01830      PINC(I)=PINT
01840      TPNET=AREA*(PEXT-PINT)
01850      GOTO 2
01860  3   TPNET=AREA*PEXT
01870      GOTO 2
01880  10  CALL FILL(PINT,3)
01890      PINC(I)=PINT
01900      TPNET=AREA*PINT
01910  2   PN(I)=TPNET/AREA
01920      D8 8 JJ=1,10
01930      Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
01940      CALL RESIST(2)
01950      QT=Q*AREA
01960  4   ANEW=(TPNET-QT)/(ZMASS*ZKLM)
01970      ADELTA=ANEW-A(I)
01980      A(I)=ANEW
01985 IF(ANEW.EQ.0)PRINT,*1985*,TIME,TPNET,QT,ZMASS,ZKLM,Y(I),A(I-1)
01990      IF(ABS(ADELTA/ANEW).LT.0.01)GOTO 9
02000  8   CONTINUE
02010      A(I)=ANEW-ADELTA/2.0
02020      WRITE(1,80)TIME,PF,A(I),Y(I)
02030  9   CONTINUE
02040      Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
02050      V(I)=V(I-1)+DELTA*(A(I)-A(I-1))/2.0
02060      VV(I)=VV1*TPNET*VV2*QT
02070      VH(I)=VH1*TPNET*VH2*QT
02080      IF(VV(I).GT.VFAIL)GOTO 7
02090C
02100C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE OF WALL
02110C: IF MAXIMUM DEFLECTION REACHED, WALL DID NOT FAIL
02120      IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GOTO 6
02130      IF(Y(I).LT.0)GOTO 6
02140      IF(TIME-DELAY.GE.0.010)DELTA=0.002
02150      IF(Y(I).LT.YU)GOTO 1
02160      IF(TIME-DELAY.GE.0.020)DELTA=0.005
02170      IF(TIME-DELAY.GE.0.100)DELTA=0.1
02180      IF(TIME-DELAY.GE.0.500)DELTA=0.1
02190C: IF FAILURE DEFLECTION REACHED, WALL FAILED
02200      IF(Y(I).GE.YFAIL)GOTO 7
02210      GOTO 1
02220C
02230C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
02240C: COLLAPSE FOR CASES WHERE DESIRED
02250C: WALL DID NOT FAIL - SET PFMIN TO PF
02260  6   CONTINUE
02270      IF(KRAND.EQ.1)GOTO 36
02280      IF(KINC.EQ.0)GOTO 18
02290  36  PFMIN=PF
02300      IF(PFMAX.G.E0)GOTO 17
02310      PF=2.0*PF
02320      GOTO 20
02330C: WALL FAILED - SET PFMAX TO PF
02340  7   CONTINUE
02350      TIMEC=TIME
02360      IF(KRAND.EQ.1)GOTO 37
02370      IF(KINC.EQ.0)GOTO 18
02380  37  PFMAX=PF
02390C: CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
02400  17  IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GOTO 16
02410      IF(KRAND.NE.1)GOTO 16
02420      CALL RANDOM(3)
02430      GOTO 34
02440C
02450C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME PF
02460C: OCCURANCE FOR A NON-FAILING WALL OR THE TIME AND VELOCITY
02470C: AT COLLAPSE FOR A FAILING WALL. OPTIONAL OUTPUT IS THE

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PROGRAM ARCHING (CONTINUED)

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02480C: ENTIRE BEHAVIOR TIME-HISTORY OF THE WALL.
02490C
02500C: OUTPUT LOAD DATA
02510 18 CALL FORCE(4)
02520C
02530C: OUTPUT FINAL RESULTS
02540      IF(Y(I).LT.YFAIL)WRITE(1,70)Y(I),T(I)
02550      IF(Y(I).GE.YFAIL)WRITE(1,71)T(I),V(I)
02560C
02570C: CHECK TO SEE IF ENTIRE TIME-HISTORY OF WALL IS DESIRED
02580      WRITE(1,72)
02590 READ,M
02600      IF(M.EQ.0)GOTO 25
02620      IF(KWALL.EQ.1)GOTO 32
02630      IF(KRF.EQ.0)GOTO 26
02640      WRITE(1,75)(T(J),PEX(J),PIN(J),PN(J),Y(J),VVC(J),VH(J),J=1,I)
02650      GOTO 25
02660 26      WRITE(1,76)(T(J),PEX(J),A(J),V(J),Y(J),VVC(J),VH(J),J=1,I)
02670      GOTO 25
02680 32      WRITE(1,76)(T(J),PIN(J),A(J),V(J),Y(J),VVC(J),VH(J),J=1,I)
02690 25      WRITE(1,77)
02700      GOTO 5
02710C
02720 67 FORMAT(/>INPUT TITLE<,>)
02730 68 FORMAT(A59)
02740 70 FORMAT(/>WALL DID NOT FAIL - MAX. DEFLECTION OF F6.2
02750*   * IN. REACHED AT F7.3. SEC*)
02760 71 FORMAT(/>WALL FAILED AT F7.3. SEC (FINAL VELOCITY ==
02770*   F7.2. IN. /SEC)*)
02780 72 FORMAT(/>IS TIME HISTORY OF WALL DESIRED (YES=1, NO=0)<,>)
02800 75 FORMAT(/>15. PRESSURE ON WALL</> TIME EXTERIOR *
02810*   *INTERIOR NET DISPLACEMENT VV VH</>
02820*   (F6.3,F10.3,F12.4,F11.0,F8.0))
02830 76 FORMAT(/> TIME PRESSURE ACCELERATION VELOCITY *
02840*   *DISPLACEMENT VV VH</>
02850*   (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0,F8.0))
02860 77 FORMAT(/>7.0-----))
02870 80 FORMAT(/>ACCELERATION NOT CONVERGING AT TIME ==,F6.3,
02880*   * SEC (PF ==,F7.3. PSI)</> A(I) SET EQUAL TO
02890*   F8.1.0 (AVG OF LAST 2 ITERATIONS)</> Y(I) ==,
02900*   F8.4.0 IN.))
02910 85 FORMAT(/>INPUT KWALL(O=EXT,I=INT),KINC,LDTYPE,KRF,KRAND=,
02920*   *(I=RANDOM)*)
02930 86 FORMAT(/>INPUT DELAY TIME (MSEC) TO INITIAL LOADING OF=,
02940*   * INTERIOR WALLS*<,>)
02950C
02960 999 STOP
02970 END
10000 SUBROUTINE FORCE(IENTRY)
10010C THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
10020C THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
10030C 1. IDEALIZED BLAST LOAD (FRONT OR SIDE FACE)
10080C
10090 COMMON Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,VH2,VV1,VV2
10100 COMMON KWALL,KINC,KRF,KRAND,I,ICASE,FU,VFAIL,FR,FPFM,EM,FDY
10110 COMMON FDC,D(4),LDTYPE,P,PR,PS0,PD0,PC,TC,TO,P0,TIME,LL,S
10140C
10150 GOTO(100,200,300,4),IENTRY
10160C
10170C INPUT LOAD PARAMETERS
10190 100 IF(KRAND.EQ.0)GOTO 102
10192 W=1000 S P0=14.7 S C0=1120. L0C=1
10194 RETURN
10196 102 PRINT 600
10200 READ,W,P0,C0,L0C,S
10210 IF(L0C.EQ.1)GOTO 105
10220 PRINT 605
10230 READ,ZLEN,CD
10240 105 IF(KINC.EQ.1)RETURN
10250 PRINT 630
10260 READ,PS0
10270 PR=2.0*PS0*(7.0*P0+4.0*PS0)/(7.0*P0+PS0)
10280 GOTO 215
11000C

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PROGRAM ARCHING (CONTINUED)

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11010C CALCULATE LOAD PROPERTIES FOR G!VEN PEAK PRESSURE
11030 200 G@T@(205,210),L@C
11040 205 PS@=(PR+14.0*P@+SQRT(196.0*P@+P@+196.0*P@+PR+PR+PR))/16.0
11050 G@T@ 215
11060 210 PS@=PR
11070 215 PD@=2.5*PS@*PS@/(7.0*P@+PS@)
11080 U=C@*SQRT(1.0*(6.0*PS@)/(7.0*P@))
11090 T@=W@@.3333/(2.2399*0.1886*PS@)
11100 G@T@(220,225),L@C
11110 220 TC=3.0*S/U
11120 PC=PS@*(1-TC/T@)*EXP(-TC/T@)+PD@*(1-TC/T@)**2*EXP(-2*TC/T@)
11130 CD=1.0
11140 RETURN
11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2T@=TA2/T@
11180 PA=PS@*(1-TA2T@)*EXP(-TA2T@)+CD*PD@*(1-TA2T@)**2*EXP(-2*TA2T@)
11190 RETURN
12000C
12010C CALCULATE L@AD
12030 300 G@T@(305,310),L@C
12040 305 TTO=TIME/T@
12050 IF(TIME.GT.TC)G@T@ 320
12060 P@=FC+(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/T@
12090 IF(TIME.GT.TA)G@T@ 320
12100 P@=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)G@T@ 330
12130 P@=PS@*(1-TTO)*EXP(-TTO)+CD*PD@*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P@=0
12170 RETURN
13000C
13010C PRINT L@AD DATA
13020 4 IF(KINC.EQ.0)G@T@ 400
13030 PRINT 640,L@TYPE
13040 G@T@ 410
13050 400 PRINT 645,L@TYPE
13060 410 CONTINUE
13070 415 G@T@(420,425),L@C
13080 420 PRINT 650
13090 G@T@ 430
13100 425 PRINT 655
13110 430 PRINT 660,W,P@,C@
13120 IF(KRADD.NE.0)RETURN
13130 G@T@(435,440),L@C
13140 435 PRINT 665,S,TC,PR
13150 G@T@ 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,U,T@,CD,PS@,PD@
13180 RETURN
14000C
14010 600 FFORMAT(/INPUT W,P@,C@,L@C,S@,*)
14020 605 FFORMAT(/INPUT L,CD@,*)
14060 600 FFORMAT(/INPUT PS@,*)
14070 640 FFORMAT(/L@AD CAUSING INCIPIENT FAILURE IS AS FOLLOWS*,I2)
14071  /,5X,*L@AD TYPE NUMBER,I2)
14080 645 FFORMAT(/PROPERTIES OF L@AD ACTING ON WALL ARE AS FOLLOWS*
14081  /,5X,*L@AD TYPE NUMBER,I2)
14090 650 FFORMAT(8X,(FRONT FACE))
14100 655 FFORMAT(8X,(SIDE FACE))
14110 660 FFORMAT(10X,*W =,F8.1,* KT   P@ =,F6.2,* PSI      CR =,
14111  F7.1,* FPS*)
14120 665 FFORMAT(10X,*S =,F6.1,* FT      TC =,F6.3,* SEC      PR =,
14121  F7.3,* PSI*)
14130 670 FFORMAT(10X,*L =,F6.1,* FT      TA =,F6.3,* SEC      PA =,
14131  F7.3,* PSI*)
14140 675 FFORMAT(10X,*U =,F7.1,* FPS    TO =,F6.3,* SEC      C =
14141  FS.1,*8X,*PS@ =,F7.3,* PSI    PDL =,F7.3,* PSI*)
15000 END
20000 SUBROUTINE FILL(P3,IENTRY)
20010C COMPUTES AVERAGE AIR PRESSURE IN ROOM DUE TO BLAST WAVE

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PROGRAM ARCHING (CONTINUED)

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20020C: INCIDENT HEAD-IN UPON FRONT WALL.
20030C
20040 COMMON Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZKLM,VH1,V,2,VV1,VV2
20060 COMMON KWALL,KINC,KRF,KRAND,II,ICASE,FU,VFAIL,FR,FPM,EM,FDY
20070 COMMON FDC,D(4),LDTYPE,PEXT,PR,PS0,PDB,PC,TC,TO,PE,TIME,L,S
20080 DIMENSION AA(8,2),NN(8)
20090 LOGICAL L1,L2,L3
20100 GOTO(10,13,11),IENTRY
20110 10 PRINT 700
20115 RH00=0.076 $ L1=.FALSE.
20120 READ,NWIN,V3
20125 AT=0$ AFRONT=0$ ASIDE=0
20130 D# 18 I=1,NWIN
20140 PRINT T10,I
20150 READ,PA(I,1),NN(I),AA(I,2)
20160 AA(I,2)=AA(I,2)/1000.0
20161 AT=AT+AA(I,1)
20162 M=NN(I)3 GOTO(12,14,14),M
20163 12 AFRONT=AFRONT+AA(I,1)
20164 GOTO 18
20165 14 ASIDE=ASIDE+AA(I,1)
20170 18 CONTINUE
20175 AFRONT=AFRONT/ATS ASIDE=ASIDE/AT
20180 700 FORMAT(/INPUT NWIN AND ROOM VOLUME (CF)*/,*)
20190 710 FORMAT(/INPUT AREA (SQ FT),LOCATION CODE & DELAY(MSEC)*
20210 * FOR WINDOW#,I2,*)
20230 G#1.4 $ G2#1./G $ G3#1.-G2 $ G4#2./G3 $ G5#G+1.
20240 G6#2.*G/G5 $ G7#(G-1.)/G5
20250 FP2#-1912
20260 C=SORT(G#P#32.*144./RH00)
20270 TAU=2.*((V3#*(1./3.))/C
20280 NSTEP=4
20290 DT=TAU/NSTEP
20300 RETURN
20310C
20320 13 P3#P#
20330 TT#0. $ T#0.
20340 RH03#RH00
20350 L2#.FALSE. $ L3#.FALSE.
20360 RETURN
20370C
20380 11 IF(L1)G810 52
20385 IF(L2.A.L3)G810 9
20390 52 DCT=(TIME-T#)*0.5
20395 ISTOP=2
20400 53 IF(DDT.LT.DT)11TA 51
20410 50 DDT=0.5*DDT
20415 ISTOP=2*ISTOP
20420 G# T# 33
20430 51 CONTINUE
20440 D# 99 I=1,ISTOP
20450 TT=T#+I*DDT
20460 IF(TT.GT.T#)G# T# 99
20470 DM#0. $ WM#0. $ NW#0
20480 D# 500 K#1,NWIN
20490 M=NN#*, $ DLY=AA(K,2)+0.000001
20500 IF(DLY.GE.T#)G# T# 500
20510 GOTP(15,16,16),M
20520 15 CDF=1.0
20530 IF(TT-TC,20,20,21
20540 20 P1#=(TC-T#)*(PR-PC)/TC+PC
20550 P#1=P1#P#
20560 G# T# 30
20570 16 CDF=0.4
20600 21 R=TT/T# S RR=1.-R
20610 PD#PD#RR#RR#EXP(-2.*R)
20620 PS#PS#-RR#EXP(-R)
20630 P1#=PS#CDF#PD
20640 P1#=P1#P#
20650 30 RH01#RH00*((P1#/P#)**G2)
20660 IF(P1#/P3#)36,36,37
20670 36 JSIGN=-1
20680 L2#.TRUE.
20770 303 P2#P1#

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PROGRAM ARCHING (CONTINUED)

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20780 RH02=((P2/P30)**G2)*RH030
20790 X=P30/RH030
20800 G0 T9 38
20810 37 JSIGN=+1
20820 306 P2=R-2*P11
20830 RH02=((P2/P11)**G2)*RH01
20840 X=P11/RH01
20850 38 U22=G4*(X-P2/RH02)*32.+144.
20860 IF(U2C)40,39,39
20870 40 PRINT,+U22 NEGATIVE+,U22
20880 STOP
20890 39 U2=SQRT(U22)*JSIGN
20900 DDM=U2*RH02*AA(K,1)*DDT
20910 DM=DM+DDM
20920 WWWWW=P11*DDM/(G_>RH01)
20930 500 CONTINUE
20940 P30=P30*(G-1.)*WWW/V3
20950 RH030=RH030+DM/V3
20960 99 CONTINUE
20970 T9=TT
20980 P3=P30-P0
20982 IF(TIME.GE.TC)L3+.TRUE.
20983 RETURN
20984 9 R=TIME/TO S RR=1.0-R
20985 PD=PD0*RR*RR*EXP(-2.0*R)
20986 PS=PS0*RR*EXP(-R)
20987 P3=PS+PD*(AFRONT-0.4*ASIDE)
20990 999 RETURN
21020 END
30000 SUBROUTINE RESIST (IENTRY)
30010C
30020C THIS SUBROUTINE INPUTS THE REQUIRED DATA AND COMPUTES VARIOUS
30030C QUANTITIES USED IN THE ANALYSIS OF WALLS WITH ONE-WAY ARCHING
30040C (SUPPORT CASE 9) OR TWO-WAY ARCHING (SUPPORT CASE 10)
30050C
30060      COMMON Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZLHM,VH1,VH2,VV1,VV2
30080      COMMON KWALL,KINC,KRF,KRAND,I,ICASE,FU,VFAIL,FR,FPM,EM,FDY
30090      COMMON FDC,DC(4),LDTYPE,PEXT,PF,PS0,PD0,PC,TC,TO,P0,TIME,L,S
30095      COMMON /RAND/ TIMEC,IWALL
30110C
30120      GETB(1,99,2),IENTRY
30125C
30130C INPUT WALL DATA
30140      I PRIN: 60
30150      READ,ZLV,ZLH,TW,TFLG,EM,FPM,ICASE,ZLW,ZLHW,GAMMA
30160C
30170C DETERMINE VALUES OF VARIOUS CONSTANTS
30175      IWALL=2
30180      ZL2=ZLV/2.0
30190      AWALL=ZLV-ZLH
30200      AWIN=ZLW-ZLHW
30210      AREA=AWALL-AWIN
30220      ZMASS=GAMMA*AREA*TW/(356.07*1728.0)
30230      RATI0=ZLV/ZLH
30240      IF(ICASE.EQ.9)RATI0=0
30250      BETA=0.5*(SQRT(3.0*RATI0**2+RATI0**4)-RATI0**2)
30260      ZLHM=(2.0-2.0*BETA)/(3.0-2.0*BETA)
30270      VV1=BETA/6.0
30280      VV2=BETA/3.0
30290      VH2=(3.0-4.0*BETA)**2/(12.0*(2.0-3.0*BETA))
30300      VH1=(1.0-BETA)/2.0-VH2
30310      ZLD=SQRT(ZL2+ZL2+TW-TW)
30320      EPC1=(ZLD-ZL2)/ZLD
30340      C2=2.0-4.0*BETA
30350      C3=0
30360      IF(RATI0.EQ.0)GETB 9
30370      C3=4.0*BETA+RATI0**2/BETA
30380      9 CONTINUE
30390      C4=12.0/(ZLV*ZLV*(3.0-2.0*BETA))
30400      YFAIL=TW
30410C
30420C DETERMINE MODIFICATION FACTOR FOR WALL WITH WINDOWS
30430C
30440      QMULT=1.0

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PROGRAM ARCHING (CONTINUED)

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30450      IF(AWIN.NE.0)CALL WINDOW (QMULT,ZLV,ZLH,ZLW,ZLHW,AWIN,
30460      AWALL,RATIO,ICASE)
30470C
30480C     OUTPUT WALL PROPERTIES
30490      PRINT 62,ICASE,ZLV,ZLH,RATIO,TW,EM,FPM,GAMMA,TFLG,ZI,VW,
30500      ZLHW,QMULT
30510      RETURN
30520C
30530      2 YU=TW*FPM/(EM*EPSM)
30540      TFLG2=2.0*TFLG
30550      IF(TFLG.4.E.0)GOTO 3
30560C
30570C     SOLID MASONRY WALL
30580      5 ZMU=0.25*FPM*(TW-YU)**2
30590      C1=0.5*ZMU*YU+FPM*(TW-YU)**3/12.0
30600      GOTO 4
30610C
30620C     HOLLOW MASONRY UNIT WALL
30630      3 Y2=TW-2.0*TFLG
30640      IF(YU.LT.Y2)GOTO 6
30650C     YU+T2 -- TREAT WALL AS SOLID WALL
30660      TFLG2=0.5 GOTO 5
30670      6 PFLG=FPM*TFLG
30680      TWF=TW-TFLG
30690      ZMU=PFLG*(TWF-YU)
30700      ZM2=PFLG*TFLG
30710      C6=0.5*(ZMU*YU+PFLG*(TW-YU)**2)
30720      C7=C6*FPM*TFLG**3/6.0
30730      4 QD=8.0*ZMU/(ZLV*ZLW)
30740      RETURN
30750C
30760      60 FORMAT(//INPUT LV,LH,TW,TFLG,EM,FPM,ICASE,LVW,LHW,GAMMA)
30770      62 FORMAT(//PROPERTIES OF UNREINFORCED MASONRY WALL (ARC-ING)
30775      * -- SUPPORT TYPE NO.1,13,
30780      * 6X,ELV =,F6.1,* INCHES*,6X,ELH =,F6.1,
30790      * INCHES   RATIO =,F6.3,/6X,EW =,FS.1,* INCHES*,
30800      7X,EM =,F10.1,* PSI   FPM =,F8.2,* PSI*,/3X,
30810      *GAMMA =,F6.1,* PCFe,7X,TFLG =,F6.3,* INCHES*,
30820      5X,ELW =,F6.1,* INCHES*,5X,ELHW =,F6.1,* INCHES*,
30830      5X,QMUL =,F6.3)
30835C
30840C     DETERMIN THE RESISTANCE FOR THE WALL AT A DEFLECTION OF Y(I)
30850      99 IF(Y(I).GT.YU)GOTO 100
30860C
30870C     DEFLECTION OF WALL LESS THAN YU
30880      ZMC=Y(I)*ZMU/YU
30890      ZMAVG=0.5*ZMC
30900      GOTO 130
30920C
30930C     DEFLECTION OF WALL GREATER THAN YU
30940      100 IF(TFLG2.NE.0)GOTO 110
30950      ZMC=0.25*FPM*(TW-Y(I))**2
30960      ZMAVG=(C1-FPM*(TW-Y(I))**3/12.0)/Y(I)
30970      GOTO 130
30980C
30990C     HOLLOW MASONRY UNIT WALL -- DEFLECTION LESS THAN Y2
31000      110 IF(Y(I).GT.Y2)GOTO 120
31010      ZMC=PFLG*(TWF-Y(I))
31020      ZMAVG=(C6-0.5*PFLG*(TWF-Y(I))**2)/Y(I)
31030      GOTO 130
31040C
31050C     HOLLOW MASONRY UNIT WALL -- DEFLECTION GREATER THAN Y2
31060      120 ZMC=0.25*FPM*(TW-Y(I))**2
31070      ZMAVG=(C7-(TW-Y(I))**2/12.0)/Y(I)
31080      GOTO 130
31090C
31100C     COMPUTE TOTAL RESISTANCE OF WALL
31110      130 Q=C4*(C2*ZMC+C3*ZMAVG)*QMUL
31120C     IF DEFLECTION IS GREATER THAN WALL THICKNESS, RESISTANCE = 0
31130      IF(Y(I).GT.TW)Q=1E-10
31140      RETURN
31150      END
60000 SUBROUTINE WINDOW(QMULT,ZLV,ZLH,ZLW,ZLHW,AWIN,AWALL,R,ICASE)
60010C

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PROGRAM ARCHING (CONTINUED)

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60020C: THIS SUBROUTINE DETERMINES THE STRUCTURAL
60030C: MODIFICATION FACTOR FOR WALLS WITH WINDOWS
60035 IF(ICASE.GT.4.AND.ICASE.NE.10)GOTO 320
60040 RWWS=ZLVW/ZLV
60050 RWWL=ZLHW/ZLH
60060 RAREA=AWIN/AWALL
60070 IF(R.LE.1.5)GOT0 300
60080 IF(RWWS.GT.0.7)GOT0 300
60090 IF(RWWL.LT.0.5)GOT0 300
60100 IF(RWWS.EQ.RWWL)GOT0 300
60110C
60120C: CASE WHERE LV/LH >= 1.5, LVW/LV <= 0.7, AND LHW/LH >= 0.5
60130C: (BUT LVW/LV NOT EQUAL TO LHW/LH)
60140 QMULT=-5.85461-12.6644*RAREA+4.39662*RWWS+0.84843*RWWL
60150+ -0.223*R-1.07269*(ZLVW/ZLHH)**0.9+6.59942*EXP(RAREA)
60160 GOT0 315
60170C
60180C: CASE WHERE ONE OR MORE OF ABOVE CONDITIONS IS NOT MET
60190 300 QMULT=0.62022-2.23415*RAREA***(RWWL**4)-0.79461*RWWL**2
60200+ -2.27663*RWWL+0.62522*RWWL/RAREA**0.3
60210+ +2.63043*EXP(RAREA)-0.09268*RWWS
60220 315 CONTINUE
60230 RETURN
60240C
60250C ONE-WAY ACTION WALLS
60260 320 QMULT=(AWALL-ZLV*ZLHW)/(AWALL-AW N)
60270 RETURN
60280 END
70000 SUBROUTINE RANDOM (IENTRY)
70010C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
70020C VARIABLES; GENERATES RANDOM VALUES; AND CONTROLS REQUIRED
70030C NUMBER OF CASES TO BE RUN, AND OUTPUTS FINAL RESULTS AND SUMMARY
70040C
70050 COMMON Y(100),YU,YFAIL,Q,QU,AREA,ZMASS,ZHLM,VH1,VH2,VV1,VV2
70060 COMMON KWALL,KINC,KRF,KRAND,I,ICASE,FU,VFAIL,FR,FPM,EM,FDY
70070 COMMON FDC,D(4),LDTYPE,PEXT,PF,PS,PDE,PC,TC,TO,PB,TIME,L,S
70080 COMMON /RAND/ TIMEC,IWALL
70090 DIMENSION CHI25(7),CHI975(7),TDIST(7)
70100C
70110C VALUES FOR 97.5% (F=19,24,29,34,39,44,49)
70120 DATA CHI25/.4688,.5167,.5533,.5825,.6065,.6267,.6440/
70130 DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
70140 DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
70150C
70160 GOT0(5,50,70),IENTRY
70170 5 XDUMMY=XNORM1(-1.0,0.0,1.0)
70180C INITIALIZE RANDOM NUMBER GENERATOR
70190 PRINT //,*INPUT NRAND*,READ,NRAND
70200 READ,NRAND
70210 DO 47 I=1,NRAND
70220 XDUMMY=XNORM1(0.0,0.0,1.0)
70230 47 CONTINUE
70240 INDEX=0$ SPS=0$ SSPS=0
70250 ICHECK=20
70260C
70270C INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
70280 PRINT 87
70290 READ,SMEAN,SSD
70300 GOT0(10,20),IWALL
70310C UNREINFORCED WALLS WITHOUT ARCHING
70320 10 PRINT 84
70330 READ,FRMEAN,FRSD
70340 PRINT 94
70350 RETURN
70360C UNREINFORCED WALLS WITH ARCHING
70370 20 PRINT 85
70380 READ,FPMMEAN,FPMSD
70390 PRINT 95
70400 RETURN
70460C
70470C GENERATE RANDOM VALUES
70480 50 GOT0(52,54),IWALL
70490 52 FR=XNORM1(0.0,FRMEAN,FRSD)
70500 IF(FR.LE.0)GOT0 52

```

PROGRAM ARCHING (CONTINUED)

```

70510    GOTB 58
70520    54 FPM=XNBRM1(0.0,FPMMEAN,FPMSD)
70530    IF(FPM.LE.0)GOTB 54
70540    55 ALPHA=XNBRM1(0.0,1.0,0.3)
70550    IF(ALPHA.LT.0.4.OR.ALPHA.GT.1.6)GOTB 55
70555    EM=1000.0*ALPHA*FPM
70585    58 IF(SMEAN.EQ.0)GOTB 65
70590    60 S=XNBRM1(0.0,SMEAN,SSD)
70600    IF(S.LE.0)GOTB 60
70610    65 INDEX=INDEX+1
70620    RETURN
70630C SUM VALUES OF PS0 AND PS0*2 FOR USE IN STATISTICAL ANALYSIS
70640    70 SPS0=SPS0+PS0
70650    SSPS0=SSPS0+PS0*PS0
70660C
70670C OUTPUT FINAL RESULTS
70680    GOTB(72,74),IWALL
70690    72 PRINT 90,FR,S,PS0,TIMEC
70700    GOTB 80
70710    74 PRINT 91,FPM,EM,S,PS0,TIMEC
70720    GOTB 80
70740    80 IF(INDEX.LT.1CHECK)RETURN
70750C
70760C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PS0
70770    ZNB=INDEX
70780    ZMEAN=SPS0/ZNB
70790    SD=SQRT((SSPS0-ZNB*ZMEAN*ZMEAN)/ZNB)
70800    STDERR=SD/(SQRT(ZNB-1))
70810C CHECK IF MAXIMUM OF 50 PS0 SAMPLES OBTAINED
70820    IF(INDEX.EQ.50)GOTB 62
70830C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PS0 VALUE IS
70840    IF(STDERR>TDIST((INDEX-15)/5)/MEAN.GT.0.12)GOTB 61
70850C
70860C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
70870C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
70880C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
70890    62 SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
70900C CHECK IF MAXIMUM OF 50 PS0 SAMPLES OBTAINED
70910    IF(INDEX.EQ.50)GOTB 53
70920C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
70930C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
70940    IF(((SDU-SD)/ZMEAN).GT.0.10)GOTB 61
70950C
70960C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
70970C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
70980C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
70990,
71000C AND 10% AND 90% PROBABILITY VALUES
71010    53 ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
71020    ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
71030    SDL=SD/(SQRT(CHI975((INDEX-15)/5)))
71040    P10=ZMEAN-1.282*SD
71050    P10L=ZMEAN-1.282*SDU
71060    P10U=ZMEAN-1.282*SDL
71070    P90=ZMEAN+1.282*SD
71080    P90L=ZMEAN+1.282*SDL
71090    P90U=ZMEAN+1.282*SDU
71100    P90U=ZMEAN+1.282*SDU
71110    P90U=ZMEAN+1.282*SDU
71120C
71130C OUTPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
71140    PRINT 100,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U
71150    P90,P90L,P90U
71160    PRINT 105,INDEX,STDERR
71170    GOTB 999
71180C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90%
71200B
71210C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
71220    61 ICHECK=ICHECK+5
71230    RETURN
71240C
71250    84 FORMAT(/INPUT MEAN AND STANDARD DEVIATION FOR FR0,1)
71260    85 FORMAT(/INPUT MEAN AND STANDARD DEVIATION FOR F'100,1)

```

PROGRAM ARCHING (CONTINUED)

```

71280 87 FORMAT(//INPUT MEAN AND STANDARD DEVIATION FOR S*,*)
71290 90 FORMAT(F9.2,F11.2,F10.2,F14.3)
71300 91 FORMAT(F9.1,F15.1,F12.2,F10.2,F14.3)
71320 94 FORMAT(//,5X,*FR6,10Y,*S*,8X,*PS%,6X,*COLLAPSE TIME*)
71330 95 FORMAT(//,5X,*FPM%,11X,*EM%,12X,*SP%,8X,*PSD%,6X,
71340*   *COLLAPSE TIME*)
71360 100 FORMAT(//,11X,*STATISTICAL PROPERTIES OF INCIPENT PS%,  

71370*   //,39X,*95% CONFIDENCE LIMITS*, //7X,*ITEM*,18X,  

71380*   *VALUE      LOWER      UPPER*, //,* MEAN*, F29.2,  

71390*   2F12.2 //,* STANDARD DEVIATI.M%, F15.2,2F12.2, //  

71400*   * 10% PROBABILITY VALUE*, 3F12.2, //  

71410*   * 90% PROBABILITY VALUE*, 3F12.2)  

71420 105 FORMAT(//,5X,*NUMBER OF OBSERVATIONS ==,13, //SX,  

71430*   *STANDARD ERROR ==,FS.2)  

71440C  

71450 999 STOPS END  

71460 FUNCTION XNORM1(X,A,B)  

71470 IF(X>10,20,20  

71480 10 X0=RANF(-1.0)  

71490 20 X1=RANF(0.0)  

71500 X2=RANF(0.0)  

71510 Y=SQRT(-2.0*ALOG(X1))*(COS(6.283184*X2))  

71520 XNORM1=A+Y*B  

71530 RETURN  

71540 END

```

ADDITION TO PROGRAM ARCHING TO INCLUDE LOAD TYPES 2 THROUGH 5:

```

10040C 2. TRINGULAR LOAD
10050C 3. STEP PULSE
10060C 4. URS SHOCK TUNNEL LOAD
10070C 5. ARBITRARY LOAD SHAPE
10120 DIMENSION TT(20),PP(20)
10150 GOTO(1,2,3,4),IENTRY
10180 1 GOTO(100,110,110,120,130),LDTYPE
10290 110 PRINT 610
10300 READ,TR,T0
10310 GOTO 125
10320 120 PRINT 615
10330 READ,TR,T1,T0
10340 125 IF(KINC.EQ.1)RETURN
10350 PRINT 630
10360 READ,PS0
10370 RETURN
10380 130 PRINT 620
10390 READ,NPOINT,(TT(J),PP(J),J=1,NPOINT)
10400 FACTOR=1.0
10410 IF(KINC.EQ.0)GOTO 150
10420 PMAX=PP(1)
10430 DO 140 J=2,NPOINT
10440 140 IF(PP(J).GT.PMAX)PMAX=PP(J)
10450 150 PX=PP(2)-PP(1)
10460 TX=T?(2)-T?(1)
10465 JJ=1
10470 RETURN
11020 2 GOTO(200,230,230,230,240),LDTYPE
11200 230 PSB=PR
11210 RETURN
11220 240 FACTOR=PR/PMAX
11225 GOTO 150
11230 RETURN
12020 3 GOTO(300,340,360,370,380),LDTYPE
12180 340 IF(TIME-TR)>340,345:345
12190 342 P=PS0*(TIME/TR)
12200 RETURN
12210 345 IF(TIME-T0)>347,350,350
12220 347 P=PS0*(T0-TIME)/(T0-TR)

```

PROGRAM ARCHING (CONCLUDED)

```
12230 RETURN
12240 350 P=0
12250 RETURN
12260 360 IF(TIME=TR)342,362,362
12270 362 IF(TIME=T0)364,364,350
12280 364 P=PS0
12290 RETURN
12300 IF(TIME=TR)342,372,372
12310 372 IF(TIME=T1)364,364,374
12320 374 IF(TIME=TC)376,376,350
12330 376 P=PS0*(T0-TIME)/(TC-T1)
12340 RETURN
12350 380 IF(TIME.LE.TT(JJ+1))G0T0 385
12360 JJ=JJ+1
12370 PX=PP(JJ+1)-PP(JJ)
12380 TX=TT(JJ+1)-TT(JJ)
12390 G0T0 380
12400 385 P=FACTOR*(PP(JJ)+(TIME-TT(JJ))*PX/TX)
12410 RETURN
13060 410 G0T0(415,450,450,460,470),LDTYPE
13190 450 PRINT 680,TR,T0,PS0
13200 RETURN
13210 460 PRINT 685,TR,T1,T0,PS0
13220 RETURN
13230 470 D0 480 J=1,NPOINT
13240 P=FACTOR*PP(J)
13250 480 PRINT 690,TT(J),P
13260 RETURN
14030 610 FORMAT(/*INPUT TR,T0*,*)
14040 615 FORMAT(/*INPUT TR,T1,T0*,*)
14050 620 FORMAT(/*INPUT NUMBER OF LOAD POINTS AND THE TIME AND *,
   *PRESSURE AT EACH POINT*)
14051*   F7.3,* PSI*)
14150 680 FORMAT(10X,*TR **,F6.3,* SEC    T0 **,F6.3,* SEC    PS0 **,
14151*   F7.3,* PSI*)
14160 685 FORMAT(10X,*TR **,F6.3,* SEC    T1 **,F6.3,* SEC    T0 **,
14161*   F6.3,* SEC*,/9X,*PS0 **,F7.3,* PSI*)
14170 690 FORMAT(F15.3,F12-2)
14180 695 FORMAT(10X,*TIME      PRESSURE*)
```

**RCWALL**

**Reinforced Concrete Wall**

PROGRAM RCWALL

```

00100 PROGRAM RCWALL1 (INPUT,OUTPUT)
00105 CALL RETRC(7HRCWALL2,7HRCWALL2)
00110C: THIS PORTION OF THE PROGRAM INPUTS THE REQUIRED WALL AND LOAD
00115C: DATA AND INITIALIZES CERTAIN PARAMETERS
00120C
00150 COMMON <WALL,KINC,LDTYPE,<RF,<RND,TIME,I,Y(100),Q,Q1,YU,YFAIL,
00152+ ZLV,ZLH,TW,PV,FPC,FDY,ICASE,V2BAR,AS(4),APS(4),D(4),DP(4),FDC,
00154+ EC,ES,R,ALP,ALP2,ARE1,ZMASS,QMULT,UFAIL,ZLM,VH1,VH2,VV1,VV2,
00156+ W,P2,C0,LBC,S,ZLEV,CD,PS3,PD3,PR,PEXT,PC,TC,TO,DELAY,
00158+ NWIN,RH03,V1,L1,AA(9,2),VV(8),AFRANT,ASIDES,G,G2,G3,G4,PP2,DT
00160C
00170C: READ TITLE AND CONTROL PARAMETERS
00175 PRINT 67
00180 READ 68,TITLE
00185 PRINT 85
00190 READ,<WALL,KINC,LDTYPE,<RF,<RND
00195 DELAY=0
00200 UFAIL=1E10
00205 67 FORMAT(*INPUT TITLE*,*)
00210 48 FORMAT(A59)
00215 85 FORMAT(*INPUT <WALL(O=EXT,I=INT),KINC,LDTYPE,<RF,<RND*,
00220+ *(I=RND0M)*)
00225C
00230C: * DETERMINE WALL PROPERTIES INDEPENDENT OF FDC,FDY, AND D
00235C
00240 4 D3 S I=1,4
00245 AS(I)=0
00250 S C3VTIVUE
00255C
00260C: * INPUT AND ECHO WALL AND REINFORCEMENT PROPERTIES *
00270 PRINT 615
00275 READ,ZLV,ZLH,1W,PV,FPC,FDY,ICASE,ZLW,ZLHW,V2BAR
00280 FDC=1.25*FPC
00285 EC=57619.0*SQRT(FPC)
00290 ES=29E6
00295 EC(IP)=EC/1000$ ES(IP)=ES/1000
00300 R=ZLH/ZLV
00305 ALP=1.0/RS ALP2=ALP*ALP
00310 IF(ICASE.EQ.4) GOTO 11
00315 R=0$ ALP=0$ ALP2=0
00320 11 PRINT 670
00325 D8 8 I=1,4
00330 PRINT 625,I
00335 READ,AS(I),D(I),APS(I),DP(I)
00350 IF(I.NE.1) GOTO 3
00355 GBT3(8,8,8,8,7,7),ICASE
00360 3 GBT3(9,8,7,6,9,9,9),ICASE
00365 6 IF(I.EQ.3) GOTO 9
00370 G3T3 8
00375 7 I=I+1
00380 9 C3VTIVUE
00385 9 C3VTIVUE
00390C
00395C: *****
00400C: * DETERMINE DEFLECTION AND MOMENT COEFFICIENTS *
00405C: *****
00410C
00415 AWALL=ZLV-ZLH
00420 AWIN=ZLW-ZLHW
00425 AREA=AWALL-AWIN
00430 ZMASS=150.0*AREA*TW/(396.07*1729.0)
00435 QMULT=1.0
00440 IF(AWIN.NE.0)CALL WINDOW (QMULT,ZLV,ZLH,ZLW,ZLHW,AWIN,AWALL,
00441+ R,ICASE)
00445 PRINT 620,ICASE,ZLV,ZLH,ALP,TW,FPC,EC(IP),FDY,ES(IP),PV,
00450+ ZLW,ZLHW,QMULT
00455 PRINT 630
00460 D8 110 I=1,4
00465 IF(AS(I).EQ.0) GOTO 110
00467 P=AS(I)/(12.0*D(I)) $ PP=APS(I)/(12.0*D(I))
00470 PRINT 640,I,AS(I),P,D(I),APS(I),PP,DP(I)
00475C CHANGE UNITS OF REINFORCEMENT FROM SQ-IN./FT TO SQ-IN./IN.
00480 AS(I)=AS(I)/12.0
00485 APS(I)=APS(I)/12.0

```

PROGRAM RCWALL (CONTINUED)

```

00490 110 CONTINUE
00495 615 FORMAT(*INPUT LV,LH,TW,PV,F'C,FDY,ICASE,LVW,LHW,VBAR*)
00500 620 FORMAT(//PROPERTIES OF REINFORCED CONCRETE WALL --,
00505+   * SUPPORT TYPE V2.*,I2,*,
00510+   * LV =*,F6.1,* IN. LH =*,F6.1,* IN. LV/LH =*,
00515+   F5.2+ * TW =*,F6.1,* IN. F'C =*,F7.1,* PSI=,5X,
00520+   *EC =*,F7.1,*=*,FDY =*,F8.1,* PSI   ES **,
00525+   F8.1,* PV =*,F6.1,* LB/IN.*/
00530+   * LVW =*,F6.1,* IN. LH =*,F6.1,* IN. QMULT =*,F6.3)
00535 625 FORMAT(*INPUT AS,D,A'S,S,D* FOR SECTION,12,*)
00540 630 FORMAT(//REINFORCEMENT VALUES/* SECTION AS (P)*,
00545+   9X,*D*,8X,*A'S (P')*,8X,*D'*/*,8X,(SQ.IN./FT.)*,8X,
00550+   *(IN.) (SQ.IN./FT.)*,8X,(IN.)*)
00555 640 FORMAT(15,F11.4,* (*,F6.4,*),F9.3,F10.4,* (*,F6.4,*),F9.3)
00560 670 FORMAT(1H )
00565C
00570C INPUT LOAD PARAMETERS
00571 IF(LTYPE.EQ.5)GOT0 25
00575 100 IF(KRADY.EQ.0)GOT0 102
00576 W=1000.0 S P2=14.7 S C3=1120.0 S L2C=1
00577 GOT0 106
00578 102 PRINT 600
00580 READ,W,P2,C3,L2C,S
00585 IF(LC.EQ.1)GOT0 105
00590 PRINT 605
00595 READ,ZLEN,CD
00600 105 IF(KINC.EQ.1)GOT0 106
00605 PRINT 610
00610 READ,PS0
00615 PR=2.0*PS0*(7.0*P2+4.0*PS0)/(7.0*P2+PS0)
00620 600 FORMAT(*INPUT W,P2,C3,L2C,S*,*)
00625 605 FORMAT(*INPUT L,CD*,*)
00630 610 FORMAT(*INPUT PS0*,*)
00635C
00640C * INPUT R034-FILLING PARAMETERS *
00645 106 IF(KRF.EQ.0)GOT0 20
00650 10 PRINT 700
00652 RH00=0.076 S L1=.FALSE.
00655 READ,NWIN,V3
00660 AT=0$ AFR0NT=0$ ASIDE=0
00665 D0 18 I=1,4WIV
00670 PRINT 710,I
00675 READ,AA(I,1),VV(I),AA(I,2)
00680 AA(I,2)=AA(I,2)/1000.0
00685 AT=AT+AA(I,1)
00690 M=VV(I)$ GOT0(12,14,14),M
00695 12 AFR0NT=AFR0NT+AA(I,1)
00700 GOT0 18
00705 14 ASIDE=ASIDE+AA(I,1)
00710 18 CONTINUE
00715 AFR0NT=AFR0NT/ATS ASIDE=ASIDE/AT
00720 700 FORMAT(*INPUT NWIV AND R034 VOLUME (CF)*,*)
00730 710 FORMAT(*INPUT AREA (SQ FT),LOCATION CODE & DELAY(MSEC)*
00735+   * FOR WINDOW*,I2,*)
00740 G=1.4 S G2=1.0/G S G3=1.0-G2 S G4=2.0/G3 S G5=G+1.
00750 PP2=.1912
00755 C=SORT(G*P2*32.*144./RH00)
00760 TAU=2.0*(V3*(1./3.))/C
00770 DT=TAU/4.0
00775C
00780 20 IF(KWALL.EQ.0)GOT0 25
00785 PRINT 86
00790 86 FORMAT(*INPUT DELAY TIME (MSEC) TO INITIAL LOADING *,*)
00795+   *INTERIOR WALL*,*)
00800 READ,DELAY
00805 DELAY=DELAY/1000.0
00810 25 CALL CHAIN(RCWALL2)
00815 99 STOP
00820 END
00825 SUBROUTINE WINDOW (QMULT,ZLV,ZLH,ZLVM,ZLHW,AWIN,AWALL,R,ICASE)
00830C
00835C THIS SUBROUTINE DETERMINES THE STRUCTURAL
00840C MODIFICATION FACTOR FOR WALLS WITH WINDOWS
00842 IF(ICASE.GT.4.AND.ICASE.NE.10)GOT0 320

```

PROGRAM RCWALL (CONTINUED)

```

00845 RWWS=ZLVW/ZLV
00850 RWL=ZLHW/ZLH
00855 RAREA=AHI/V/AWALL
00860 IF(R.LE.1.5)GOTO 300
00865 IF(RWWS.GT.0.7)GOTO 300
00870 IF(RWL.LT.0.5)GOTO 300
00875 IF(RWWS.EQ.RWL)GOTO 300
00880
00885C: CASE WHERE LV/LH >= 1.5, LV/LV <= 0.7, AND LH/LH >= 0.5
00890C: (BUT LVWLV NOT EQUAL TO LHW/LH)
00895 TMULT=-5.85461-12.5644*RAREA+4.39662*RWWS+0.84843*RWL
00900+ -0.2235R-1.07269*(?LVW?LHW)**0.9+6.59542*EXP(RAREA)
00905 GOTO 315
00910C
00915C: CASE WHERE 3NE. OR MORE OF ABOVE CONDITIONS IS NOT MET
00920 300 QMULT=0.62022-2.23415*RAREA**((RWL**4)-0.79461*RWL**2
00925+ -2.27663*RWL+0.62522*RWL/RAREA**0.3
00930+ +2.63043*EXP(RAREA)-0.09268*RWL
00935 315 CONTINUE
00940 RETURN
00945C
00950C 3NE-WAY ACTION WALLS
00955 320 QMULT=(AWALL-ZLV*ZLHW)/(AWALL-AHI)
00960 RETURN
00965 END
01000 SEGMENT RCWALL2 (INPUT,OUTPUT)
01010C THIS SEGMENT CALCULATES THE RESISTANCE FUNCTION AND
01020C LOADING AND SOLVES THE DYNAMIC EQUATIONS OF MOTION
01030C
01050 C3M4N4V (WALL,INC,LDTYPE,KRF,CRAND,TIME,1,Y(100),0,0,0,YFAIL,
01052+ ZL,V,ZLH,TW,PV,FPC,FDY,ICASE,N3BAR,AS(4),APSC(4),DC(4),DP(4),FDC,
01054+ EC,ES,R,ALP,ALP2,AREA,TMASS,TMULT,VFAIL,ZLM,VH1,VH2,VV1,VV2,
01056+ WP3,CD,L3C,S,ZLEV,CD,PS3,PD3,PF,PEXT,PC,TC,TD,DELAY,
01058+ VV1,VH3,V3,L1,AA(9,2),VV(8),AFR3NT,ASIDE,G,G2,G3,G4,PP2,DT
01078 C3M4N4V /RAND/ TIMEC
01080 DIMEVSN4V A(80),V(80),T(80),VV(80),VH(80),PEX(80),PIN(80),PV(80)
01100C
01250 IF(<INC.VE.1.0.R,LDTYPE,EQ.5)CALL FORCE()
01260 14 IF(<CRAND,VE.1)GOTO 35
01270 CALL FORCE(4)
01280 CALL RAND3M(1)
01290 34 CALL RAND3M(2)
01300 35 CALL RESIST(3)
01310C
01320C: MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
01330C: WHERE THE LOAD CAUSING INCIPIENT COLLAPSE IS TO BE FOUND
01340 13 IF(<INC.EQ.0)GOTO 23
01350 PF=0
01360 PFMAX=0
01370 PFMIN=PF/2.0
01380 GOTO 20
01390 16 PF=(PFMIN+PFMAX)/2.0
01400 20 CALL FORCE(2)
01410 23 IF(<RF.EQ.0)GOTO 24
01420 CALL FILL(PINT,2)
01430C
01440C: INITIALIZE VALUES FOR BETA METH3D (BETA = 1/6) AND COMPUTE VALUE
01450C: FOR FIRST TIME INTERVAL ASSUMING WALL INITIALLY AT REST
01460 24 I=1
01470 TI4F=0
01480 T(1)=0$ V(1)=0$ Y(1)=0
01490 DELTA=0.001
01520 IF(<WALL.EQ.0)GOTO 29
01530 27 IF(TIME.GE.(DELAY-0.00001))GOTO 28
01540 TIME=TIME+DELTA
01550 CALL FILL(PINT,3)
01560 GOTO 27
01570 28 PIN(1)=PINT
01580 TPVET=AREA*PINT
01590 T(1)=TIME
01600 GOTO 30
01610 29 CALL FORCE(3)
01620 TPVET=AREA*PEXT
01630 PV(1)=PEXT

```

PROGRAM RCWALL (CONTINUED)

```

01640 30 CALL RESIST(2)
01650 A(1)=TPNET/(2*MASS*2*L4)
01660 VV(1)=VV1*TPNET
01670 VH(1)=VH1*TPNET
01680C
01690C: PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
01700 I I=1
01710 IF(I.LT.3)GOTO 11
01720 PRINT 93,TIME
01730 99 F30WHAT(/#I=3) TIME =1,F6.3+ FAILURE ASSUMED IF NOT OCCURS
01740 IGT3 6
01750 11 TI=TIME+DELT
01760 T(I)=TIME
01770 A(I)=A(I-1)
01780 CALL F30GE(3)
01790 PEX(I)=PEXT
01800 IF((XWALL.EQ.1)GOTO 10
01810 IF((XW.EQ.0)GOTO 3
01820 CALL F30F(PINT,3)
01830 PIV(I)=PINT
01840 TI=TI-AREAS*(PEXT-PINT)
01850 GOTO 2
01860 3 TPNET=AREA*PEXT
01870 GOTO 2
01880 10 CALL F30F(PINT,3)
01890 PIV(I)=PINT
01900 TPNET=AREA*PIV
01910 2 PV(I)=TPNET/AREA
01920 DO 3 I=1,10
01930 Y(I)=Y(I-1)+DELT*V(I-1)+DELT*DELT*A(I-1)/3.+A(I)/6.+
01940 CALL RESIST(2)
01950 QT=0*AREA
01960 4 ANEW=(TPNET-QT)/(2*MASS*2*L4)
01970 A' DELTA=ANEW-A(I)
01980 A(I)=ANEW
01945 IF(ANEW.LT.0)PRINT *1945*,TIME,TPNET,QT,24255,?,(L4,Y(I),A(I-1)
01990 IF(CABS(ADELTA/(ANEW-1))LT.0.01)GOTO 2
02000 8 CONTINUE
02010 A(I)=ANEW-1*DELT/2.0
02020 PRINT 30,TIME,PF,A(I),Y(I)
02030 9 CONTINUE
02040 Y(I)=Y(I-1)+DELT*V(I-1)+DELT*DELT*A(I-1)/3.+A(I)/6.+
02050 V(I)=V(I-1)+DELT*A(I)+A(I-1)/2.0
02060 VV(I)=VV1*TPNET*VV2*QT
02070 VH(I)=VH1*TPNET*VM2*QT
02090C
02100C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE OF WALL
02110C: IF MAXIMUM DEFLECTION REACHED, WALL DID NOT FAIL
02120 IF(Y(I).LE.Y(I-1).AN..PV(I).LE.PV(I-1))GOTO 6
02130 IF(Y(I).LT.0)GOTO 6
02140 IF(TIME-DELAY.GE.0.010)DELT=0.002
02160 IF(TIME-DELAY.GE.0.020)DELT=0.005
02170 IF(TIME-DELAY.GE.0.100)DELT=0.010
02180 IF(TIME-DELAY.GE.0.500)DELT=0.050
02190C: IF FAILURE DEFLECTION REACHED, WALL FAILED
02200 IF(Y(I).GE.YFAIL)GOTO 7
02210 GOTO 1
02220C
02230C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIDENT
02240C: COLLAPSE F30 CASES WHERE DESIRED
02250C: WALL DID NOT FAIL - SET PF4IN TO PF
02260 4 CONTINUE
02270 IF(KINC.EQ.0)GOTO 14
02290 36 PF4IN=PF
02300 IF(PFMAX.GT.0)GOTO 16
02310 PF=2.0*PF
02320 GOTO 20
02330C: WALL FAILED - SET PFMAX TO PF
02340 7 CONTINUE
02350 TIME=TIME
02370 IF(KINC.EQ.0)GOTO 18
02380 37 PFMAX=PF
02390C: CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
02400 17 IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GOTO 16

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PROGRAM RCWALL (CONTINUED)

```

02410      IF(CKRND,NE,1)GOT 18
02420      CALL RAND34(3)
02430      GOT 34
02440C
02450C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
02460C: ACCURANCE FOR A NON-FAILING WALL OR THE TIME AND VELOCITY
02470C: AT COLLAPSE FOR A FAILING WALL. OPTIONAL INPUT IS THE
02480C: ENTIRE BEHAVIOR TIME-HISTORY OF THE WALL.
02490C
02500C: OUTPUT LOAD DATA
02510 18      CALL FORCE(4)
02520C
02530C: OUTPUT FINAL RESULTS
02540 IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
02550 IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
02560C
02570C: CHECK TO SEE IF ENTIRE TIME-HISTORY OF WALL IS DESIRED
02580 PRINT 72
02590 READ,M
02600      IF(M.EQ.0)GOT 25
02620      IF(CWALL.EQ.1)GOT 32
02630      IF(CRF.EQ.0)GOT 26
02640 PRINT 75,(T(J),PEX(J),PIN(J),PV(J),YC(J),VVC(J),VMC(J),J=1,1)
02650      GOT 25
02660 26 PRINT 76,(T(J),PEX(J),AC(J),VC(J),YC(J),VVC(J),VMC(J),J=1,1)
02670      GOT 25
02680 32 PRINT 76,(Y(J),PIN(J),AC(J),VC(J),YC(J),VVC(J),VMC(J),J=1,1)
02690 25 PRINT 77
02700 STOP
02710C
02740 70 FORMAT(/*WALL DID NOT FAIL - MAX. DEFLECTION 3F*F6.2
02750*   * IV. REACHED 4T*F7.3,* SEC*)
02760 71 FORMAT(/*WALL FAILED AT*,F7.3,* SEC (FINAL VELOCIT*,F7.2*
02770*   F7.2* IV./SEC*)*)
02780 72 FORMAT(/*IS TIME HISTORY OF WALL DESIRED (YES=1, NO=0)*,I1)
02790 75 FORMAT(15X*PRESSURE ON WALL*/* TIME EXTERIOR *
02810*   *INTERIOR   VET   DISPLACEMENT   VV   VM/*
02820*   (F6.3,F10.3,F12.4,F11.0,FR.0))
02830 76 FORMAT(/* TIME PRESSURE ACCELERATION VELOCITY *
02840*   *DISPLACEMENT   VV   VM/*
02850*   (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0,FR.0))
02860 77 FORMAT(/*,7(*-----*)*)
02870 80 FORMAT(/*ACCELERATION VET CONVERGING AT TIME *,F6.3,
02880*   * SEC (PF =*,F7.3,* PSI)*/* C(I) SET EQUAL TO *,
02890*   FR.1* (AVG OF LAST 2 ITERATIONS)*/* Y(I) =*,F6.4,* (V.*)
02900*   F6.4,* (V.*)
02960 999  EXIT
02970  END
1000C SUBROUTINE FORCE(1ENTRY)
10010C THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
10020C THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
10030C 1. IDEALIZED BLAST LOAD (FRONT OR SIDE FACE)
10050C 044444<WALL,KINC,LDTYPE,KRF,KRND,TIME,I,Y(100..2,0),YU,YFAIL>L,
100524<LV,ZLH,TU,PV,FPC,FDY,ICASE,V3BAR,AC(4),APS(4),D(4),DP(4),FDC,
10055<EC,ES,R,ALF,ALPR,AREA,Z4ASS,MULT,UFAIL>ZLH,VM1,VM2,VV1,VV2,
10056<WPB,CB,LBC,S,ZLEV,CD,PSB,PDJ,PR,P,PC,TC,TD,DELAY,
10058<VV1,VV2,RH98,V3L1,AA(8,2),VN(8),AFR97,ASIDE,G,G2,G3,G4,PP2,UT
10060 DIMENSION TT(10),PP(10)
10080C
10130 IF(LDTYPE.EQ.5)GOT 500
10140C
10150 GOT 215,200,300,41,1ENTRY
11000C
11010C CALCULATE LOAD PROPERTIES FOR GIVEN PEAK PRESSURE
11030 200 GOT 205,210,LBC
11040 205 PSB=(PR-14.0*PS+SQRT(196.0*PS*PS+196.0*PS*PR+PR*PR))/16.0
11050 GOT 215
11060 210 PSB=PR
11070 215 PDB=2.5*PSB*PSB/(7.0*PR+PSB)
11080 U=CR*SQRT(1.0*(6.0*PSB)/(7.0*PR))
11090 TU=WP*0.3333/(2.2399*0.1956*PSB)
11100 GOT 220,225,LBC
11110 P20=TC*3.0*S/U
11120 PC=PSB*(1-TC/TO)*EXP(-TC/TO)+PDB*(1-TC/TO)**2*EXP(-2*TC/TO)

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PROGRAM RCWALL (CONTINUED)

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11130 C0=1.0
11140 RET IRV
11150 225 TA=TL/PV/ I
11160 TA2=TA/2.0
11170 TA20=TA2/I0
11180 PAP=PI*(1-TA2/I0)*EXP(-TA2/I0)+C0*PI2*(1-TA2/I0)*2*F(P=2*I0/TA2/I0)
11190 RET/2
12000C
12010C CALCULATE L1A0
12030 300 G1T1(305,310),LAC
12040 305 TT0=TIME*P0
12050 FACT14F=.87,TT0=G1T1 320
12060 P=PP*(I0-1)*P0*(P0-P1)/I0
12070 RET IRV
12080 310 TT1=TIME*P0-(I0-1)*P0/I0
12090 FACT14F=.87,TT1=G1T1 320
12100 P=PP*(I0-1)*P0/I0
12110 RET/IRV
12120 320 LF((P0),P0+1.0),G1T1 330
12130 P=PP*(I0-1)*P0*(P0-TT0)+C0*PI11*(1-TT0)*2*F(P=2*T0)
12150 RET IRV
12160 322 P=2
12170 PFI IRV
13000C
13010C PRINT L1A0, L1A1
13020 4 LF((L1A0,L1A1),1),G1T1 400
13030 PRINT 640,L1TYPE
13040 5112 413
13050 400 PRINT 640,L1TYPE
13060 413 G1T1(405,425),LAC
13070 415 G1T1(420,425),LAC
13080 420 PRINT 650
13090 G1T0 430
13100 425 PRINT 655
13110 430 PRINT 640,40,P1,C1
13120 LF((L1A0,L1A1),0)RET/IRV
13130 G1T0(435,440),LAC
13140 435 PRINT 655,40,T0,P-
13150 G1T1 445
13160 440 PRINT 670,1LF4,TA,PA
13170 445 PRINT 675,470,C0,P0,P11
13180 RET/IRV
13500C
13510C L1A0 TYPE S -- ARRHEMAYER L1A0 SHAPE
13520 500 G1T1(510,520,530,540),LF ITPV
13530C
13540C INPUT L1A0 DATA
13550 510 PRINT 640
13560 4840,4931,4976,TT(1),PP(1),I=1,4P31,4P7
13570 FACT39*1.6
13580 IF((L1C,0,0))G1T1 514
13590 PMAX=PP(1)
13600 03 515 J=2,4P31
13610 515 IF(PP(1),GT,PMAX)PMAX=PP(1)
13620 515 P=PP(2)-PP(1)
13630 I=I+TT(2)-TT(1)
13640 J/J
13650 RET/IRV
13660C
13670C CALCULATE MAXIMUM L1A0
13680 520 FACTMAX=PP/PMAX
13691 G1T0 514
13700 RET/IRV
13710C
13720C CALCULATE L1A1
13730 530 LF((TIME,L1A1),I0+1),G1T1 530
13740 I=I+1
13750 P=PP(I)=PP(I)
13760 T0=TT(I)=TT(I)
13765 LF((T0,S),0)ITK=1E-10
13770 G1T0 530
13780 535 P=FACT39*(PP(1)+C1*45-TT(1))*P0/T0
13790 RET IRV
13800C

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PROGRAM RCWALL (CONTINUED)

```

1310C PRINT LOAD DATA
1315 S40 IF(INC.EQ.1)PRINT 640,LDTYPE
1320 IF(INC.EQ.0)PRINT 645,LDTYPE
1325 PRINT 690
1330 D8 S45 I=1,NPRINT
1340 P=FACTR*PPC()
1350 S45 PRINT 695,TTC(),P
1360 RETURN
1400C
14010 600 F9RMAT(/+IPIT W,P3,38,L3C,S+,)
14020 605 F9RMAT(/+INPUT L,CCS++)
14030 630 F9RMAT(/+INPUT PSR++,)
14040 640 F9RMAT(/+L3A1) -USING INCIDENT FAILURE IS AS FOLLOWING:
14041 /,5X,0L3AD TYPE NUMBER,12)
14042 645 F9RMAT(/+P7)PROPERTIES OF LOAD ACTING ON WALL ARE AS FOLLOWS:
14043 /,5X,0L3AD TYPE NUMBER,12)
14044 650 F9RMAT(BX,*(FRONT FACE))
14100 655 F9RMAT(BX,*(SIDE FACE))
14110 660 F9RMAT(10X,0W 00,FH,1,0 <T P3 00,F6,2,0 PSI CD 0,
14111 F7,1,0 FPS)
14120 665 F9RMAT(10X,0S 00,F6,1,0 FT TC 00,F6,3,0 SEC PR 0,
14121 F7,3,0 PSI)
14130 670 F9RMAT(10X,0L 00,F6,1,0 FT TA 00,F6,3,0 SEC PA 0,
14131 F7,3,0 PSI)
14140 675 F9RMAT(10X,0U 00,F7,1,0 FPS TO 00,F6,3,0 SEC CD 0,
14141 FS,1,/,5X,0PSD 00,F7,3,0 PSI PD4 00,F7,3,0 PSI)
14150 680 F9RMAT(/+INPUT NUMBER OF LOAD POINTS AND THE TIME AND 0,
14151 *PRESSURE AT EACH POINT)
14160 690 F9RMAT(/+10X,0TIME PRESSURE)
14170 695 F9RMAT(F15.3,F12.2)
15000 END
20000 SUBROUTINE FILL(P3,I24TRY)
20010C COMPUTES AVERAGE AIR PRESSURE IN R834 DUE TO BLAST WAVE
20020C INCIDENT HEAD-ON UPON FRONT WALL.
20030C
20030 C8M43N <WALL,<INC,<LDTYPE,<RF,<RAND,TIME,II,Y(100),Q,QU,YFAIL,
20052 Z,V,ZLH,TW,PV,FPC,FDY,1CASE,V3BAR,AS(4),APS(4),DC4),DP(4),FDC,
20054 ECA,F3,R,ALP,4LP2,AREA,ZMASS,QMULT,YFAIL,ZALH,VM1,VM2,VV1,VV2,
20056 W,PB,C9,L3C,S,ZLEN,CD,PS4,PD8,PR,PEXT,PC,TC,TO,DELAY,
20058 VV1,RH80,V3,L1,AA(3,2),VV(R:,AFR3VT,ASIDE,G,G2,G3,G4,PP2,DT
20090 LOGICAL L1,L2,L3
20095C
20100 G010(10,13,11),IENTRY
20110 10 RETURN
20310C
20320 I3 P30=P3
20330 TT=0.5 T9=0.
20340 RH332=RH83
20350 L2=.FALSE. S L3=.FALSE.
20360 RETURN
20370C
20380 II IF(L1)G0T8 S2
20385 IF(L2.A.L3)G0T9 9
20390 S2 DDT=(TIME-T3)*0.5
20395 IST8P=2
20400 S3 IF(DDT.LT.DT)G0T8 S1
20410 S0 DDT=0.5*DDT
20415 IST8P=2*IST8P
20420 DB T9 S3
20430 S1 CONTINUE
20440 DB 99 I=1,IST8P
20450 TT=T8+I*DDT
20460 IF(TT.GT.Y0)DB T9 99
20470 DM=G. S MM0. S YW0
20480 DB 500 <0.1,YW1
20490 M=YV(X) 3 DLV=AA(X,2)+0.000001
20500 IF(DLV.GE.TT)DB T9 500
20510 G0T2(I5,16,16),4
20520 I5 CDV=1.0
20530 IF(TT-TC)20,20,21
20540 20 P11=(TC-TT)*(PR-PC)/TC+PC
20550 P110P;1*PR
20560 GE T9 30
20570 16 CDF=-2.4

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PROGRAM RCWALL (CONTINUED)

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20400 91 P=TT/T0 S RR=1.-R
20410 P0=P0*RR*EXP(-2.*R)
20420 PS=PS3+RR4-E(PC-2)
20430 P11=PS+CDF<P0
20440 P11=P11+P1
20450 30 RH31=RH31*((P11/P1)*G2)
20460 IF(P11>P34)36,76,77
20470 ISIGN=-1
20480 L2=.TRUE.
20490 303 P2=P11
20500 PH32=((P2/P11)**G2)*RH33
20510 X=P33/RH33
20520 G3 T3 38
20530 37 ISIGN=+1
20540 306 PC=PP2+P11
20550 RH32=((PH32/P11)**G2)*RH31
20560 Y=P11/RH31
20570 38 J22=64*(X-P2/RH32)*32.+144.
20580 IF(J22>40)39,39
20590 40 P2=Y*G2 NEGATIVE*,J22
20600 STOP
20610 39 J2=SORTC(J22)*ISIGN
20620 0ME=J2*RH32*ACK(+1)*DDT
20630 D4=D4+DDM
20640 4m=1+P11*DDM/(G3*RH31)
20650
20660 500 CONTINUE
20670 P33=P33+(G-1.)*YW/Y3
20680 RH33=RH33+D4/Y3
20690 99 CONTINUE
20700 T3=TT
20710 P3=P33-P1
20720 IF(TIME.GE.TCIL3=.TRUE.
20730 RETURN
20740 9 RETIME/T0 S RR=1.0-R
20750 P0=P0*RR*EXP(-2.0*R)
20760 PS=PS3+RR*EXP(-R)
20770 P3=PS+P1*(AFR3YT-0.4*AS1DF)
20780 999 RETURN
21020 END
30000 SUBROUTINE RESIST (IENTRY)
30010C: THIS SUBROUTINE INPUTS THE REQUIRED WALL DATA, DETERMINES THE
30020C: RESISTANCE FUNCTION, TRANSMISSION FACTORS, AND REACTION
30030C: COEFFICIENTS AND SUPPLIES THE REACTION VALUES FOR SPECIFIC
30040C: DEFLECTIONS REQUIRED IN THE DYNAMIC ANALYSIS
30045C
30050 C0113V <WALL,<INC,LTYPE,KRF,<RAND,TIME,I,Y(100),O,OU,YU,YFAIL,
30051> RL,V>ZLH,TW,PV,FPC,FDY,I,CASE,VRAR,AS(4),APS(4),DP(4),FDC,
30052> SC,ES,R,ALP,ALP2,ARE4,ZMASS,DMULT,VFAIL,T<LM,VH1,VH2,VVI,VV2,
30053> W,P3,C3,L0CS,ZLEN,CD,PS3,PD3,PR,PEXT,PC,TC,T0,DISPLAY,
30054> VVIN,R400,Y3,L1,AA(3,2),VV(3),AFR3YT,ASIDES,G,G2,G3,G4,PP2,DT
30100 REAL N,IC,IG,MM,((1,-2),(3,MJ(4)),IC(4))
30135C
30140 G3TR(4,500,45),1ENTRY
30150 4 RETURN
30790C
30800C: ***** * ENTRY 2: DETERMINE WALL PROPERTIES *
30810C: * DEPENDENT ON FDC, FDY, AND D *
30820C: * ***** *
30830C: ***** *
30840C: ***** *
30850 45 N=FS/SC
30860 FR=4.0*SORT(FDC)
30870 1G=TW*(3/12+(V-1)*(ASC(1)+(OC(1)-TW/2)**2+APS(1)*(TW/2-OP(1))**2)
30880 CALL C3FF((ICA-5,R,ASS,455,1F,RF,1G,ZL,V>ZLH,PV,VX,CF,SC,1)
30890 1M=2.0*IG*(FR+PV/TW)/TW
30920 CALL M34ENT(FDC,FDY,ES,N,PV,I+0,AS,APS,0,DP,1,I,IC)
31470 GMU=MU(2)/M(1)
31480C
31490C: DETERMINE POSITION OF YIELD LINES AND ULTIMATE RESISTANCE
31500C: COEFFICIENTS FOR TWO-WAY WALLS
31510 IF(ICASE.GT.4)G11 106
31520 Z11=MU(4)/MU(2)
31530 Z13=MU(3)/MU(1)

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PROGRAM RCWALL (CONTINUED)

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31540 GAMMA12=2.0*SORT(1.0+Z11)
31550 GAMMA34=2.0*SORT(1.0+Z13)
31560 GRAT=GAMMA12/GAMMA34
31570 B=SORT(1+Z11)*(GMU*ALP2/GAMMA34)*(SQR(GRAT**2+3/
31580+ (GMU*ALP2))-GRAT)
31590C IF BETA IS GREATER THAN 0.5 ASSUMPTION OF CRACK PATTERN A
31600C NOT VALID AND CRACK PATTERN B IS ASSUMED TO OCCUR
31610 IF(B.LE.0.5)GOT9 105
31620C
31630C CRACK PATTERN B
31640 KRAM=1
31650 B=SORT(1.0+Z13)*(SQR(1.0/GRAT**2+GMU*ALP2*3.0)-1.0/GRAT)
31660+ /(GMU*ALP2*GAMMA12)
31670 OUTERM=6.0*GAMMA12**2*ZL1*GMU/(SQR(3.0/(GMU*ALP2*GRAT**2)))
31680+ -1.0/(SQR(GMU*ALP2*GRAT))**2
31690 GOT9 108
31700C
31710C CRACK PATTERN A
31720 105 CONTINUE
31730 KRAM=0
31740 OUTERM=6.0*GAMMA34**2/(ALP*(SQR(3+GMU*ALP2*GRAT**2)
31750+ -ALP*GRAT*SQR(GMU))**2)
31760 GOT9 105
31770C
31780C DETERMINE MOMENT AND DEFLECTION COEFFICIENTS
31790C FOR CRACKED PORTION OF WALL BEHAVIOR
31800 106 B=0
31810 106 IF(PV.EQ.0)GOT9 180
31820 CALL COEF(ICASE,R,ASSC,BSSC,AFC,BFC,IC,ZLV,ZLH,PV,X,CF,EC,2)
31830 GOT9(195,195,195,195,112,115,120),ICASE
31840 112 OUTERM=1.0/(BSSC*ZLV)
31850 GOT9 195
31860 115 OUTERM=(1.0/BSSC+(ZLV*ZLV*PV/(EC*IC))*MU(3)/(MU(1)*((1.0
31870+ -COS(0.5*ZLV*SQR(PV/(EC*IC)))))/ZLV
31880 CF*BFC
31890 GOT9 195
31900 120 OUTERM=(1.0+0.5*MU(3)/(MU(1))*COS(0.5*ZLV*SQR
31910+ (PV/(EC*IC)))/(BSSC*ZLV)
31920 CF=BFC
31930 GOT9 195
31940 180 ASSC=ASSS AFC=AF
31950 GOT9(195,195,195,185,185,190),ICASE
31960 182 OUTERM=1.0/(BSSC*ZLV)
31970 GOT9 195
31980 185 OUTERM=(MU(3)/MU(1)+1.0)/(BSSC*ZLV)
31990 GOT9 195
32000 190 OUTERM=(0.5*MU(3)/MU(1)+1.0)/(BSSC*ZLV)
32010 195 GOT9(200,210,210,210,200,210,210),ICASE
32020C
32030C *****DETERMINATION OF RESISTANCE CURVE FOR WALL*****
32040C * DETERMINE RESISTANCE CURVE FOR WALL *
32050C * (3 IS IN UNITS OF PSI, KK IN LB/CU-IN., AND Y IN INCHES) *
32060C ****DETERMINATION OF RESISTANCE CURVE FOR WALL****
32070C
32080C CASES 1 AND 5
32090 200 Q1=MM/(BSSC*ZLV*ZLV)
32100 KK1=EC*IG*(ASSC*ZLV**4)
32110 Y1=Q1/KK1
32120 KK2=EC*IC*(ASSC*ZLV**4)
32130 IF(ICASE.EQ.5)GOT9 205
32140 QU=OUTERM*MU(1)/(ZLV*ZLH+0.5*OUTERM*PV/KK2)
32150 GOT9 208
32160 205 QU=OUTERM*MU(1)/ZLV
32170 208 YU=QU/KK2
32180 GOT9 280
32190C
32200C CASES 2, 3, 4, 6, & 7
32210 210 Q1=MM/(BFC*ZLV*ZLV)
32220 KK1=EC*IG*(AF*ZLV**4)
32230 Y1=Q1/KK1
32240 Q2=MU(4*X)/(CF*ZLV*ZLV)
32250 KK2=EC*IC*(AFC*ZLV**4)
32260 Y2=Q2/KK2
32270 KK3=EC*IC*(ASSC*ZLV**4)

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PROGRAM RCWALL (CONTINUED)

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32240 IF((ICASE.GT.4)GOTO 215
32240 QJ=QITER4*(4*(1)-PV*(Y2-22/((3)/2)/(7LV*7LH+1)+3*QITER4*PV/((3)
32360 GOTO 220
32310 215 11E0ITER4*PV*(1)/2LV
32320 220 YU=Y2+(QJ-72)/((3
32330 230 IF(PV.GE.0)YFV=PV*(1)/(PV*(1.0-9))
32340C
32350C: CHECK FOR TYPE OF FAILURE - LIGHTLY REINFORCED OR CONVENTIONAL
32360 IF(YH*(1).LT.1.5*MM)GOTO 244
32370C
32380C: CONVENTIONAL TYPE FAILURE
32390C: YFAIL=Y*(0.1/(AS*(1)/D*(1)))
32400C: STABILITY FACTOR MUST BE <= 30
32410 IF(YFAIL.GT.30.0*YU/YFAIL=30.0*YU
32430 GOTO 245
32440C
32450C: LIGHTLY REINFORCED TYPE OF FAILURE
32460C: THE FOLLOWING EXPRESSION IS BASED ON A STEEL ELONGATION OF 20%
32470 238 JCDEF=30
32480 11PJ=JCDEF*SORT(FDC)
32490 ABAR=.14159*(V13A2/14.1)**2
32500 299 YFAIL=SORT((0.2*ABAR*F0Y/10.1*71.0/2.1)**2-(7LV*2.3)**2)
32510 245 IF(PV.E.1.0)GOTO 295
32520C
32530C: IF FAILURE DEFLECTION DUE TO INSTABILITY IS LESS THAN VALUE
32540C: BASED ON REINFORCEMENT, SUBSTITUTE THIS VALUE FOR YFAIL
32550 IF(YFAIL.GT.YFV)YFAIL=YFV
32560 QFAIL=30*(YFV-YFAIL)/(YFV-YU)
32570 GOTO 299
32580 295 QFAIL=70
32590 299 C9NTINUE
32600C
32610C: MODIFY RESISTANCE VALUES BY WIND/WAVE MODIFICATION FACTOR
32620 Q1=Q1*QMULT
32630 Q2=Q2*QMULT
32640 Q3=Q3*QMULT
32650 QFAIL=QFAIL*QMULT
32660 ((1=(((1*QMULTS ((2=((2*QMULTS ((3=((3*QMULTS
32670C
32680C: INPUT IT IS A DEFLECTION CURVE
32690 IF(KRAN0.EQ.1)GOTO 335
32700 PRINT 630
32710 IF(ICASE.EQ.1.OR.ICASE.EQ.5)GOTO 320
32720 PRINT 660,Q1,Y1,Q2,Y2
32730 GOTO 330
32740 320 PRINT 660,Q1,Y1
32750 330 PRINT 660,QU,YU,QFAIL,YFAIL
32760 335 C9NTINUE
32770C
32780 CALL TRNS (3,7LV,2LH,ICASE,CR4K,24L4SE,24L4FE,24L4P,V41S,V42S,
32790, VV1S,VV2S,V41F,V42F,VV1F,VV2F,V41P,V42P,VV1P,VV2P)
32810 RETURN
32820C
32830C: ****
32840C: * ENTRY 3: DETERMINE THE RESISTANCE (PER UNIT AREA) *
32850C: * IF THE WALL AS A FUNCTION OF Y(I) *
32860C: ****
32870C
32880 500 IF(Y(I).GE.YFAIL)GOTO 540
32890 IF(Y(I).GT.YU)GOTO 540
32900 GOTO(S01,S20,S20,S01,S20,Y20),ICASE
32910 S01 C9NTINUE
32920C
32930C: ELASTIC RANGE -- CASES 1 AND 5
32940 ZKL4=24L4SE
32950 V41=V41S S V42=V42S
32960 VV1=VV1S S VV2=VV2S
32970 IF(Y(I).GT.Y1)GOTO 510
32980C
32990C: UNCRACKED PARTITION -- ALL CASES
33000 S05 Q=Y(I)*441
33010 RETURN
33020C
33030C: CRACKED PARTITION -- CASES 1 AND 5

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PROGRAM RCWALL (CONTINUED)

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33040 S10 Q=Q1+(Y(I)-Y1)*(QU-Q1)/(YU-Y1)
33050 RETURN
33060C
33070 S20 IF(Y(I).GT.Y2)GOT3 S30
33080C
33090C: ELASTIC RANGE -- CASES 2,3,4,6,7
33100 ZKL4=ZKL4FE
33110 VH1=VH1F $ VH2=VH2F
33120 VV1=VV1F $ VV2=VV2F
33130 IF(Y(I).LT.Y1)GOT8 S55
33135C: CRACKED PARTITION -- CASES 2,3,4,6,7
33140 Q=Q1+(Y(I)-Y1)*(Q2-Q1)/(Y2-Y1)
33145 RETURN
33150C
33160C: ELASTIC-PLASTIC RANGE -- CASES 2,3,4,6,7
33170 S30 ZKL4=ZKL4SE
33180 VH1=VH1S $ VH2=VH2S
33190 VV1=VV1S $ VV2=VV2S
33200 Q=Q2+KK3*(Y(I)-Y2)
33210 RETURN
33220C
33230C: PLASTIC RANGE -- ALL CASES
33240 S40 ZKL4=ZKLMP
33250 VH1=VH1P $ VH2=VH2P
33260 VV1=VV1P $ VV2=VV2P
33270 IF(PV.GT.0)GOT3 S50
33280C: VS INPLACE FORCES
33290 Q=QU
33300 RETURN
33310C: WITH INPLACE FORCES
33320 S50 Q=QU*(YFV-Y(I))/(YFV-Y1))
33330 RETURN
33340C
33350C: WALL COLLAPSED - VS RESISTANCE (TO AVOID NUMERICAL DIFFICULTIES)
33360C: FOR CERTAIN CASES SET RESISTANCE EQUAL TO VERY SMALL VALUE)
33370 S60 Q=1E-10
33380 RETURN
33390C
333530 650 FORMAT(//*LOAD-DEFLECTION CURVE*,//3X,7Q (PSI)      Y (IN.)*)
333530 660 FORMAT(F9.2,F12.4)
33370 END
35000 SUBROUTINE MOMEVT(FDC,FDY,ES,N,PV,B,AS,APS,D,DP,MU,ICR,IC)
35010C THIS SUBROUTINE DETERMINES THE ULTIMATE MOMENT CAPACITY AND
35020C CRACKED MOMENT OF INERTIA FOR REQUIRED SECTIONS
35040 REAL I1(2),K3(4),UD(4),IC,ICTBT,MU(4),ICR(4),AS(4),APS(4),D(4),DP(4)
35050C
35060C: DETERMINE VALUES OF CONCRETE PARAMETERS
35070 45 K1=0.94-FDC/26E3
35080 42=0.50-FDC/8E4
35090 K3=(3900.0*J.35*FDC)/(3E3+0.82*FDC-FDC*FDC/26E3)
35100 EPSC=0.004-FDC/65E5
35150C: ***** DETERMINE ULTIMATE MOMENT CAPACITY AND CRACKED *****
35160C: * MOMEVT OF INERTIA FOR REQUIRED SECTIONS *
35170C: * MU(4) = MOMEVT OF INERTIA FOR REQUIRED SECTIONS *
35180C: ***** ***** ***** ***** ***** ***** ***** ***** ***** *****
35190C
35200 II=03 ICTBT=0
35210 DO 170 I=1,4
35220 IF(AS(I).EQ.0)GOT8 170
35230 II=II+1
35240C: ALL PROPERTIES ARE COMPUTED FOR A WIDTH B
35250 TEVS=AS(I)*FDY+PV
35260 IF(APS(I).LE.0)GOT9 150
35270C
35280C: WALL HAS COMPRESSION REINFORCEMENT
35290 C=(K1*(3*FDC+B*DP(I))
35300 TERM1=0.5*(TEVS/APS(I)+ES*EPSC)
35310 TERM2=ES*EPSC*(TEVS-C)/APS(I)
35320C: DETERMINE LOCATION OF NEUTRAL AXIS
35330 IF(TEVS.LE.C)GOT8 140
35340C
35350C: KUD > D'
35360 FPS=TERM1*(K3*FDC/2.0-SQRT((TERM1*(K3*FDC/2.0)**2
35370- (TERM2*ES*EPSC*(K3*FDC)))

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PROGRAM RCWALL (CONTINUED)

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35330C: F'S MUST BE <= FDY
35340 IF(FPS.LT.FDY)GOTO 130
35400 FPS=FDY
35410 130 TPS=APS(1)*(FPS- $\sqrt{3*FDC}$ )
35420  $\sqrt{UD}=(TFNS-TPS)/(\sqrt{3*FDC})$ 
35430  $M(I)=TFNS-TPS*(DC(I)-2*\sqrt{UD})+TPS*(DC(I)-DP(I))$ 
35440  $ICR(I)=R<(UD*3/3.0+N*ASC(I)*DC(I)-\sqrt{UD})*2$ 
35450+  $+(-1)*APS(1)*((UD-DR(I))*2$ 
35460 GOTO 152
35470C
35480C:  $UD < 0$ 
35490 140 FNS=TERM1*SDRT(TERM1**2-TERM2)
35500C: F'S MUST BE <= FDY
35510 IF(FPS.LT.FDY)GOTO 140
35520 FPS=FDY
35530 145 TERM3=TFNS*APS(1)*FPS
35540  $(UD=TERM3/(\sqrt{3*FDC}))$ 
35550  $M(I)=TERM3*(DC(I)-2*\sqrt{UD})-APS(1)*FPS*(DC(I)-DP(I))$ 
35560  $ICR(I)=R<(UD*3/3.0+N*ASC(I)*(DC(I)-\sqrt{UD})*2+V*APS(1)*(DP(I)-\sqrt{UD})*2$ 
35570 GOTO 152
35580C
35590C: WALL HAS NO COMPRESSIVE REINFORCEMENT
35600 150  $UD=TFNS/(\sqrt{3*FDC})$ 
35610  $M(I)=TFNS*(DC(I)-2*\sqrt{UD})$ 
35620  $ICR(I)=R<(UD*3/3.0+N*ASC(I)*(DC(I)-\sqrt{UD})*2$ 
35630C
35640 152 ICR(I)=ICR(I)*ICR(I)
35650 170 CONTINUE
35660C
35670C: DETERMINING AVERAGE CRACKED MOMENT OF INERTIA
15610 175  $IC=ICT1/11$ 
15620 RPT 124
15700 END
40000 SUBROUTINE COEF(CASE,R,ASS,RES,AF,EL,LU,ZL,H,P,V,NX,CF,
40010+ E,ENTRY)
40020C: THIS SUBROUTINE DETERMINES MOMENT AND DEFLECTION COEFFICIENTS
40030C: FOR ONE-WAY (CASES 5-7) AND TWO-WAY (CASES 1-4) WALLS
40040C
40050     REAL T,MPR,MPSD,V
40060     IF(ENTRY.EQ.2)GOTO 200
40070     V=1
40080     IF(ICASE.GT.4)GOTO 50
40090C
40100     R2=R*R
40110     R3=R*R2
40120     R4=R2*R2
40130     ASS=-.007030+.013990*R-.003456*R2+.000286*R3
40140     RES=-.059332+.139314*R-.035609*R2+.003016*R3
40150  5   MTR(41,20,30,40),ICASE
40160C
40170C: CASE 2. FIXED IN FOUR SIDES
40180  20  V=3
40190     AF=-.003430+.007327*R+.001365*R2+.0006546*R3-.00004766*R4
40200     RF=-.101150+.260875*R+.138942*R2+.034677*R3-.004016*R4
40210+   -.000170*R**5
40220     CF=-.1674+.3554*R+.1714*R2+.0286*R3
40230     MTR 41
40240C
40250C: CASE 3. FIXED IN SHORT SIDES, SIMPLY SUPPORTED IN LONG SIDES
40260  30  V=4
40270     AF=.004513+.017525*R+.023095*R2+.010325*R3+.002147*R4
40280+   -.000220*R**5 + .000004408*R**6
40290     RF=-.122149+.134450*R+.153979*R2+.036192*R3+.004015*R4
40300+   -.0001646*R**5
40310     CF=.21954-.7564*R+.10.R376*R2-.7.2495*R3+.3446*R4
40320+   -.2954*R**5
40330     MTR 41
40340C
40350C: CASE 4. SIMPLY SUPPORTED IN SHORT SIDES, FIXED IN LONG SIDES
40360  40  V=3
40370     AF=-.002765+.008652*R+.005698*R2+.001829*R3-.0002859*R4
40380+   -.00001739*R**5
40390     RF=-.060320+.256515*R+.175649*R2+.057928*R3-.009227*R4
40400+   -.000569*R**5

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PROGRAM RCWALL (CONTINUED)

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40410 CF=5.8987*R-1+6669+7.939R*R2+5.3142*R3-1+7623*R4+.2313*R5
40420C
40430 41 IF(R.GT.7.0)CF=1.0/12.0
40440 IF(PV.EQ.0)RETURN
40450 ARAT10=AF/ASSS BRAT10=BF/BSS
40460 RF3=BFS CF3=CF
40470 GOTO 220
40480C
40490 50 IF(PV.NE.0)GOTO 305
40500C: CASE 5. ONE-WAY SIMPLY SUPPORTED WALL,
40510 ASS=5.0/384.0
40520 BSS=0.125
40530 GOTO(270,270,270,270,60,70),IC: SE
40540C
40550C: CASE 6. ONE-WAY FIXED END WALL
40560 60 AF=1.0/384.0
40570 BF=1.0/12.0
40580 CF=1.0/12.0
40590 NX=3
40600 RETURN
40610C
40620C: CASE 7. ONE-WAY PREPARED CANTILEVER WALL
40630 70 AF=1.0/185.0
40640 BF=0.125
40650 CF=0.125
40660 NX=3
40670 RETURN
40680C
40690 200 IF(ICASE.GT.4)GOTO 300
40700C: DETERMINE ELASTIC DEFLECTION AND MOMENT COEFFICIENT FOR
40710C: TWO-WAY WALL WITH INPLANE FORCES
40720 220 PI=3.14159165
40730 VU=0.3
40740 PE=4.0*PI*PI*E*I/(ZLV*ZLV*(1.0-VU*VU))
40750 BV=0
40760 230 AV=0
40770 PPE=PV/PE
40780 TERM6=4.0*PI*PI*R*SORT(PPE)
40790C
40800C: SERIES SOLUTION USED TO DETERMINE COEFFICIENTS
40810 DO 250 M=1,7,2
40820 MPR=M*PI*r
40830 QPRSQ=M*PR*0.2
40840 QMSQ=4*PR*0.2+0*4PR*PI*SORT(PPE)
40850 EMSQ=4*PR*0.2-0*4PR*PI*SORT(PPE)
40860 TERM5=4*4PRSD*(QPRSQ-4.0*PI*PI*PPE)
40870 CSHE42=0.5*(EXP(0.5*SORT(QMSQ))+EXP(-0.5*SORT(QMSQ)))
40880 IF(CMSQ.LT.0)GOTO 240
40890 CSHE42=0.5*(EXP(0.5*SORT(EMSQ))+EXP(-0.5*SORT(EMSQ)))
40900 GOTO 245
40910 240 CSHE42=CSHE42*(1.0-SORT(-EMSQ))
40920 245 AV=AV+(1.0-MSQ/CASHM2-MSQ/CSHE42)/(4*TERM5)
40930* *(-1)*((M-1)/2)/TERMS
40940 BV=BV+(4PRSD*(VU*MSQ-4PRSO)/CSHE42-EMSQ*(VU*MSQ
40950* -4PRSO)/CSHE42)/(4*TERM5)+(-1)*((4-1)/2)/TERMS
40960 250 CONTINUE
40970C
40980C: CASE 1
40990 AVSS=AV*(1.0-VU*VU)*R4+4.0/PI
41000 BVSS=BV*P2+4.0/PI
41010 IF(ICASE.EQ.1)GOTO 260
41020C
41030C: CASES 2, 3, AND 4
41040 AVF=AVSS*ARAT10
41050 RVF=BVSS*BRAT10
41060 CF=CF3*BVF/RVF
41070 258 AFS=AVF
41080 BFF=BVF
41090 260 ASS=AVSS
41100 BSS=BVSS
41110 270 RETURN
41120C
41130C: ONE-WAY WALLS
41140 300 EIPV=E*I/PV

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PROGRAM RCWALL (CONTINUED)

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41150      U1=ZL,V/SQRT(FIPV)
41160      U2=0.5*U1
41170      TERM1=1.0/C3S(U2)-1.0
41180C: CASE 3: 2-N WAY SIMPLY SUPPORTED WALL
41190      RSS=TERM1/10**2
41200      ASS=(RSS+0.125)/10**2
41210      G11(270,270,270,270,310,320),ICAS-
41220
41230C: CASE 4: 1-N WAY FIXED END WALL
41240      VY=3
41250 310  VF=(1.0-U2/TAN(U2))/U.*2
41260      AF=-VF*RSS+ASS
41270      RF=VF*VY
41280
41290C: CASE 5: 1-N WAY FIXED END WALL
41300      VY=3
41310 320  VF=(TAN(U2)+U2)/(U*(TAN(U2)-U))
41320      RF=(VF*(0.5*SIN(U)/TAN(U)-C3S(U2)))-(SIN(U2)/TAN(U)
41330      -C3S(U2)-SIN(U2)/SIN(U)+0.125*U*U+1.0)/U**2
41340
41350      RETURN
41360 999 END
50000 SUBROUTINE TRANS (4,ZLV,ZLH,ICASE,LRACK,ZLMSE,ZLMSE,ZLMF,VLI,
50010  VL2S,VS1S,VS2S,VL1P,VL2F,VS1F,VS2F,VL1P,VL2P,VS1P,VS2P)
50030C: THIS SUBROUTINE DETERMINES LOAD AND MASS TRANSFORMATION FACTORS
50050C: AND DYNAMIC REACTION COEFFICIENTS FOR TWO-WAY WALLS.
50060C
50070C: DETERMINE LOAD AND MASS TRANSFORMATION FACTORS
50080      B2=B*8
50090      B3=B*82
50100      B4=B2*B2
50110      B5=B2*B3
50120      B6=B3*B3
50130C: CASES 1 & 5 -- ELASTIC RANGE
50150 330  ZK4SE1=20.48*93*(1./12.-R2/7.5+R3/21+R4/14-R5/18+R6/90)
50160  ZK4SE2=0.503R-0.7066*8
50170  ZKLS1=6.48R2*(1./6.-R2/10.+R3/30.)
50180  ZKLS2=0.64-0.8134*8
50190  RARS1=R*(1./12.-R2/15.+R3/42.)/(1./6.-R2/10.+R3/30.)
50200  RARS2=(0.127043-0.154524*8)/(0.4-0.594333*8)
50210  ZK4SF=ZK4SE1+ZK4SE2
50220  ZKLSF=ZKLS1+ZKLS2
50230  IF(LRACK.EQ.1)GOTO 335
50240C: CRACK PATTERN A
50250      CVS=0.5*8
50260      CVL=0.5*(1.0-R)
50270      XP=ZLH*B/3.0
50280      XBARS=BARS1*ZLH
50290      ZP=ZLV*(1.0-4.0*R/3.0)/(4.0*(1.0-R))
50300      ZBARS=RARS2*ZLV
50310      XBARP=0.5*B*ZLH
50320      ZBARP=ZLV*(1./24.-R/16.)/(1./4.-R/6.)
50330      G3T3 339
50340C: CRACK PATTERN B
50350 335  CVS=0.5*(1.0-R)
50360      CVL=0.5*8
50370      XP=ZLH*(1.0-4.0*R/3.0)/(4.0*(1.0-R))
50380      XBARS=RARS2*ZLH
50390      ZP=ZLV*R/3.0
50400      ZBARS=RARS1*ZLV
50410      XBARP=ZLH*(1./24.-R/16.)/(1./R.-R/6.)
50420      XBARP=0.5*B*ZLV
50430 338  LMSE=ZLMSE/ZLMSE
50450      G11(390,340,350,360,390,340,470),ICASE
50460C
50470C: CASES 2, 3, 4 & 4 -- ELASTIC RANGE
50490 350  IF(LRACK.EQ.0)GOTO 365
50490      G3T3 340
50500 360  IF(LRACK.EQ.0)GOTO 365
50510C: CASES 2 & 3, 4, 5 & 6
50520 340  ZK4F=.512-0.95*(1.0/30.-R/10.5+3.0*R/24.-R3/18.+R4/90.)
50530      *KLF6, 32.0*47*(1./12.-R/10.+R2/30.)

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PROGRAM RCWALL (CONTINUED)

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S0540      BARF1=8*(.05-B/15.+B/42.)/(1./12.-B/10.+B/30.)
S0550      GJT3(370,365,370,370,370,365),1CASE
S0560C: CASES 2A, 2B, 3B, 4A, & 6
S0570 345  ZK4FE2=0.4065-0.6144*B
S0580      ZKLFE2=0.5344-0.7324*B
S0590      BARF2=(.091667-.138095*B)/(.266667-.366667*B)
S0600      GJT3(375,363,375,375,375,363),1CASE
S0610C: CASES 2A & 2B
S0620 368  ZK4FE=ZK4FE1+ZK4FE2
S0630      ZKLFE=ZKLFE1+ZKLFE2
S0640      GJT3 380
S0650C: CASES 3A & 4B
S0660 370  ZK4FE=ZK4FE1+ZK4FE2
S0670      ZKLFE=ZKLFE1+ZKLFE2
S0680      GJT3 380
S0690C: CASES 3B, 4A, & 6
S0700 375  ZK4FE=ZK4FE1+ZK4FE2
S0710      ZKLFE=ZKLFE1+ZKLFE2
S0720 380  ZKL4FE=ZK4FE/ZKLFE
S0740      GJT3 390
S0750C: CASE 7
S0760 470  ZKL4FE=0.78
S0770C
S0780C: ALL CASES -- PLASTIC RANGE
S0790 390  ZK4P=(1.0-B)/3.0
S0800      ZKL4P=0.5-B/3.0
S0810      ZKLMP=ZK4P/ZKL4P
S0820C
S0830C
S0840C: DETERMINE DYNAMIC REACTION COEFFICIENTS FOR SMART (VS) AND
S0850C: LONG (VL) EDGES
S0860C
S0870      IF((ICASE.LT.5) GJT3 395
S0880      XBARS=1E-10$ BARF1=1E-10$ XBARP=1E-10
S0890 395  CONTINUE
S0900      GJT3(450,400,400,420,450,400,445),1CASE
S0910 400  IF((KRAK.EQ.1) GJT3 410
S0920      XBARF=BARF1*ZLH
S0930      IF((ICASE.EQ.3) GJT3 410
S0940 405  ZBARF=BARF2*ZLV
S0950      GJT3 440
S0960 410  XBARF=BARF2*ZLH
S0970      IF((ICASE.EQ.3) GJT3 435
S0980 415  ZBARF=BARF1*ZLV
S0990      GJT3 440
S1000 420  IF((KRAK.EQ.1) GJT3 425
S1010      XBARF=BARS1*ZLH
S1020      GJT3 405
S1030 425  XBARF=BARS2*ZLH
S1040      GJT3 415
S1050 430  ZBARF=BARS2*ZLV
S1060      GJT3 440
S1070 435  ZBARF=BARS1*ZLV
S1080 440  CONTINUE
S1090C
S1100C: CASES 2, 3, 4, & 6 -- ELASTIC RANGE
S1110      VS1F=CVS*(1.0-XP/XBARF)
S1120      VS2F=CVS*(XP/XBARF)
S1130      VL1F=CVL*(1.0-ZP/ZBARF)
S1140      VL2F=CVL*(ZP/ZBARF)
S1170      GJT3 450
S1180C
S1190C: CASE 7 -- ELASTIC RANGE
S1200 445  VS1F=0
S1220      VL1F=0.459
S1230      VL2F=0.165
S1250C
S1260C: CASE 1 & 5 -- ELASTIC RANGE
S1270 450  VS1S=CVS*(1.0-XP/XBARS)
S1280      VS2S=CVS*(XP/XBARS)
S1290      VL1S=CVL*(1.0-ZP/ZBARS)
S1300      VL2S=CVL*(ZP/ZBARS)
S1340C
S1350C: ALL CASES -- PLASTIC RANGE

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PROGRAM RCWALL (CONTINUED)

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71340 460  VS1P=CVS*(1.0-

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51370  VS2P=CVS*(

\sqrt{L},VH1,VH2,VV1,VV2,
700560  >,P3,C3,L3,C2,L2N,CD,PS3,PD3,PR,PEXT,PC,TC,TO,DELAY,
700580  VWIN,RH39,V3,L1,AA(4,2),VV(4),AFRINT,ASIDE,G1,G2,G3,G4,PP2,DT
70080  C34424 /RAND/ TIMEC
70090  DIMENSION CH125(7),CH1975(7),TOIST(7)
70100C
70110C VALUES FOR 97.5% (F=19,24,29,34,39,44,49)
70120  DATA CH125/ .4638, .5167, .5533, .5425, .6055, .6267, .6440/
70130  DATA CH1975/ 1.729, 1.6402, 1.5766, 1.5234, 1.4903, 1.4591, 1.4331/
70140  DATA TDIST/2.093, 2.064, 2.045, 2.032, 2.022, 2.014, 2.010/
70150C
70160  G7T)(5,50,70),IENTRY
70170  S X0/IMM4=XNDRM1(-1.0,0,0,1.0)
70180C INITIALIZE RANDOM NUMBER GENERATOR
70190  PRINT,/*INPUT VRAND*/
70200  READ,VRAND
70210  DO 47 I=1,VRAND
70220  XDIMM4=XNDRM1(0.0,0.0,1.0)
70230  47 CONTINUE
70240  INDEX=0$  SPS3=0$  SSPS3=0
70250  ICHEC=20
70260C
70270C INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
70280  PRINT 87
70290  READ,SMEAV,SD
70410C REINFORCED CONCRETE WALLS
70420  30 PRINT 46
70430  READ,FDYMEAN,FDYSD
70440  PRINT 96
70450  RETURN
70460C
70470C GENERATE RANDOM VALUES
70570  50 FDY=XNDRM1(0.0,FDYMEAN,FDYSD)
70580  IF(FDY.LE.0)G7T3 50
70585  IF(SMEAV.EQ.0)G7T3 65
70590  S=XNDRM1(0.0,SMEAV,SD)
70600  IF(S.LE.0)G7T3 60
70610  65 INDEX=INDEX+1
70620  RETURN
70630C SUM VALUES OF PSD AND PS3**2 FOR USE IN STATISTICAL ANALYSIS
70640  70 SPS3=SPS3+PS1
70650  SSPS3=SSPS3+PS1*PS1
70660C
70670C INPUT FINAL RESULTS
70730  76 PRINT 92,FDY,S,PS3,TIMEC
70740  40 IF(INDEX.LT.(ICHECK))RETURN
70750C
70760C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PSD
70770  ZN1=INDEX
70780  ZMEAN=SPS3/ZN1
70790  SD=SQRT((SSPS3-ZN1*ZMEAN*ZMEAN)/ZN1)
70800  STDERR=SD/SQRT(ZN1-1))
70810C CHECK IF MAXIMUM OF 50 PSD SAMPLES OBTAINED
70920  IF(INDEX.EQ.50)G7T3 62
70930C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PSD VALUE IS
70940  IF(STDERR*TDIST((INDEX-15)/S)>ZMEAN+GT*0.10)G7T3 61
70950C
70960C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
70970C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
70990C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
70990  62 SDU=SD/(SQRT(CH125((INDEX-15)/S)))


```

PROGRAM RCWALL (CONCLUDED)

```

70900C CHECK IF MAXIMUM OF 50 PTS SAMPLES RETAINED
70910  IF(INDEX.EQ.50)GOTO 53
70920C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
70930C DEVIATION IS WITHIN 0.104464 OF THE STANDARD DEVIATION
70940  IF(((SD1-SD2)/74EAV).GT.0.104464)GOTO 61
70950C
70960  95% CONFIDENCE INTERVAL IS WITHIN 104 FOR BOTH MEAN AND SD
70970C PROBABILITY VALUE == THEREFORE SUFFICIENT SAMPLES RETAINED
70980C DETERMINING 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
70990,
71000C AND 102 AND 90% PROBABILITY VALUES
71010  53 74EAV=74EAV-STD*RR*TOLST((INDEX-15)/5)
71020  74EAV1=74EAV+SDERR*TOLST((INDEX-15)/5)
71030  SD1=SD1/(SQR((C41975*((INDEX-15)/5)))
71040  P10=74EAV-1.232450
71050  P10L=74EAV-1.232450
71060  P10U=74EAV-1.232450
71070  P20=74EAV+1.232450
71080  P20L=74EAV+1.232450
71090  P20U=74EAV+1.232450
71100  P30=74EAV+1.232450
71110  P30U=74EAV+1.232450
71120C
71130C INPUT STATISTICAL PARAMETERS OF INCIDENT COLLAPSE PRESSURE
71140  PRINT 100,74EAV,74EAV1,SD1,SD1,SDERR,P10,P10L,P10U
71150*
71160  PRINT 105,INDEX,SDERR
71170  GOTO 999
71180C
71190C 95% CONFIDENCE INTERVAL IS NOT WITHIN 104 FOR BOTH MEAN AND SD
71200C
71210C VALUES == THEREFORE RETAIN 5 ADDITIONAL SAMPLES
71220  61 1CHECK=1CHECK+5
71230  RETURN
71240C
71250  46 F1FORMAT//,INPUT MEAN AND STANDARD DEVIATION FOR F14.3)
71260  87 F1FORMAT//,INPUT MEAN AND STANDARD DEVIATION FOR S4.3)
71270  90 F1FORMAT(F9.2,F11.2,F10.2,F14.3)
71280  92 F1FORMAT(F9.1,F11.2,F10.2,F14.3)
71290  96 F1FORMAT(//,SX,*F14.3,X,*S*,R*,PSJ*,6K,*COLLAPSE,T142*)
71300  100 F1FORMAT(//,11X,*STATISTICAL PROPERTIES OF INCIDENT PRESSURE,
71310  //,79X,*95% CONFIDENCE LIMITS,/,7X,*T142*,14X,
71320  *VAL,IE  LOWER  UPPER,/,//,4,F12.2,F12.2,/
71330  *2F12.2,/,* STANDARD DEVIATION,*,F15.2,2F12.2,/
71340  * 102 PROBABILITY VALUE,*,3F12.2,/
71350  * 90% PROBABILITY VALUE,*,3F12.2)
71420  105 F1FORMAT(//,SX,*NUMBER OF OBSERVATIONS =,I3,/,SX,
71430  *STANDARD ERROR =,F5.2)
71440C
71450  799 STOPS END
71460 FUNCTION X41RM1((A,B)
71470  IF(X)>10.20.20
71480  10 X0=RANF(-1.0)
71490  20 X1=RANF(0.0)
71500  22=RANF(0.0)
71510  Y=SQR((2.0*AL1G(X1))+(COS(6.243184*X2))
71520  X41RM1=A+Y*B
71530  RETURN
71540  END

```

**RCSLAB**

**Reinforced Concrete Slab**

PROGRAM RCSLAB

```

00100 PROGRAM RCSLAB1 (INPUT,OUTPUT,TAPE1)
00105 CALL RETR(THRCSLAB2,THRCSLAB3)
00110C * THIS PORTION OF THE PROGRAM INPUTS THE REQUIRED ELEMENT AND
00115C LOAD DATA AND INITIALIZES CERTAIN PARAMETERS *
00120C
00150 C3MM3N <INC,LDTYPE,<RF,<RAND,TIME,I,Y(80),D,DU,YU,YFAIL,
00152* ZLS,ZLL,HS,FPC,FDY,ICASE,N3HRS,AS(4),APS(4),DC(4),DP(4),FDC,
00154* EC,ES,R,ALP,ALP2,AREA,ZMASS,YFAIL,ZLL4,W1,W2,VS1,VS2,
00155* MEMB,ASCL,ASCS,VCL,VCS,ASS,BSS,AF,BF,CF,VS,
00156* W,P0,C0,L0C,S,ZLN,CD,PS9,PD9,PR,PEXT,PC,TC,TQ,DG,AT,
00158* NWIN,RH33,V3,L1,AA(4,2),NN(4),AFHT,ASIDE,G,G2,G3,G4,PH2,DT
00160 LOGICAL L1
00165C
00170C READ TITLE AND CONTROL PARAMETERS
00175 PRINT 67
00180 READ 64,TITLE
00185 PRINT 95
00190 READ,<INC,LDTYPE,<RF,<RAND
00195 DELAY=0
00200 YFAIL=1E10
00205 67 FORMAT(*INPUT TITLE*,*)
00210 68 FORMAT(A39)
00215 65 FORMAT(*INPUT <INC,LDTYPE,<RF,<RAND(I=RAV034)*,*)
00234C
00236 4 DD 5 I=1*4
00238 AS(I)=0
00240 5 CONTINUE
00242C
00246 * INPUT AND ECHO SLAB AND REINFORCEMENT PROPERTIES *
00246 PRINT 615
00245 READ,ZLS,ZLL,HS,FPC,FDY,ICASE,N3HRS
00250 FDC=1.25*FPC
00252 EC=57619.0*SART(FPC)
00254 ES=2956
00256 AREA=ZLS*ZLL
00258 EC4IP=EC/10000 ES4IP=ES/1000
00260 R=ZLL/ZLS
00262 ALP=1.0/R ALP2=ALP+ALP
00264 IF(ICASE.LE.4)GBT3 11
00266 R=0.8 ALP=0.8 ALP2=0
00268 11 PRINT 670
00270 DD 5 I=1*4
00272 PRINT 625,:
00274 READ,AS(I),DC(I),APS(I),DP(I)
00276 IF(I.NE.1)GBT3 3
00278 3 GT3(5,5,5,5,9,7,7),ICASE
00280 3 GT3(5,5,7,6,9,9,9),ICASE
00282 6 IF(I.EQ.3)GBT3 9
00284 GBT3 8
00286 7 I=1*1
00288 8 CONTINUE
00290 9 CONTINUE
00292 PRINT 711
00294 READ,4D4B
00296 IF(4D4B.NE.1)GBT3 15
00300 IF(ICASE.GT.4)GBT3 13
00302 PRINT 701
00304 READ,ASCS,ASCL
00306 ASCL=ASCL/12.0
00308 GBT3 16
00310 13 PRINT 706
00312 READ,ASCS
00314 ASCL=0.0
00316 16 ASCS=ASCS/12.0
00318C: *****
00320C: *****
00322C: * DETERMINE DEFLECTION AND SHEAR COEFFICIENTS *
00324C: *****
00326C
00328 15 ZMASS=150.0*AREA*HS/(396.07*1728.01)
00330 PRINT 620,ICASE,ZLS,ZLL,HS,FPC,FDC,EC4IP,FDY,ES4IP
00332 PRINT 630
00334 DD 110 I=1*4
00336 IF(AS(I).EQ.0)GBT3 110

```

PROGRAM RCSLAB (CONTINUED)

```

00332 P24S(1)/(12.0*0(1)) $ P25APS(1)/(12.0*0(1))
00340 PRINT 643,I,ASC(1),0,0(1),APS(1),P26,DP(1)
00342 CHARGE UNITS OF REINFORCEMENT LBS/SQ.FT TO CM. . .
00344 VCS(1)=45(1)/12.0 $ APS(1)=APS(1)/12.0
00346 110 CANTILEVER
00348
10350 VCL4X=VCL4X*(FPC)/(1-P20(1)/PLS)+3000*(ASC(1)/D(1))/VCS(1)/PLS
00351 VCL4AX=3*50*RT(FPC)/(1.0-2.0*0(1)/PLS)
00352 IF(VCL>GT,VCL4AX)VCL=VCL4AX
00353 IF(CASE,GT,0,I,GT)=20
00354 VCS=2.25*F24(FPC)/(1-2.0*D(2)/PLL)+3000*(AS(2)/D(2))/VCS(2)/PLL
00355 VCMAX=3*50*RT(FPC)/(1.0-2.0*0(2)/PLL)
10356 IF(VCS>GT,VCL4AX)VCS=VCL4AX
00357 PRINT 643,VCL,VCS
00358 GT=35
00360 30 PRINT 645,VCL
00362 35 CANTILEVER
00364 CALL CSPEC(ASC,4,ARE,BSL,AF,RF,0,0,PLS,PLL,PV,VR,CF,EC,1)
00366 615 F3R4ATC//+18-JT LS(LL,4S,F1C,FDY,ICASS,N3R4R2,0,0)
00368 625 F3R4ATC//INPUT AS,BS,AS,RF,0,0,PLS,PLL,PSI,PSI,PSI,PSI
00370 620 F3R4ATC//+0R3RPT15 IF REINFORCED CONCRETE SLAB --+
00372   * SUPPORT TYPE H14,12,/
00374   * LS =,F4,1,* 14,   * 1, =,F6,1,* 14,*64,*45 =,
00376   * F6,1,* 14,*64,*45 F1C =,F7,1,* MSL FDY =,F7,1,* 
00378   * PSI =,FS,4,EC =,F7,1,* PSI =,F7,1,* FUY =,F4,1,* PSI =, 
00380   * FS,*7,S =,F4,1,* PSI =,F4,1,* PSI =
00382 633 F3R4ATC//+REINFORCEMENT VALUES// SECTION AS (P) +
00384   98,094,9X,0A15 (P116,4X,0114*,/34,*0(S) 14./FT)*10X
00386   0C14,1 (S) 14./FT)*10X,(14.)*
00388 640 F3R4ATC//S,F11,4,* (4,F6,4,*),F9,3,F10,3,* (4,F6,4,*),F9,3
00390 670 F3R4ATC// 
00392 680 F3R4ATC//S(0, =,F6,1,* PSI /CC =,F6,1,* PSI)
00394 685 F3R4ATC//S(0, =,F6,1,* PSI)
00396 701 F3R4ATC//INPUT CANTILEVER REINFORCEMENT PARALLEL T3 ++
00398   *SHRT AND S,OLANG SPANS (S0 IN./FT)*,+
00400 703 F3R4ATC//INPUT CANTILEVER REINFORCEMENT PARALLEL T3 ++
00402   *SHRT SPAN (S0 IN./FT)*,+
00404 711 F3R4ATC//S THE SPAN REINFORCEMENT IS BE INCLUDED (0=NO).
00406   0137E51*+,+
00408
105700 INPUT LS40 PARAMETERS
00571 IF(LTYPE,0,5)GTT 20
00572 LOCATE 1, FRONT FACE LOADING USED IN R334-FILLING PROCEDURE
00573 100 A=1000.0 $ P1=14.7 $ C1=1120.0
00574 IFC(RP,NE-1)GTT 102
00575 LTC1
00582 IFC(RP,0,1)GTT 104
00584 PRINT 400
00586 READS
00588 GT=105
00590 LOCATION 2, TIP FACE LOADING
00592 112 C0=0 $ LTC2
00594 PLR=PLS/12.0
00600 105 IFC(14.5,0,1)GTT 106
00605 PRINT 510
00610 READS,PSI
00615 MR=(3.0*PSI*(7.0*P3+4.0*PSI))/(7.0*P3*PSI)
00620 600 F3R4ATC//INPUT S0,+
00630 510 F3R4ATC//+INPUT PSI,+
00635
106400 * INPUT R334-FILLING PARAMETERS *
00641 104 IFC(RP,0,0)GTT 20
00650 17 PRINT 700
10652 RM3=0.076 * L1=,FALSE.
00653 DS,4Y=1E10
00655 DS,0,VW,V3
00660 AT=0.8 AFRA=0.8 AF10E=0
00665 DR,14,I=1,4,MIN
00670 PRINT 710,I
00675 READ,AA(1,1),VV(1),AA(1,2)
00680 AA(1,2)=AA(1,2)/1000.0
00685 AT=AT+AA(1,1)
00690 4*VV(1)S GTT(12,14,14),4
10695 12 AFPRINT=AFAINT=AA(1,1)

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PROGRAM RCSLAB (CONTINUED)

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00700 GOT0 18
00705 14 ASIDE=ASIDE+AA(I,1)
00710 18 IF(AA(I,2).LT.-DELAY)DELAY=AA(I,2)
00715 4FR3VT=4FR3VT/AT ASIDE=ASIDE/AT
00720 700 F3RHAT(/+INPUT VVIV AND R334 VOLUME (CF)*,+)
00730 710 F3RHAT(/+INPUT AREA (.50 FT),LOCATION CODE & DELAY(.4SEC)*
00735+   * F3R WNDW=.12,+)
00740 G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3 $ G5=G+1.
00750 PP2=.1912
00755 C=SORT(GP3=.32.+144./RH33)
00760 TAU=2.*((V3*(1./3.))/C
00770 DT=TAU/4.0
00775C
00780 20 CONTINUE
00810 25 CAL CHAIN(RCSLAB2)
00815 99 STOP
00820 EVD
00830 SUBROUTINE C3EF(ICASE,R,ASS,BSS,AF,BF,I,ZLV,ZLH,PV,VX,CF,
00832+   ENTRY)
00834C: THIS SUBROUTINE DETERMINES M3ENT AND DEFLECT3N COEFFICIENTS
00836C: FOR 3VE-WAY (CASES 5-7) AND TWO-WAY (CASES 1-4) ELEMENTS
00838C
00840      REAL I,MPR,4PR 1,VX
00842      VX=1
00844      IF(ICASE.GT.4) GET3 50
00846C
00848      R2=R+R
00850      R3=R*R2
00852      R4=R2*R2
00854      ASS=-.007030+.013890*R-.003456*R2+.000286*R3
00856      BSS=-.058332+.139314*R-.035609*R2+.003016*R3
00858 4      GET3(41,20,30,40),ICASE
00860C
00862C: CASE 2. FIXED 3V FAUR SIDES
00864 20      VX=3
00866      AF=-.003430+.007327*R-.003365*R2+.000864*R3-.00004766*R4
00868      BF=-.101150+.260875*R-.138982*R2+.034677*R3-.004056*R4
00870+     +.500170*R4+5
00872      CF=-.1674+.3554*R-.1714*R2+.0286*R3
00874      GET3 41
00876C
00878C: CASE 3. FIXED 3V SHORT SIDES. SIMPLY SUPPORTED 3V LONG SIDES
00880 30      VX=4
00882      AF=-.004513-.017525*R+.023095*R2-.010325*R3+.002187*R4
00884+     -.000220*R4+5 + .000004405*R4+5
00886      BF=-.122149+.313445*R-.153979*R2+.036192*R3+.004015*R4
00888+     +.00016464*R4+5
00890      CF=2.1954-.7.7564*R+.10.9376*R2-.7.2495*R3+.2.3444*R4
00892+     -.2954*R4+5
00894      GET3 41
00896C
00898C: CASE 4. SIMPLY SUPPORTED 3V SHORT SIDES. FIXED 3V LONG SIDES
00900 40      VX=3
00902      AF=-.002765+.06.6524*R-.005694*R2+.001529*R3-.0002859*R4
00904+     +.00001739*R4+5
00906      BF=-.060320+.256515*R-.175649*R2+.057928*R3-.009227*R4
00908+     +.000569*R4+5
00910      CF=5.8997*R-.1.6669-.7.9398*R2+.3142*R3-.1.7823*R4+.2313*R4+5
00912C
00914 41      IF(R.GT.2.0)CF=1.0/12.0
00916      RETURN
00918C
00920 50      CONTINUE
00922C: CASE 5. 3VE-WAY. SIMPLY SUPPORTED
00924      ASS=5.0/38.0
00926      BSS=0.125
00928      GET3(270,270,270,270,60,70),ICASE
00930C: CASE 6. 3VE-WAY. FIXED ENDS
00932C: CASE 6. 3VE-WAY FIXED END WALL
00934 60      AF=1.0/38.0
00936      BF=1.0/12.0
00938      CF=1.0/12.0
00940      VX=3
00942      RETURN

```

PROGRAM RCSLAB (CONTINUED)

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00944C
00946C: CASE 7. 3NE-WAY, PRAPPED CANTILEVER
00948 70 AF=1.0/195.0
00950 9F=0.125
00952 CF=0.125
00954 VX=3
00956 270 RETIRV
00958 EVD
01000 SEGMENT RCSLAB2 (INPUT,OUTPUT,TAPE1)
01010C THIS SEGMENT CALCULATES THE RESISTANCE FUNCTION AND
01020C L3ADING AND SOLVES THE DYNAMIC EQUATIONS OF MOTION
01030C
01050 C3MM3Y XINC,LDTYPE, KRF,XRAVD,TIME,I,Y(80),Q,OU,YJ,YFAIL,
01052+ ZLS,ZLL,HS,PV,FPC,FPY,ICASE,N3BAR,AS(4),APS(4),O(4),DP(4),FDC,
01054 ECFS,R,ALP,ALP2,AREA,ZMASS,VFAIL,ZLM,VL1,VL2,VS1,VS2,
01055 ME4B,ASCL,ASCS,VCL,VCS,ASS,BSS,AF,BF,CF,VX,
01056+ W,PS,C9,L9CS,ZL5N,CD,PS2,PD9,PF,PEXT,PC,TC,T0,DELAY,
01058+ NWIV,RH00,V3,L1,AA(B,2),VV(B),AFRNT,ASIDE,G,G2,G3,G4,PP2,DT
01076 C3MM3V /SAR/SAREAS/SAREAL
01078 C3MM3V /RAVD/TIMEC
01080 DIMENSION A(80),V(80),T(80),VS(80),VL(80),PV(80)
01100C
01250 IF((XINC,NE,1.0R,LDTYPE,E0.5)CALL FORCE(1)
01260 14 IF((XRAVD,NE,1)G3T0 35
01270 CALL FORCE(4)
01280 CALL RAVD34(1)
01290 34 CALL RAVLJM(2)
01300 35 CALL RESIST(3)
01310C
01320C MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
01330C WHERE THE LOAD CAUSING INCIPIENT COLLAPSE IS TO BE FOUND
01340 13 IF((XINC,E0.0)G3T3 23
01350 PF=OU
01360 PFMAX=0
01370 PFMIN=PF/2.0
01380 G3T0 20
01390 16 PF=(PFMIN+PFMAX)/2.0
01400 20 CALL FORCE(2)
01410 23 IF((KRF,E,0)G3T1 24
01420 CALL FILL(PINT,2)
01430C
01440C: INITIALIZE VALUES FOR BETA METHOD (BETA = 1/6) AND COMPUTE VALUE
01450C: FOR FIRST TIME INTERVAL ASSUMING ELEMENT INITIALLY AT REST
01460 24 I=1
01470 TIME=0
01480 T(1)=0$ V(1)=0$ Y(1)=0
01490 DELTA=0.001
01500 IF((KRF,NE,1)G3T0 30
01510 27 IF((TIME,NE,(DELAY-.00001))G3T0 30
01520 TIME=TIME+DELTA
01530 CALL FILL(PINT,3)
01540 G3T0 ??
01550 IF(Y(1),GE,YFAIL)PRINT 71,T(1),Y(1)
01640 30 CALL RESIST(2)
01650 A(1)=0.0 S VS(1)=0.0 S VL(1)=0.0
01660 T(1)=TIME
01680C
01690C: PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
01700 1 I=I+1
01710 IF(I<LT,91)G3T0 11
01720 PRINT 98,TIME
01730 98 FORMAT(/*I=91*/ TIME =:,F6.3,* FAILU C ASSUMED TO NOT OCCUR*)
01740 G3T0 6
01750 11 TIME=TIME+DELTA
01760 T(1)=TIME
01770 A(1)=A(I-1)
01775 IF((KRF,NE,0)G3T0 10
01780 CALL FORCE(3)
01790 PV(1)=PEXT
01800 G3T0 2
01880 10 CALL FILL(PINT,3)
01890 PV(I)=PINT
01910 2 CONTINUE
01920 03 R J=1,10

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PROGRAM RCSLAB (CONTINUED)

```

01930      Y(I)=Y(I-1)+DELTAT*V(I-1)+DELTAT*DELTAT*(A(I-1)/3.+A(I)/6.)
01940      CALL RESIST(2)
01960 4     ANEW=AREA*(PV(I)-2)/(2*MASS*Z(LM))
01970      ADELTA=ANEW-A(I)
01980      A(I)=ANEW
01985 IF(ANEW.EQ.0)PRINT 1985,TIME,PV(I),0,2*MASS,Z(LM),Y(I),A(I-1)
01990      IF(ABS(ADELTA/(ANEW+1E-10)).LT.0.01)GOTO 9
02000 9     CONTINUE
02010      A(I)=ANEW-ADELTA/2.0
02020 PRINT 80,TIME,PF,A(I),Y(I)
02030 9     CONTINUE
02040      Y(I)=Y(I-1)+DELTAT*V(I-1)+DELTAT*DELTAT*(A(I-1)/3.+A(I)/6.)
02050      V(I)=V(I-1)+DELTAT*(A(I)+A(I-1))/2.0
02060      VSC(I)=AREA*(VS1*PV(I)+VS2*2)
02070      VL(I)=AREA*(VL1*PV(I)+VL2*2)
02090C
02100C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE OF WALL
02110C: IF MAXIMUM DEFLECT<BY ACHEC ELEMENT DID NOT FAIL
02120      IF(Y(I).LE.Y(I-1).AND.PV(I).LE.PV(I-1))GOTO 6
02130      IF(Y(I).LT.0)GOTO 6
02140      IF(TIME-DELAY.GE.0.010)DELTAT=0.002
02160      IF(TIME-DELAY.GE.0.020)DELTAT=0.005
02170      IF(TIME-DELAY.GE.0.100)DELTAT=0.010
02180      IF(TIME-DELAY.GE.0.500)DELTAT=0.050
02190C: IF FAILURE DEFLECTION REACHED, WALL FAILED
02200      IF(Y(I).GE.Y(.L))GOTO 7
02210      GOTO 1
02220C
02230C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
02240C: COLLAPSE FOR CASES WHERE DESIRED
02250C: ELEMENT DID NOT FAIL -- SET PFMIV TO PF
02260 6     CONTINUE
02280      IF(KINC.EQ.0)GOTO 18
02290 36    PFMIV=PF
02300 IF(PFMAX.GT.0)GOTO 16
02310 PF=2.0*PF
02320      GOTO 20
02330C: ELEMENT FAILED -- SET PFMIV TO PF
02340 7     CONTINUE
02350      TIMEC=TIME
02370      IF(KINC.EQ.0)GOTO 18
02380 37    PFMAX=PF
02390C: CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
02400 17    IF((PFMAX-PFMIV)/PFMIN.GT.0.01)GOTO 16
02410      IF(XRAND.NE.1)GOTO 18
02420      CALL RANDOM(3)
02430      GOTO 34
02440C
02450C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
02460C: OCCURANCE FOR A NON-FAILING WALL OR THE TIME AND VELOCITY
02470C: AT COLLAPSE FOR A FAILING ELEMENT. 3PT13VAL 3OUTPUT
02480C: ENTIRE BEHAVIOR TIME-HISTORY OF THE WALL.
02490C
02500C: 3OUTPUT LOAD DATA
02510 18    CALL FORCE(4)
02520C
02530C: 3OUTPUT FINAL RESULTS
02540 IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
02550 IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
02552C
02554 PRINT 90
02556 READ,FILE
02558 IF(<FILE.EQ.0)GOTO 40
02560 PRINT 95
02562 READ,NAMEF
02564 CALL PFUR(3HRET,1,NAMEF)
02566 WRITE(1,)SAREAS,SAREAL,HS
02568 WRITE(1,)I
02570 WRITE(1,)(T(J),PV(J),VSC(J),VL(J),J=1,I)
02574 CALL PFUR(3HREP,1,NAMEF)
02576 40 CONTINUE
02578C: CHECK TO SEE IF ENTIRE TIME-HISTORY IS DESIRED
02580 PRINT 72
02590 READ,4

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PROGRAM RCSLAB (CONTINUED)

```

02690      IF(4.E2>0)GOTO 25
02690 PRINT 76,(T(J),PV(J),A(J),V(J),Y(J),VS(J),VL(J),J=1,I)
02690 25 PRINT 77
02710C
02740 70 FIRMAT(/*N3 FAILURE = MAX. DEFLECTION 3E6,F6.2)
02750*   * IN. REACHED*,F7.3,* SEC*)
02760 71 FIRMAT(/*FAILURE OCCURRED AT*,F7.3,* SEC (FINAL VELOCITY **)
02770*   F7.2,* IN./SEC*)*/
02780 72 FIRMAT(/*TIME HISTORY DESIRED (YES=1, NO=0)*,*)
02790 76 FIRMAT(/* TIME PRESSURE ACCELERATION VELOCITY */
02840*   401)SPLACEMENT VS VI,*,*,
02850*   (F6.2,F9.3,F12.1,F12.2,F12.4,F11.0,F8.0)
02860 77 FIRMAT(/*,7(*-----*)*)
02870 80 FIRMAT(/*ACCELERATION AT CONVERGING AT TIME **,F6.3,
02880*   * SEC (PF **,F7.3,* PSI)**/* A(I) SET EQUAL T3**,
02890*   FR-1.* (AVG OF LAST 2 ITERATIONS)**/* Y(I) **,
02900*   (F8.4,* IN.*)
02930 90 FIRMAT(/*4002 REACTIONS TO BE INPUT TO FILE (D=N3,I=YES)*,*)
02940 95 FIRMAT(/*INPUT NAME OF SLAB REACTION DATA FILE*,*)
02940 999 STOP
02970 END
10000 SUBROUTINE F3PCF(ENTRY)
10010C THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
10020C THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
10030C 1. IDEALIZED BLAST LOAD (FRONT OR SIDE FACE)
10050 C34134 KINC,LTYPE,XRF,XRAU,TIME,(Y(80),0.0),Y0,YFAIL,
10052* ZLS,ZLL,MS,PV,FPC,FDY,(CASE,N25R,AS(4),APS(4),B(4),DP(4),FDC,
10054* EC,ES,P,AL,P,AL2,AREA,MASS,YFAIL,ZKL4,VL1,VL2,VS1,VS2,
10055* ME,H,ASG,ASCS,VCL,VCS,ASS,RES,AF,RF,CF,VK,
10056* W,P,B,C,L3C,S2LEV,C0,PS3,P03,PR,P,PC,TC,T0,D,AY,
10058* VV1N,RH03,V3,L1,AA(K,2),VV(K),AFR3NT,ASIDE,G,G2,G3,G4,PP2,DT
10060 DIMENSION TT(20),PP(20)
10040C
10130 IF(LTYPE.EQ.5)GOT3 500
10140C
10150 GOT3(215,200,300,...),IFENTRY
10000C
11010C CALCULATE LOAD PROPERTIES FOR GIVEN PEAK PRESSURE
11030 200 GAT3(203,210),L3C
11040 205 PS0=(PR-1.0*P3+50RT(196.0*P3*P3+196.0*P3*PR+PR*PR))/16.0
11050 GOT3 215
11060 210 PS9=PR
11070 215 P09=2.5*PS0*PS0/(7.0*P3+PS0)
11080 220 PS0*50RT(1.0+(6.0*PS0)/(7.0*P3)),
11090 T0=w*0.3333/(2.2399*0.1896*PS0)
11100 GOT3(220,222),L3C
11110 220 TC=3.0*S/U
11120 PC=PS0*(1-TC/T0)+EXP(-TC/T0)+P09*(1-TC/T0)**2*EXP(-2*TC/T0)
11130 CD=1.0
11140 RETURN
11150 225 TA=7LEV/11
11160 TA2=TA/2.0
11170 TA2T0=TA2/T0
11180 PA=PS9*(1-TA2T0)*EXP(-TA2T0)+CD*P09*(1-TA2T0)**2*EXP(-2*TA2T0)
11190 RETURN
12030C
12010C CALCULATE LOAD
12020 300 GAT2(305,310),L3C
12040 305 TTO=TIME/T0
12050 IF(TIME.GT.T0)GAT3 320
12060 P=PC*(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/T0
12090 IF(TIME.GT.T0)GAT3 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)GAT3 330
12130 P=PS0*(1-TT0)*EXP(-TT0)+CD*P09*(1-TT0)**2*EXP(-2*TT0)
12140 RETURN
12150 330 P=0
12170 RETURN
13000C
13010C PRINT LOAD DATA
13020 IF(<INC,89-02)GOT3 400

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PROGRAM RCSLAB (CONTINUED)

```

13030 PRINT 540,LDTYPE
13040 G0T3 410
13050 400 PRINT 645,LDTYPE
13060 410 C0NTINUE
13070 415 G0T3(420,425),L3C
13080 420 PRINT 650
13090 G0T3 430
13100 425 PRINT 655
13110 430 PRINT 660,W,PA,C0
13120 IF(KRND,4E-0)RETURN
13130 G0T3(435,440),L3C
13140 435 PRINT 665,S,TC,P0
13150 G0T3 445
13160 440 PRINT 670,ZEV,TA,PA
13170 445 PRINT 675,U,TO,CI,PS0,PD0
13180 RETURN
13500C
13510C LOAD TYPE 5 -- ARBITRARY LOAD SHAPE
13520 500 G0T3(510,520,530,540),L3TRY
13530C
13540C INPUT LOAD DATA
13550 510 PRINT 680
13560 READ,VP0INT,(TT(J),PP(J),J=1,VP0INT)
13570 FACT0R=1.0
13580 IF(K1NC.EQ.0)G0T3 S18
13590 PMAX=PP(1)
13600 M 515 J=2,VP0INT
13610 515 IF(PP(J).GT.PMAX)PMAX=PP(J)
13620 515 PX=PP(2)-PP(1)
13630 TX=TT(2)-TT(1)
13640 JJ=1
13650 RETURN
13660C
13670C CALCULATE MAXIMUM LOAD
13680 520 FACT0R=PR/PMAX
13690 G0T3 S18
13700 RETURN
13710C
13720C CALCULATE LOAD
13730 530 IF(TIME.LE.TT(JJ+1))G0T3 S35
13740 JJ=JJ+1
13750 PX=PP(JJ+1)-PP(JJ)
13760 TX=TT(JJ+1)-TT(JJ)
13765 IF(TX.EQ.0)TX=1E-10
13770 G0T3 530
13780 535 P=FACT0R*(PP(JJ)+(TIME-TT(JJ))*PX/TX)
13790 RETURN
13800C
13810C PRINT LOAD DATA
13815 540 IF(K1NC.EQ.1)PRINT 640,LDTYPE
13820 IF(K1NC.EQ.0)PRINT 645,LDTYPE
13825 PRINT 690
13830 D8 545 J=1,VP0INT
13840 P=FACT0R*PP(J)
13850 545 PRINT 695,TT(J),P
13860 RETURN
14000C
14070 640 FORMAT(/,L8AD CAUSING INCIPIENT FAILURE IS AS FOLLOWS:*)
14071*   /*SX,*L8AD TYPE NUMBER*,I2)
14080 645 FORMAT(/,PR0PERTIES OF LOAD ACTING ON ELEMENT ARE AS *
14081*   /*8L3W$/*,/*SX,*L8AD TYPE NUMBER*,I2)
14090 650 FORMAT(9X,*(FRONT FACE))
14100 655 FORMAT(SX,*(SIDE OR T0P FACE))
14110 660 FORMAT(10X,*W =*,F6.1,* T   PR =*,F6.2,* PSI      CD =*,*
14111*   F7.1,* FPS*)
14120 665 FORMAT(10X,*S =*,F6.1,* FT      TC =*,F6.3,* SEC      PR =*,*
14121*   F7.3,* PSI*)
14130 670 FORMAT(10X,*L =*,F6.1,* FT      TA =*,F6.3,* SEC      PA =*,*
14131*   F7.3,* PSI*)
14140 675 FORMAT(10X,*U =*,F7.1,* FPS      TO =*,F6.3,* SEC      CD =*,*
14141*   FS =*,/*SX,*PS0 =*,F7.3,* PSI      PD0 =*,F7.3,* PSI*)
14150 680 FORMAT(/,INPUT NUMBER OF LOAD POINTS AND THE TIME AND *
14151*   *PRESSURE AT EACH POINT*)
14160 690 FORMAT(/10X,*TIME      PRESSURE*)

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PROGRAM RCSLAB (CONTINUED)

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14170 675 F3H4AT(F15.3,F12.2)
15009 END
20000 SUBROUTINE FILL(P3,IENTRY)
20010C: COMPUTES AVERAGE AIR PRESSURE IN R334 DUE TO BLAST WAVE
20020C: INCIDENT HEAD-IN UPON FRONT WALL.
20030C
20030 C1441N <INCALDTYPE,<RF,<RAND,TIME,11,Y(40),0,015,Y,J,VFAIL,
20052* ZLS,P,L1,15,PV,PPC,POY,ICASE,N3442,4S(4),4P(3),0(4),0P(4),FDC,
20054* ECFS,DJ4,ALP,ALP2,AREA,ZMASS,VFAIL,ZKL4,VL1,1,1,721,1,1,2,
20055* 4ENR,4SCL,4SCS,VCL,VCS,ASS,BSS,AF,BF,CF,VK,
20056* M,P3,C9,L3C,S,ZLEN,C0,P53,P03,PR,PEXT,PC,TC,TO,DELAY,
20057* V,W,V,RH33,V3,L1,A4(R,2),VV(R),AFR3VT,AF1D2,G,(P3,R3,PP2,DT
20059 L0GICAL L1,L2,L3
2005C
20100 G3T3(10,13,11),IENTRY
20110 TO RETURN
20310C
20320 I3 P3=P3
20330 TT=0. S T3=0.
20340 R433=R433
20350 L2=.FALSE. S L3=.FALSE.
20360 RETURN
20370C
20380 I1 IF(L1)G3T3 S2
20385 I1 IF(L2.A.L3)G3T3 9
20390 S2 DDT=(T14E-T0)*0.5
20395 IST3P=2
20400 S3 IF(DDT<LT-DT)G3T3 S1
20410 S0 DDT=0.5*DDT
20415 IST3P=2*IST3P
20420 G3 T3 S3
20430 S1 CANTINUE
20440 D3 99 I=1,IST3P
20450 TT=T3+I*DDT
20460 IF(TT>T0)G3 T3 99
20470 DM=0. S WM=0. S VM=0
20480 DM 500 <=1,VMIV
20490 M=VM(<) S DLY=AA(<,2)+0.000001
20500 IF(DLY>TT)G3 T3 500
20510 G3T3(15,16,16),M
20520 I5 CDF=1.0
20530 IF(TT-TC)20,20,21
20540 20 P11=(TC-TT)*(PR-PC)/TC+PC
20550 P11=P11+P3
20560 G3 T3 30
20570 I6 CDF=-0.4
20600 21 R=TT/T0 S RR=1.-R
20610 PD=PD3*RR*RR*EXP(-2.*R)
20620 PS=PS3*RR*EXP(-R)
20630 P11=PS*CDF*PD
20640 P11=P11+P3
20650 30 RH331=RH330*((P11/P3)**G2)
20660 IF(P11-P3)>36.-36.37
20670 36 JSIGN=-1
20680 L2=.TRUE.
20770 303 P2=P11
20740 RH32=((P2/P3)**G2)*RH33
20790 X=P3/RH330
20800 G3 T3 39
20810 37 JSIGN=+1
20820 306 P2=PP2*P11
20830 RH32=((P2/P11)**G2)*RH31
20840 X=P11/RH31
20850 38 U22=G4*(X-P2/RH32)*32.*144.
20860 IF(U22)40,39,39
20870 40 PRIVT,*U22 V*GATIVE*,U22
20880 STOP
20890 39 U2=SQRT(U22)*JSIGN
20900 DD4=U2*RH32*AA(<,1)*DDT
20910 DM=0.4*UD4
20920 WM=WM+P11*UD4/(G3*RH31)
20925C
20930 S00 CANTINUE
20940 P30=P11*(G-1.)*WM/V3

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PROGRAM RCSLAB (CONTINUED)

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20950 RM333=RH333+04/V7
20960 99 C0NTIN'IF
20970 T3=TT
20980 P3=P33-P3
20982 IF(TI4.E>TC)L3=.TRUE.
20983 RETURN
20984 9 RE-TIME/TG S RR=1.0-R
20985 PD=PD3*RR*RR*EXP(-2.0*R)
20986 PS=PSA*RR*EXP(-R)
20987 P3=PS*PD*(AFR9NT-0.4*SIDF)
20990 999 RETURN
21020 END
30000 SUBROUTINE RESIST (IENTRY)
30010C: THIS SUBROUTINE INPUTS THE REQUIRED WALL DATA, DETERMINES THE
30020C: RESISTANCE FUNCTION, TRANSFORMATION FACTORS, AND REACTION
30030C: COEFFICIENTS AND SUPPLIES THE REACTION VALUES FOR SPECIFIC
30040C: DEFLECTIONS REQUIRED IN THE DYNAMIC ANALYSIS
30045C
30050 C3443N <INC>LDTYPE,<RF>,(RAN0,TIME,I,Y(80),2,911,Y11,YFAIL,
30052> ZL,S,ZLL,HS,PV,FPC,FDY,(ICASE,N3BAR,AS(4),APS(4),D(4),FDC,
30054> EC,ES,R,ALP,ALP2,AREA,ZMASS,VFAIL,?L1,V1,L2,VS1,VS2,
30056> M4M,ASCL,ASCS,VCL,VCS,ASS,BSS,AF,BF,CF,VS,
30058> ,P3,C3,L1C,S,ZLEV,CD,PS3,PD3,PR,PEXT,PC,TC,TD,DELAY,
30059> V11,RH33,V3,L1,44(9,2),VN(R),AFR9NT,ASIDE,G,G2,G3,G4,PP2,DT
30070 C3443N /SAR/ SAREAS,SAREAL
30100 REAL V,IC,IG4M,44(1),44(2),44(3),MU(4),ICR(4),LT
30130 G3TA(4,500,45),LETRY
30140 4 RETURN
30810C
30820C: ****
30830C: * ENTRY 2: DETERMINE ELEMENT PROPERTIES *
30840C: * DEPENDENT ON FDC, FDY, AND D *
30850C
30860 45 V=ES/EC
30870 FR=8.0*SORT(FDC)
30880 IG=HS*3/12*(V-1)*(AS(1)*(D(1)-HS) - 2*APS(1)*(HS/2-DP(1))**2)
30900 M4=2.0*IG*FR/HS
30920 CALL M04ENT(FDC,FDY,FS,4,0,1.0,AS,4,S,D,PP,MU,ICR,IC)
31490 GMU=MU(2)/MU(1)
31500C
31510C: DETERMINE POSITION OF YIELD LINES AND ULTIMATE RESISTANCE
31520C: COEFFICIENTS FOR TWO-WAY SLAB
31530 IF(ICASE.GT.4)G3T3 106
31540 Z11=MU(4)/MU(2)
31550 Z13=MU(3)/MU(1)
31560 GM4412=2.0*SORT(1.0+Z11)
31570 GM4434=2.0*SORT(1.0+Z13)
31580 GRAT=GM4412/GM4434
31590 B=SORT(1+Z11)*(GMU+ALP2/GM4434)*(SORT(GRAT)**2/3/
31600- (GMU+ALP2))-GRAT
31610C: IF BETA IS GREATER THAN 0.5 ASSUMPTION OF CRACK PATTERN A
31620C: NOT VALID AND CRACK PATTERN B IS ASSUMED TO OCCUR
31630 IF(B.LE.0.5)G3T2 105
31640C
31650C: CRACK PATTERN B
31660 LRAK=1
31670 B=SORT(1.0+Z13)*(SORT(1.0/GRAT)**2+GMU+ALP2*3.0)-1.0/GRAT
31680- /(GMU+ALP2*GM4412)
31690 DUTER=6.0*GM4412**2*ALP*GMU*(SORT(3+1/(GMU+ALP2*GRAT**2))
31700- -1.0/(SORT(GMU)+ALP*GRAT))**2
31705 SAREAS=0.5*ZLS*ZLL*(1.0-R) $ SAREAL=0.5*ZLS*ZLL*R
31710 G3T2 109
31720C
31730C: CRACK PATTERN A
31740 105 C0NTIN'IF
31750 LRAK=0
31760 TERM=6.0*GM4434**2/(ALP*(SORT(3+GMU+ALP2*GRAT**2)
31770- -ALP*GRAT*SORT(GMU))**2)
31775 SAREAS=0.5*ZLS*ZLL*R $ SAREAL=0.5*ZLS*ZLL*(1.0-R)
31780 G3T2 109
31790C
31800C: DETERMINE MOMENT AND DEFLECTION COEFFICIENTS
31810C: FOR CRACKED PARTITION OF SLAB BEHAVIOR
31820 106 R=0

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PROGRAM RCSLAB (CONTINUED)

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31425 SAEAS=0.0 S SAREAL=0.5*ZLS*ZLL
31430 103 C3V1(VUE
31440 GTF(195,195,195,195,142,185,190),1CASE
31450 192 QUTERM=1.0/(RSS*ZLS)
31460 GTF 195
31470 185 QUTERM=(MUC(3)/MUC(1)+1.0)/(RSS*ZLS)
31480 GTF 195
31490 190 QUTERM=(0.5*MUC(3)/MUC(1)+1.0)/(RSS*ZLS)
31500 195 GTF(200,210,210,210,200,210,210),1CASE
31510C
31520C * DETERMINE RESISTANCE CURVE FOR WALL *
31530C * (Y IS IN UNITS OF PSI, K IN LB/CH. IN., AND Y IN INCHES) *
31540C ****
31550C
31560C CASES 1 AND 5
31570 200 Q1=4/(RSS*ZLS*ZLS)
31580 <<1=EC*1G/(RSS*ZLS**4)
32000 Y1=Q1/<<1
32010 <<2=EC*IC/(RSS*ZLS**4)
32020 IF(ICASE.EQ.5)GTF 200
32030 Q0=QUTERM*MUC(1)/AREA
32040 GTF 200
32050 205 Q1=QUTERM*MUC(1)/ZLS
32060 208 YII=Q1/<<2
32070 GTF 280
32080C
32090C CASES 2, 3, 4, 6, & 7
32100 210 Q1=4M/(RF*ZLS*ZLS)
32110 <<1=EC*1G/(AF*ZLS**4)
32120 Y1=Q1/<<1
32130 Q2=MU(YK)/(CF*ZLS*ZLS)
32140 <<2=EC*IC/(AF*ZLS**4)
32150 Y2=Q2/K<<2
32160 <<3=EC*IC/(RSS*ZLS**4)
32170 IF(ICASE.GT.4), 1 P15
32180 Q1=QUTERM*MUC(1)/AREA
32190 GTF 220
32200 215 Q1=QUTERM*MUC(1)/ZLS
32210 220 YII=Y2*(Q1-Q2)/<<3
32220 280 CONTINUE
32260 YFAIL=Q1
32270 YT=999.9
32280C
32290C CHECK FOR TYPE 3F FAILURE - LIGHTLY REINFORCED OR CONVENTIONAL
32300 IF(MUC(1).LT.1.5*44)GTF 280
32310C
32320C CONVENTIONAL TYPE FAILURE
32322 IF(ICASE.EQ.1.OR.ICASE.EQ.5)GTF 272
32324 YE=Y2+YII*(1.0-0.2/Q1)
32326 GTF 273
32328 272 YE=YE
32330 273 YFAIL=YE*0.1/(AS(1)/DC(1))
32340C DUCTILITY FACTOR MUST BE <= .30
32350 IF(YFAIL.GT.30.0*YE)YFAIL=30.0*YE
32370 GTF 300
32380C
32390C LIGHTLY REINFORCED TYPE 3F FAILURE
32400C THE FOLLOWING EXPRESSION IS BASED ON A STEEL ELONGATION OF 20%
32410 293 UC3EF=30.0
32420 UPU=UC3EF*S2RT(FDC)
32430 ABAR=3.14159*(VJBAR/16.)**2
32440 290 YFAIL=S2RT((0.2*ABAR*FDY/UPU*ZLS/2.)**2-(ZLS/2.)**2)
32460C
32470C TENSILE MEMBRANE BEHAVIOR
32480 300 IF(MDCB.EQ.1)GTF 285
32530 TS=ASCL*FDY
32535 IF(ASCL.EQ.0)GTF 312
32540 TL=ASCL*FDY
32550 C1=3.14159*SORT(TS/TL)*ZLL/(2.0*ZLS)
32560 KT=0
32570 DO 310 JJ=1,13,4
32580 JJ2=JJ+2
32592 CJSHJJ=0.5*(EXP(JJ*C1)+EXP(-JJ*C1))

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PROGRAM RCSLAB (CONTINUED)

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32584 C3SHJJ2=0.5*(EXP(JJ2*C1)+EXP(-JJ2*C1))
32590 C2=(1.0-1.0/CASHJJ)/JJ**3-(1.0-1.0/CASHJJ2)/JJ2**3
32600 310 XT=T*T*C2
32610 XT=1.5*3.14159**3/(4.0*T)
32620 G0T3 314
32630 312 XT=8.0*1.5
32640 314 YT=QU*ZLS*ZLS/(XT*TS)
32642 QT=QU
32644 IF(YT.LE.YFAIL)G0T3 316
32646 YT=YFAIL
32648 QT=YT*XT*TS/(2LZ*ZLS)
32650 316 YFAIL=0.15*ZLS
32660 QFAIL=YFAIL*XT*TS/(2LZ*ZLS)
32665C
32670C * ADJUST LOAD-DEFLECTION CURVE FOR SLAB DEAD LOAD
32680 295 QDL=150.0*HS/1728.0
32700 IF(QDL.GT.Q1)G0T3 292
32710 YDL=QDL/441
32712 G0T3 295
32713 292 G0T3(293,294,294,294,293,294,294),ICASE
32714 293 YDL=Y1+(QDL-Q1)*(YU-Y1)/(QU-Q1)
32715 IF(QDL.LT.QU)G0T3 295
32716 PRINT,*QDL ==,QDL,* Q1 ==,Q1 $ STOP
32717 294 YDL=Y1+(QDL-Q1)*(YU-Y1)/(QU-Q1)
32718 IF(QDL.LT.Q2)G0T3 295 S PRINT,*QDL ==,QDL,* Q2 ==,Q2 $ STOP
32719 295 CONTINUE
32720 Y1=Y1-YDLS Y2=Y2-YDLS YU=YU-YDLS YT=YT-YDLS YFAIL=YFAIL-YDL
32725 Q1=Q1-QDLS Q2=Q2-QDLS QU=QU-QDLS QT=QT-QDLS QFAIL=QFAIL-QDL
32730 IF((RAND.VE.1))PRINT 633,QDL,YDL
32750C
32760C: OUTPUT LOAD-DEFLECTION CURVE
32770 IF((RAND.VE.1))G0T3 335
32780 PRINT 650
32790 IF(ICASE.EQ.1.3R+ICASE.EQ.5)G0T3 320
32800 PRINT 660,Q1,Y1,Q2,Y2
32810 G0T3 330
32820 320 PRINT 660,Q1,Y1
32830 330 IF(MEN1.EQ.1)G0T3 332
32840 PRINT 660,Y1,YU,YT,YFAIL
32850 G0T3 335
32855 332 IF(QT.NE.QU)G0T3 333
32860 PRINT 660,QU,YU,QT,YT,QFAIL,YFAIL
32862 G0T3 335
32864 333 PRINT 660,QU,YU,QT,YT,YT,QFAIL,YFAIL
32870 335 CONTINUE
32880C
32890 CALL TRANS (9,?LS,ZLL,ICASE,?RAC,?L4SE,?L4FS,?L4MP,VL1S,VL2S,
32900+ VS1S,VS2S,VL1F,VL2F,VS1F,VS2F,VL1P,VL2P,VS1P,VS2P)
32910 QSHRL=VCL*D(1)*?LL/((VL1S+VL2S)*AREA)
32920 IF(ICASE.GT.4)G0T3 340
32930 QSHRS=VCS*D(2)*?LS/((VS1S+VS2S)*AREA)
32940 IF((RAND.VE.1))PRINT 690,QSHRL,QSHRS
32950 G0T3 345
32960 340 IF((RAND.VE.1))PRINT 675,QSHRL
32970 345 CONTINUE
32980 RETURN
32990C
33000C: *****
33010C: * ENTRY 3: DETERMINE THE RESISTANCE (PER UNIT AREA) *
33020C: * 3F THE WALL IS A FUNCTION OF Y(I) *
33030C: *****
33040C
33050 500 IF(Y(I).GE.YFAIL)G0T3 560
33060 IF(Y(I).GT.YU)G0T3 540
33070 G0T3(S01,S20,S20,S20,S01,S20,S20),ICASE
33080 S01 CONTINUE
33090C
33100C: ELASTIC RANGE -- CASES 1 AND 5
33110 ZL4=?L4SE
33120 VL1=VL1S $ VL2=VL2S
33130 VS1=VS1S $ VS2=VS2S
33140 IF(Y(I).GT.Y1)G0T3 510
33150C
33160C: UNCRACKED PORTION -- ALL CASES
33170 505 Q=Y(I)<<1

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PROGRAM RCSLAB (CONTINUED)

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33130 RETURN
33190C
33200C: CRACKED PARTITION -- CASES 1 AND 5
33210 S10 =Q1+(Y(I)-Y1)*(QU-Q1)/(YU-Y1)
33220 RETURN
33230C
33240 S20 IF(Y(I).GT.Y2) GOT3 S10
33250C
33260C: ELASTIC RANGE -- CASES 2,3,4,6,7
33270 ZAL4=ZAL4FF
33280 VL1=VL1F S VL2=VL2F
33290 VS1=VS1F S VS2=VS2F
33300 IF(Y(I).LT.Y1) GOT3 S05
33310C: CRACKED PARTITION -- CASES 2,3,4,6,7
33320 Q=Q1+(Y(I)-Y1)*(Q2-Q1)/(Y2-Y1)
33325 RETURN
33330C
33340C: ELASTIC-PLASTIC RANGE -- CASES 2,3,4,6,7
33350 S30 ZLM=ZLMFE
33360 VL1=VL1S S VL2=VL2S
33370 VS1=VS1S S VS2=VS2S
33380 Q=Q2+K3*(Y(I)-Y2)
33390 RETURN
33400C
33410C: PLASTIC RANGE -- ALL CASES
33420 S40 ZLM=ZLMPP
33430 VL1=VL1P S VL2=VL2P
33440 VS1=VS1P S VS2=VS2P
33450 IF(Y(I).GT.YT) GOT3 S50
33460 Q=QU
33470 RETURN
33480C
33490C TENSILE MEMBRANE RANGE -- ALL CASES
33500 S50 Q=0.0*(Y(I)-YT)*(QFAIL-QT)/(YFAIL-YT)
33510 RETURN
33520C
33530C: ELEMENT COLLAPSED - Y1 RESISTANCE (TO AVOID NUMERICAL DIFFICULTIES)
33540C: FOR CERTAIN CASES SET RESISTANCE EQUAL TO VERY SMALL VALUE
33550 S60 Q=1E-10
33560 RETURN
33570C
33683 633 FORMAT(*,F6.2,* PSI      YOL =*,F8.4,* IV.*)
33700 650 F9R4T//LJAU-DEFLECT3N CURVE*,/*X,*2 (PSI)    Y (IV.*)
33710 660 F9R4T(F9.2,F12.4)
33750 690 F9R4T/*QSHRL =*,F9.2,* PSI      QSHRS =*,F9.2,* PSI*)
33760 695 F9R4T/*ASHRL =*,F9.2,* PSI*)
33810 END
35000 SUBROUTINE M4M4NT(FDC,FDY,ES,V,PV,B,AS,APS,D,DP,MU,ICR,IC)
35010C THIS SUBROUTINE DETERMINES THE ULTIMATE M4M4NT CAPACITY AND
35020C CRACKED MOMENT OF INERTIA FOR REQUIRED SECTIONS
35040 REAL A1,A2,A3,AUD,V,IC,ICTMT,MU(4),ICR(4),AS(4),APS(4),D(4),DP(4)
35050C
35060C: DETERMINE VALUES OF CONCRETE PARAMETERS
35070 45 A1=0.94*FDC/26E3
35080 A2=0.50*FDC/5E4
35090 A3=(3900.0+0.35*FDC)/(3E3+0.82*FDC-FDC*FDC/26E3)
35100 EPSC=0.004*FDC/65E5
35150C ****
35160C: * DETERMINE ULTIMATE M4M4NT CAPACITY AND CRACKED *
35170C: * MOMENT OF INERTIA FOR REQUIRED SECTIONS *
35180C: ****
35190C
35200 II=05 ICTMT=0
35210 D0 170 I=1,4
35220 IF(AS(I).EQ.0) GOT3 170
35230 II=II+1
35240C: ALL PROPERTIES ARE COMPUTED FOR A WIDTH 9
35250 TEVS=AS(I)*FDY+PV
35260 IF(APS(I).LE.0) GOT3 150
35270C
35280C: WALL HAS C3 PRESSURE REINFORCEMENT
35290 C3=K1*(3*FDC*S4*DPC(1))
35300 TERM1=0.5*(TEVS/APS(I)+ES*EPSC)
35310 TERM2=ES*EPSC*(TEVS-C)/APS(I)
35320C: DETERMINE LOCATION OF NEUTRAL AXIS

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PROGRAM RCSLAB (CONTINUED)

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35330 IF(TEVS.LE.0)G3T3 140
35340C
35350C: UD > 0'
35360 FPS=TERM1*(3*FDC/2.0-SORT((TERM1*(3*FDC/2.0)**2
35370+ -(TERM2*ES*EPSC*(3*FDC))
35380C: F'S MUST BE <= FDY
35390 IF(FPS.LT.FDY)G3T3 130
35400 FPS=FDY
35410 130 TPS=APS(I)*(FPS-(3*FDC)
35420 *(UD-TEVS-TPS)/(4*(3*FDC*B))
35430 MU(I)=(TEVS-TPS)*(D(I)-2*(UD)+TPS*(D(I)-DP(I))
35440 ICR(I)=B*(UD**3/3.0+N*ASC(I)*(D(I)-UD)**2
35450+ +(N-1)*APS(I)*(UD-DP(I)**2
35460 G3T3 152
35470C
35480C: UD < 0'
35490 140 FPS=TERM1+SORT(TERM1**2-TERM2)
35500C: F'S MUST BE <= FDY
35510 IF(FPS.LT.FDY)G3T3 145
35520 FPS=FDY
35530 145 TERM3=TEVS+APS(I)*FPS
35540 *(UD-TERM3/(4)*(3*FDC*B))
35550 N(I)=TERM3*(D(I)-2*(UD)-APS(I)*FPS*(D(I)-DP(I))
35560 ICR(I)=B*(UD**3/3.0+N*ASC(I)*(D(I)-UD)**2+N*APS(I)*(DP(I)-UD)**2
35570 G3T3 152
35580C
35590C: WALL HAS NO COMPRESSION IN REINFORCEMENT
35600 150 UD=TEVS/(4*(3*FDC*B))
35610 MU(I)=TEVS*(D(I)-2*(UD))
35620 ICR(I)=B*(UD**3/3.0+N*ASC(I)*(D(I)-UD)**2
35630C
35640 152 ICTOT=ICTOT+ICR(I)
35650 170 C2VTINGE
35660C
35670C: DETERMINE AVERAGE CRACKED MOMENT OF INERTIA
35680 175 IC=ICTOT/I
35690 RETURN
35700 END
50000 SUBROUTINE TRANS (B,ZLV,ZLH,ICASE,CRAK,ZLMSE,ZLMFE,ZLMPP,V1S,
50010+ V2S,S1S,V2S,V1F,V2F,V1F,V2F,V1P,V2P,V1P,V2P)
50030C
50040C: THIS SUBROUTINE DETERMINES LOAD AND MASS TRANSFORMATION FACTORS
50050C: AND DYNAMIC REACTION COEFFICIENTS FOR TWO-WAY WALLS.
50060C
50070C: DETERMINE LOAD AND MASS TRANSFORMATION FACTORS
50080 B2=B*B
50090 B3=B*B*B
50100 B4=B2*B2
50110 B5=B2*B3
50120 B6=B3*B3
50130C
50140C: CASES 1 & 5 -- ELASTIC RANGE
50150 330 ZK4SE1=20.48*B3*(1./12.-B2/7.5+B3/21+B4/14+B5/15+B6/90)
50160 Z44SE2=0.5038-0.7066*B
50170 ZKLSE1=6.4*B2*(1./6.-B2/10.+B3/30.)
50180 ZKLSE2=0.64-0.8134*B
50190 BARS1=B*((1./12.-B2/15.+B3/42.)/(1./6.-B2/10.+B3/30.))
50200 BARS2=(0.127043-0.184524*B)/(0.4-0.508333*B)
50210 Z44SE=Z44SE1+Z44SE2
50220 ZKLSE=ZKLSE1+ZKLSE2
50230 IF(CRAK.EQ.1)G3T3 335
50240C: CRACK PATTERN A
50250 CVS=0.5*B
50260 CVL=0.5*(1.0-B)
50270 XP=ZLH*B/3.0
50280 XBARC=BARS1*ZLH
50290 ZP=ZLV*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
50300 ZBARS=BARS2*ZLV
50310 XBARP=0.5*B*ZLH
50320 ZBARP=ZLV*(1./24.-B/16.)/(1./8.-B/6.)
50330 G3T3 335
50340C: CRACK PATTERN B
50350 335 CVS=0.5*(1.0-B)
50360 CVL=0.5*B
50370 XP=ZLH*(1.0-4.0*B/3.0)/(4.0*(1.0-B))

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PROGRAM RCSLAB (CONTINUED)

```

S0380      XBARS=BAR52*ZLH
S0390      ZP=ZLV*9/3.0
S0400      ZBARS=BAR51*ZLV
S0410      XBARP=ZLH*(1./24.-R/16.)/(1./8.-R/6.)
S0420      ZBARP=0.5*ZLH
S0430 338  ZLYSE=ZLYSF/ZLSE
S0450      G7T1(390,340,350,360,390,340,470),ICASE
S0460C
S0470C: CASES 2, 3, 4 & 6 -- PLASTIC RANGE
S0480 350 IF(CRAK.E0.1)G7T3 345
S0490      G7T3 340
S0500 360 IF(CRAK.E0.0)G7T3 365
S0510C: CASES 2A, 3A, 4A, & 6
S0520 340 ZK4FE1=512.0*B5*(1.0/30.-4/10.5+3.*R2/28.-93/14.+84/90.)
S0530      ZKLF1=32.0*R3*(1./12.-R/10.+R2/30.)
S0540      BARF1=R*(0.05-R/15.+R2/42.)/(1./12.-R/10.+R2/30.)
S0550      G7T3(370,345,370,370,370,365),ICASE
S0560C: CASES 2A, 2B, 3B, 4B, & 6
S0570 365 ZK4FE2=0.4055-0.6144*R
S0580      ZKLF2=0.5344-0.7323*R
S0590      BARF2=(.091667-.138095*B)/(.256667-.366667*B)
S0600      G7T3(375,369,375,375,375,368),ICASE
S0610C: CASES 2A & 2B
S0620 368 ZK4FE=ZK4FE1+ZK4FE2
S0630      ZKLF=ZKLF1+ZKLF2
S0640      G7T3 380
S0650C: CASES 3A & 4B
S0660 370 ZK4FE=ZK4FE1+ZK4FE2
S0670      ZKLF=ZKLF1+ZKLF2
S0680      G7T3 380
S0690C: CASES 3B, 4A, & 6
S0700 375 ZK4FE=ZK4FE1+ZK4FE2
S0710      ZKLF=ZKLF1+ZKLF2
S0720 380 ZK4FE=ZK4FE/ZKLF
S0740      G7T3 390
S0750C: CASE 7
S0760 470 ZK4FE=0.73
S0770C
S0780C: ALL CASES -- PLASTIC RANGE
S0790 390 ZK4P=(1.0-R)/3.0
S0800      ZKL=0.5-R/3.0
S0810      ZKLMP=ZK4P/ZKL
S0820C
S0830C
S0840C: DETERMINE DYNAMIC REACTION COEFFICIENTS FOR SHORT (VS) AND
S0850C: LONG (VL) EDGES
S0860C
S0870      IF(ICASE.LT.5)G7T3 395
S0880      XBARS=1E-10$ BARF1=1E-10$ XBARP=1E-10
S0890 395  C9NTINUE
S0900      G7T9(450,400,400,420,450,400,445),ICASE
S0910 400  IF(CRAK.E0.1)G7T3 410
S0920      XBARF=BARF1*ZLH
S0930      IF(ICASE.E0.3)G7T3 430
S0940 405  ZBARF=BARF2*ZLV
S0950      G7T3 440
S0960 410  XBARF=BARF2*ZLH
S0970      IF(ICASE.E0.3)G7T3 435
S0980 415  ZBARF=BARF1*ZLV
S0990      G7T3 440
S1000 420  IF(CRAK.E0.1)G7T3 425
S1010      XBARF=PARS1*ZLH
S1020      G7T3 405
S1030 425  XBARF=BAR52*ZLH
S1040      G7T3 415
S1050 430  ZBARF=BAR52*ZLV
S1060      G7T3 440
S1070 435  ZBARF=BAR51*ZLV
S1080 440  C9NTINUE
S1090C
S1100C: CASES 2, 3, 4, & 6 -- ELASTIC RANGE
S1110      VS1F=CVS*(1.0-XP/XBARF)
S1120      VS2F=CVS*(XP/XBARF)
S1130      VL1F=CVL*(1.0-XP/ZBARF)
S1140      VL2F=CVL*(XP/ZBARF)

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PROGRAM RCSLAB (CONTINUED)

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S1170      G9T9 450
S1180C CASE 7 -- ELASTIC RANGE
S1200 445 VS1F=0
S1220  VL1F=0.459
S1240  VL2F=0.165
S1250C
S1260C CASE 1 & 5 -- ELASTIC RANGE
S1270 450 VS1S=CVS*(1.0-XP/XBARS)
S1280  VS2S=CVS*(XP/XBARS)
S1290  VL1S=CVL*(1.0-ZP/ZBARS)
S1300  VL2S=CVL*(ZP/ZBARS)
S1340C
S1350C ALL CASES -- PLASTIC RANGE
S1360 460 VS1P=CVS*(1.0-XP/XBAPP)
S1370  VS2P=CVS*(XP/XBAPP)
S1380  VL1P=CVL*(1.0-ZP/ZBAPP)
S1390  VL2P=CVL*(ZP/ZBAPP)
S1400  RETURN
S1410  END
70000  SUBROUTINE RANDM (IENTRY)
70010C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDM
70020C VARIABLES, GENERATES RANDM VALUES, AND CONTROLS REQUIRED
70030C NUMBER OF CASES TO BE RUN, AND OUTPUTS FINAL RESULTS AND SUMMARY
70040C
70050 C0440N <INC,LOTYPE,<RF,<RAND,TIME,I,Y(30),Q,OU,YFAIL,
70052+ ZLS,ZLL,HSP,PV,FPC,FDY,I,CASE,VBAR,AS(4),APS(4),D(4),DP(4),FDC,
70054+ EC,ES,R,ALP,ALP2,AREA,MASS,VFAIL,ZLM,VL1,VL2,VS1,VS2,
70055+ MEMB,ASCL,ASCS,VCL,VCS,ASS,BSS,AF,BF,CF,4X,
70056+ W,P3,C9,L3C,S,ZLEV,CD,PS0,PD0,PR,PEXT,PC,TC,TO,DELAY,
70058+ VWIN,RH00,V3,L1,AA(8,2),VV(H),AFRANT,ASIDE,G,G2,G3,G4,PP2,DT
70080  C0440V /RAND/ TIMEC
70090  DIMENSI0N CHI25(7),CHI975(7),TDIST(7)
70100C
70110C VALUES FOR 97.5% (F=19,24,29,34,39,44,49)
70120  DATA CHI25/.4688,.5167,.5533,.5825,.6065,.6267,.6440/
70130  DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
70140  DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
70150C
70160  G0T0(5,50,70),IENTRY
70170  S XDUM4Y=XN0RM1(-1.0,0.0,1.0)
70180C INITIALIZE RANDM NUMBER GENERATOR
70190  PRINT//,*'INPUT VRAND*', 
70200  READ,VRAND
70210  D9 47 I=1,VRAND
70220  XDUM4Y=XN0RM1(0.0,0.0,1.0)
70230  47 CONTINUE
70240  INDEX=0$ SPS3=0$ SSPS3=0
70250  ICHECK=20
70260C
70270  INPUT MEAN AND STANDARD DEVIATION FOR RANDM VARIABLES
70275  IF(LAC.EQ.2)G9T0 30
70280  PRINT 87
70290  READ,SMEAN,SSD
70410C REINFORCED CONCRETE WALLS
70420  30 PRINT 86
70430  READ,FDYMEAN,FDYSD
70440  IF(LAC.EQ.1)PRINT 96
70445  IF(LAC.NE.1)PRINT 95
70450  RETURN
70460C
70470C GENERATE RANDM VALUES
70570  50 FDY=XN0RM1(0.0,FDYMEAN,FDYSD)
70580  IF(FDY.LT.0)G9T0 50
70595  IF(LAC.EQ.2,3R,SMEAN,EQ.0)G9T0 65
70590  60 S=XN0RM1(0.0,SMEAN,SSD)
70600  IF(S.LE.0)G9T0 60
70610  65 INDEX=INDEX+1
70620  RETURN
70630C SUM VALUES OF PS0 AND PS0**2 FOR USE IN STATISTICAL ANALYSIS
70640  70 SPS3=SPS0+PS0
70650  SSPS3=SSPS3+PS0*PS0
70660C
70670C OUTPUT FINAL RESULTS
70730  76 IF(LAC.EQ.1)PRINT 92,FDY,S,PS0,TIMEC
70735  IF(LAC.NE.1)PRINT 90,FDY,PS0,TIMEC

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PROGRAM RCSLAB (CONCLUDED)

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70740 80 IF(INDEX.LT.1CHECK)RETURN
70750C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PSI
70770    INDEX=INDEX
70780    ZMEAN=PSI/240
70790    SDU=SORT((SSPS)-ZMEAN*ZMEAN)/240
70800    STDERR=SD/(SORT(AN-1))
70810C CHECK IF MAXIMUM OF 50 PSI SAMPLES OBTAINED
70820    IF(INDEX.EQ.50)GOTO 62
70830C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PSI VALUE IS
70840    IF(STDERR*TDIST((INDEX-15)/5)>=MEAN.GT.0.10)GOTO 61
70850C
70860C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
70870C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
70880C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
70890    62 SDU=SD/(SORT(CHI25((INDEX-15)/5)))
70900C CHECK IF MAXIMUM OF 50 PSI SAMPLES OBTAINED
70910    IF(INDEX.EQ.50)GOTO 51
70920C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
70930C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
70940    IF(((SDU-SD)/ZMEAN).GT.0.10)GOTO 61
70950C
70960C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
70970C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
70980C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
70990,
71000C AND 10% AND 90% PROBABILITY VALUES
71010    53 ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
71020    ZMEANH=ZMEAN+STDERR*TDIST((INDEX-15)/5)
71030    SDL=SD/(SORT(CHI975((INDEX-15)/5)))
71040    P10=ZMEAN-1.282*SD
71050    P10L=ZMEAN-1.282*SDU
71060    P10U=ZMEAN+1.282*SD
71070    P90=ZMEAN+1.282*SD
71080    P90L=ZMEAN+1.282*SDL
71090    P90U=ZMEAN+1.282*SD
71100    P90L=ZMEAN+1.282*SDU
71110    P90U=ZMEAN+1.282*SDJ
71120C
71130C 7-INPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
71140    PRINT 100,ZMEAN,ZMEANL,ZMEANH,SD,SDL,SDU,P10,P10L,P10U,
71150*      P90,P90L,P90U
71160    PRINT 105,INDEX,STDERR
71170    GOTO 999
71180C
71190C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90%
71200*
71210C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
71220    61 1CHECK=1CHECK+5
71230    RETURN
71240C
71270    86 FFORMAT// INPUT MEAN AND STANDARD DEVIATION FOR FDY*,*
71280    87 FFORMAT// INPUT MEAN AND STANDARD DEVIATION FOR S*,*
71290    90 FFORMAT(F9.1,F10.2,F14.3)
71310    92 FFORMAT(F9.1,F11.2,F10.2,F14.3)
71340    95 FFORMAT(//,5X,*FDY*7X,*PS3*6X,*COLLAPSE TIME*)
71350    96 FFORMAT(//,5X,*FDY*,9X,*S*,8X,*PS3*,6X,*COLLAPSE TIME
71360    100 FFORMAT(//,11X,*STATISTICAL PROPERTIES OF INCIPIENT F 10,
71370*      //,39X,*95% CONFIDENCE LIMITS*,/,7X,*ITEM*,14X,
71380*      *VALUE*   L3WH   UPPER*,//,* MEAN*,F23.2,
71390*      2F12.2,/* STANDARD DEVIATION*,F15.2,2F12.2,*/,
71400*      * 10% PROBABILITY VALUE*,3F12.2,*/
71410*      * 90% PROBABILITY VALUE*,3F12.2,
71420    105 FFORMAT(//,5X,*NUMBER OF OBSERVATIONS *13,/,5X,
71430*      *STANDARD ERROR **,FS.2)
71440C
71450    999 STOP$ END
71460 FUNCTION XNORM1(X,A,B)
71470 IF(X)10,20,20
71480 10 X0=RANF(-1.0)
71490 20 X1=RANF(0.0)
71500  X2=RANF(0.0)
71510 Y=SORT(-2.0*A*(B*X1)+(L ,(6.233184*X2))
71520 XNORM1=A+Y*B
71530 RETURN
71540 END

```

**RESTRAN**

**Restrained Reinforced Concrete Slab**

PROGRAM RESTRAN

```

01000 PROGRAM RES (INPUT,OUTPUT)
01010C THIS PROGRAM CALCULATES THE RESISTANCE OF A REINFORCED CONCRETE
01020C SLAB RESTRAINED AGAINST LATERAL MOVEMENT AT THE EDGES
01030C
01050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,FDC,
01052+ ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PS0,PDO,PF,PEXT,PC,TC,TO,
01054+ PO,DELAY,S,FPC,FY
01060 DIMENSION A(80),V(80),T(80),VS(80),QQ(80),PN(80)
01080 COMMON /RAND/ TIMEC
01100C
01104C PRINT PROGRAM TITLE, DATE, AND TIME
01105 5 DA=DATE(I DATE) S CL=CLOCK(ICLOCK)
01106 PRINT 603, I DATE, ICLOCK
01107 603 FORMAT(//PROGRAM RESTRAN (REVISED 12/22/73)*,5X,A9,5X,A9)
01108C
01110C * READ TITLE AND CONTROL PARAMETERS *
01120 PRINT 67
01130 READ 68,TITLE
01140 PRINT 65
01150 READ,KINC,LDTYPE,KRF,KRAND
01155C
01160 DELAY=0
01180 CALL RESIST(1)
01182 IF(KRAND.NE.1)CALL RESIST(2)
01185 IF(LDTYPE.EQ.0)GOTO 50
01190 CALL FORCE(1)
01200 IF(KRF.EQ.0)GOTO 14
01210 CALL FILL(PINT,1)
01260 14 IF(KRAND.NE.1)GOTO 13
01270 CALL FORCE(4)
01280 CALL RANDOM(1)
01290 34 CALL RA(DOM(2))
01300 35 CALL RLSIST(2)
01310C
01320C MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
01330C WHERE THE LOAD CAUSING INCIPIENT COLLAPSE IS TO BE FOUND
01340 13 IF(KINC.EQ.0)GOTO 23
01350    PF=QU
01360    PFMAX=0
01370    PFMIN=PF/2.0
01380    GOTO 20
01390 16 PF=(PFMIN+PFMAX)/2.0
01400 20 CALL FORCE(2)
01410 23 IF(KRF.EQ.0)GOTO 24
01420 CALL FILL(PINT,2)
01430C
01440C: INITIALIZE VALUES FOR BETA METHOD (BETA=1/6) AND COMPUTE VALUES
01450C: FOR FIRST TIME INTERVAL ASSUMING ELEMENT INITIALLY AT REST
01460 24    I=1
01470    TIME=0
01480    V(1)=0 S Y(1)=0
01490    DELTA=0.001
01500    IF(KRF.NE.1)GOTO 30
01510 27 IF(TIME.GE.(DELAY-.00001))GOTO 30
01520    TIME=TIME+DELTA
01530    CALL FILL(PINT,3)
01540    GOTO 27
01640 30 CALL RESIST(3)
01650    A(1)=0.0 S VS(1)=0.0
01660    T(1)=TIME
01680C
01690C: PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
01700 1    I=I+1
01710    IF(I.LT.81)GOTO 11
01720    PRINT 98,TIME
01730 98 FORMAT(/*I=81) TIME --,F6-3,* FAILURE ASSUMED TO NOT OCCUR*)
01740    GOTO 6
01750 11 TIME=TIME+DELTA
01760    T(I)=TIME
01770    A(I)=A(I-1)
01775    IF(KRF.NE.0)GOTO 10
01780    CALL FORCE(3)
01790    PN(I)=PEXT
01800    GOTO 2

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PROGRAM RESTRAN (CONTINUED)

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01880 10    CALL FILL(PINT,3)
01890    PN(I)=PINT
01910  2    CONTINUE
01920    DO 8 JJ=1,10
01930    Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
01940 CALI  RESIST(3)
01960  4    ANEW=AREA*(PN(I)-Q)/(ZMACS*ZHLM)
01970    ADELTA=ANEW-A(I)
01980    A(I)=ANEW
01985 IF(ANEW.EQ.0)PRINT,*1985*,TIME,PN(I),Q,ZMASS,ZHLM,Y(I),A(I-1)
01990    IF(ABS(ADELTA/(ANEW+1E-10)).LT.0.01)GOTO 9
02060  8    CONTINUE
02010    A(I)=ANEW-ADELTA/2.0
02020 PRINT 80,TIME,PF,A(I),Y(I)
02030  9    CONTINUE
02040    Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
02050    V(I)=V(I-1)+DELTA*(A(I)-A(I-1))/2.0
02060    VS(I)=4.0*AREA*(VS1*PN(I)+VS2*Q)
02070    QQ(I)=Q
02090C
02100C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE
02110C: IF MAXIMUM DEFLECTION REACHED, WALL DID NOT FAIL
02120    IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GOTO 6
02130    IF(Y(I).LT.0)GOTO 6
02135    IF(Y(I).GE.YFAIL)GOTO 7
02140    IF(TIME-DELAY.GE.0.010)DELTA=0.002
02160    IF(TIME-DELAY.GE.0.020)DELTA=0.005
02170    IF(TIME-DELAY.GE.0.100)DELTA=0.010
02180    IF(TIME-DELAY.GE.0.500)DELTA=0.050
02190C: IF FAILURE DEFLECTION REACHED, ELEMENT FAILED
02210    GOTO 1
02220C
02230C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
02240C: COLLAPSE FOR CASES WHERE DESIRED
02250C: ELEMENT DID NOT FAIL -- SET PFMIN TO PF
02260  6    CONTINUE
02280    IF(KINC.EQ.0)GOTO 18
02290  36   PFMIN=PF
02300 IF(PFMAX.GT.0)GOTO 16
02310    PF=2.0*PF
02320    GOTO 20
02330C: ELEMENT FAILED -- SET PFMAX TO PF
02340  7    CONTINUE
02350    TIMEC=TIME
02370    IF(KINC.EQ.0)GOTO 18
02380  37   PFMAX=PF
02390C: CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
02400  17   IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GOTO 16
02410    IF(KRAND.NE.1)GOTO 18
02420    CALL RANDOM(3)
02430    GOTO 34
02440C
02450C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
02460C: OCCURANCE FOR A NON-FAILING ELEMENT OR THE TIME AND VELOCITY
02470C: AT COLLAPSE FOR A FAILING ELEMENT. OPTIONAL OUTPUT IS THE
02480C: ENTIRE BEHAVIOR TIME-HISTORY.
02490C
02500C: OUTPUT LOAD DATA
02510  18   CALL FORCE(4)
02520C
02530C: OUTPUT FINAL RESULTS
02540 IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
02550 IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
02570 GOTO 42
02577C
02578C CHECK TO SEE IF ENTIRE TIME-HISTORY IS DESIRED
02580  42 PRINT 72
02590 READ,IPRINT
02600 IF(IPRINT.EQ.0)GOTO 25
02680 PRINT 76,(T(J)-PN(J),A(J),V(J),Y(J),QQ(J),VS(J),J=1,I)
02690  25 PRINT 77
02700 GOTO 5
*10C
*180 67 FORMAT(//*INPUT TITLE*,*)

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PROGRAM RESTRAN (CONTINUED)

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02730 68 FORMAT(A59)
02740 70 FORMAT(/NO FAILURE - MAX DEFLECTION OF.,F6.2,
02750+   * IN. REACHED AT F7.3,* SEC*)
02760 71 FORMAT(/FAILURE OCCURRED AT *,F7.3,* SEC (FINAL VELOCITY *,
02770+   F7.2* IN./SEC*)*)
02780 72 FORMAT(/IS TIME HISTORY DESIRED (YES=1, NO=0)*,1)
02830 76 FORMAT(/ TIME PRESSURE ACCELERATION VELOCITY *
02840+   *DISPLACEMENT   QQ    VS*,/,
02850+   (F6.3,F9.3,F12.1,F12.2,F12.4,F10.2,F9.0))
02860 77  FORMAT(//,7(*-----*))
02870 80 FORMAT(/ACCELERATION NOT CONVERGING AT TIME **,F6.3,
02880+   * SEC (PF **,F7.3* PSI)*/* A(I) SET EQUAL TO *,
02890+   F8.1,* (AVG OF LAST 2 ITERATIONS)**/* Y(I) **,
02900+   F8.4* IN.*)
02910 85 FORMAT(/INPUT KINC,LDTYPE,KRF,KRAND(I=RANDOM)*,1)
02950C
03000C  OUTPUT RESISTANCE FUNCTION (LDTYPE=0)
03010 50 I=1
02J80 PRINT 60
03030 52 READ,YSTART,YEND,YINC
03040 IF(YINC.EQ.0)GOTO 25
03050 PRINT 62
03060 Y(I)=YSTART
03070 54 CALL RESIST(3)
03080 PRINT 63,Y(I),Q
03090 Y(I)=Y(I)+YINC
03100 IF(Y(I).LE.YEND)GOTO 54
03110 PRINT 61
03120 GOTO 52
03130C
03200 60 FORMAT(/IF INTERMEDIATE VALUES OF RESISTANCE FUNCTION ARE *,
03210+   * TO BE PRINTED,*/INPUT STARTING, ENDING, AND INCREMENTAL *,
03220+   *DEFLECTION VALUES/*(IF NO INTERMEDIATE VALUES ARE *
03230+   *TO BE PRINTED, INPUT ZEROS)*)
03240 61 FORMAT(/MORE VALUES*,1)
03255 62 FORMAT(/DEFLECTION (IN.)*,5X,*RESISTANCE (PSI)*)
03260 63 FORMAT(F11.4,F21.2)
03270C
03500 999 STOP
03510 END
10000 SUBROUTINE FORCE(IENTRY)
10010C THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
10020C THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
10030C   1. IDEALIZED BLAST LOAD (FRONT OR SIDE FACE)
10040C
10050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,FDC,
10052+ ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PS0,P0,PR,PC,TC,TO,
10054+ PO,DELAY,S,FPC,FY
10060 DIMENSION TT(20),PP(20)
10120C
10130 IF(LDTYPE.EQ.5)GOTO 500
10140C
10150 GOTO(100,200,300,4),IENTRY
10160C
10170C * INPUT LOAD PARAMETERS *
10180C: LOCATION 1. FRONT FACE LOADING (USED IN ROOM-FILLING PROCEDURE)
10190 100 W=1000.0 S P0=14.7 S CD=1120.0
10200 IF(KRF.NE.1)GOTO 102
10210 LOC=1
10220 IF(KRAND.EQ.1)RETURN
10230 PRINT 600
10240 READ,S
10250 GOTO 105
10260C: LOCATION 2. TOP FACE LOADING
10265 102 CD=0 $ LOC=2
10270 ZLEN=ZLS/12.0
10275 105 IF(KINC.EQ.1)RETURN
10280 PRINT 610
10285 READ,PS0
10290 PR=2.0*PS0*(7.0*P0+4.0*PS0)/(7.0*P0+PS0)
10295 GOTO 215
11000C
11010C CALCULATE LOAD PROPERTIES FOR GIVEN PEAK PRESSURE
11030 200 GOTO(205,210),LOC

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PROGRAM RESTRAN (CONTINUED)

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11040 205 PS0=(PR-14.0*PO+SQRT(196.0*PO*PO+196.0*PO*PR+PR*PR))/16.0
11050 GOTO 215
11060 210 PS0=PR
11070 215 PDO=2.5*PS0*PS0/(7.0*PO*PS0)
11080 U=C0*SQRT(1.0*(6.0*PS0)/(7.0*PO))
11090 T0=W*0.3333/(2.2399*0.1886*PS0)
11100 GOTO(220,225),LOC
11110 220 TC=3.0*S/U
11120 PC=PS0*(1-TC/T0)*EXP(-TC/T0)+PDO*(1-TC./0)**2*EXP(-2*TC/T0)
11130 CD=1.0
11140 RETURN
11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2T0=TA2/T0
11180 PA=PS0*(1-TA2T0)*EXP(-TA2T0)+CD*PDO*(1-TA2T0)**2*EXP(-2*TA2T0)
11190 RETURN
12000C
12010C CALCULATE LOAD
12030 300 GOTO(305,310),LOC
12040 305 TTO=TIME/T0
12050 IF(TIME.GT.TC)GOTO 320
12060 P=PC+(IC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TIO=(TIME-TA2)/T0
12090 IF(TIME.GT.TA)GOTO 320
12100 P=PA+TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)GOTO 330
12130 P=PS0*(1-TT0)*EXP(-TT0)+CD*PDO*(1-TT0)**2*EXP(-2*TT0)
12150 RETURN
12160 330 PO=0
12170 RETURN
13000C
13010C PRINT LOAD DATA
13020 4 IF(KINC.EQ.0)GOTO 400
13030 PRINT 640,LDTYPE
13040 GOTO 410
13050 400 PRINT 645,LDTYPE
13060 410 CONTINUE
13070 415 GOTO(420,425),LOC
13080 420 PRINT 650
13090 GOTO 430
13100 425 PRINT 655
13110 430 PRINT 660,W,PO,C0
13120 IF(KRAND.NE.0)RETURN
13130 GOTO(435,440),LOC
13140 435 PRINT 665,S,TC,PR
13150 GOTO 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,U,T0,CD,PS0,PDO
13180 RETURN
13500C
13510C LOAD TYPE S -- ARBITRARY LOAD SHAPE
13520 500 GOTO(510,520,530,540),IENTRY
13530C
13540C INPUT LOAD DATA
13550 510 PRINT 680
13560 READ,NPOINT,(TT(J),PP(J),J=1,NPOINT)
13570 FACTOR=1.0
13580 IF(KINC.EQ.0)GOTO 518
13590 PMAX=PP(1)
13600 DO 515 J=2,NPOINT
13610 515 IF(PP(J).GT.PMAX)PMAX=PP(J)
13620 518 PX=PP(2)-PP(1)
13630 TX=TT(2)-TT(1)
13640 JJ=1
13650 RETURN
13660C
13670C CALCULATE MAXIMUM LOAD
13680 520 FACTOR=PR/PMAX
13690 GOTO 518
13700 RETURN
13710C
13720C CALCULATE LOAD

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PROGRAM RESTRAN (CONTINUED)

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13730 530 IF(TIME.LE.TT(JJ+1))GOTO 535
13740 JJ=JJ+1
13750 PX=PP(JJ+1)-PP(JJ)
13760 TX=TT(JJ+1)-TT(JJ)
13765 IF(TX.EQ.0)TX=1E-10
13770 GOTO 530
13780 535 P=FACTOR*(PP(JJ)+(TIME-TT(JJ))*PX/TX)
13790 RETURN
13800C
13810C PRINT LOAD DATA
13815 540 IF(KINC.EQ.1)PRINT 640,LDTYPE
13820 IF(KINC.EQ.0)PRINT 645,LDTYPE
13825 PRINT 690
13830 DO 545 J=1,NPOINT
13840 P=FACTOR*PP(J)
13850 545 PRINT 695,TT(J),P
13860 RETURN
14000C
14010 600 FORMAT(//INPUT S*,*)
14020 310 FORMAT(//INPUT PS0*,*)
14070 640 FORMAT(/*LOAD CAUSING INCIPIENT FAILURE IS AS FOLLOWS:*,  
14071* /,5X,*LOAD TYPE NUMBER*.I2)
14080 645 FORMAT(/*PROPERTIES OF LOAD ACTING ON WALL ARE AS FOLLOWS:*,  
14081* /,5X,*LOAD TYPE NUMBER*.I2)
14090 650 FORMAT(8X,*FRONT FACE*)
14100 655 FORMAT(5X,*SIDE OR TOP FACE*)
14110 660 FORMAT(10X,*W **,F8.1,* KT PO **,F6.2,* PSI CO **,  
14111* F7.1,* FPS*)
14120 665 FORMAT(10X,*S **,F6.1,* FT TC **,F6.3,* SEC PR **,  
14121* F7.3,* PSI*)
14130 670 FORMAT(10X,*L **,F6.1,* FT TA **,F6.3,* SEC PA **,  
14131* F7.3,* PSI*)
14140 675 FORMAT(10X,*U **,F7.1,* FPS TO **,F6.3,* SEC CD **,  
14141* FS: i,/,8X,*PS0 **,F7.3,* PSI PDO **,F7.3,* PSI*)
14150 680 FORMAT(//INPUT NUMBER OF LOAD POINTS AND THE TIME AND *  
14151* *PRESSURE AT EACH POINT*)
14160 690 FORMAT(10X,*TIME PRESSURE*)
14170 695 FORMAT(F15.3,F12.2)
15000 END
20000 SUBROUTINE FILL(P3,IENTRY)
20010 RETURN
20020 END
30000 SUBROUTINE RESIST (IENTRY)
30010C THIS SUBROUTINE DETERMINES THE RESISTANCE FUNCTION,
30020C TRANSFORMATION FACTORS, AND REACTION COEFFICIENTS
30030C FOR A LONGITUDINALLY RESTRAINED REINFORCED CONCRETE SLAB
30040C
30050 COMMON KINC,LDTYPE,KR5,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,FDC,
30052* ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PS0,PDO,PR,PEXT,PC,TC,TO,
30054* PO,DELAY,S,FPC,FY
30080 COMMON /MOM/ AS(4),D(4),APS(4),DP(4),MU(4),R(4),
30085* K1,K2,K3,EPSC,ES,FPS,KUD,E(4)
30090 REAL MU,K1,K2,K3,KUD,N,NUX0,NUXBL,NUXAVG,NUZ0,NUZLSR,NUZAVG
30095 REAL MU1BAR,MU2BAR,MU3BAR,MUABAR,MU1,MU3,NB,KT
30100C
30110 GOTO (1,2,3), IENTRY
30120C
30130C ENTRY 1. INPUT AND ECHO SLAB AND REINFORCEMENT PROPERTIES
30150 1 PRINT 600
30160 READ,ZLS,ZLL,HS,FPC,FY,DIF
30165 PRINT 670
30170 DO 100 I=1,4
30180 PRINT 610,I
30190 P(I)=0.0
30200 READ,AS(I),D(I),APS(I),DP(I)
30240C SLAB ASSUMED TO BE RESTRAINED AT CENTERLINE OF CROSS SECTION
30250 E(I)=0.0
30260 100 CONTINUE
30262 PRINT 711
30265 READ,ASCZ,ASCX
30266 ASCZ=ASCZ/12.0 $ ASCX=ASCX/12.0
30270 PRINT 602
30280 READ,SZ,SX
30281C

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PROGRAM RESTRAN (CONTINUED)

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30262C CALCULATE VARIOUS CONSTANTS
30263 DIF=1.0+DIF/100.0
30265 FDC=DIF+FPC $ FDY=DIF+FY
30300 ALP=ZLS/ZLL
30310 ALP2=ALP*ALP
30315 ES=29E6
30318 AREA=ZLS*ZLL
30319 ZMASS=150.0*AREA*HS/(386.07*1728.0)
30320C
30321C OUTPUT SLAB PROPERTIES
30322 PRINT 620,ZLS,ZLL,HS,FDC,FDY
30323 PRINT 630
30324 DO 104 I=1,4
30325 IF(AS(I).EQ.0)GOTO 104
30326 P=AS(I)/(12.0*D(I)) $ PP=APS(I)/(12.0*D(I))
30327 PRINT 640,I,AS(I),P,D(I),APS(I),PP,DP(I)
30328C CHANGE UNITS OF REINFORCEMENT FROM SQ.IN./FT TO SQ.IN./IN.
30329 AS(I)=AS(I)/12.0 $ APS(I)=APS(I)/12.0
30330 104 CONTINUE
30332 RETURN
30340C
30350C ENTRY 2. DETERMINE PROPERTIES DEPENDENT UPON FDY AND FDC
30360 2 EC=57619.03*SQRT(FPC)
30370 N=ES/EC
30380 FDC=DIF+FPC $ FDY=DIF+FY
30390 K1=0.94-FDC/26E3
30400 K2=0.50-FDC/6E4
30410 K3=(3900.0+0.35*FDC)/(3E3+0.62*FDC-FDC*FDC/26E3)
30420 EPSC=0.004-FDC/65E6
30430 DO 110 I=1,4
30440 110 CALL MOMENT (0.0,I,FDY,FDC,HS)
30450 IF(MU(I).GT.0.0)GOTO 120
30460 QUTERM=0.0
30470 B=0.5*(SQRT(3.0*ALP2+ALP2**2)-ALP2)
30480 GOTO 108
30490 120 GMU=MU(2)/MU(1)
30500C
30510C: DETERMINE POSITION OF YIELD LINES AND ULTIMATE RESISTANCE
30520C: COEFFICIENTS FOR TWO-WAY WALLS
30530 Z11=MU(4)/MU(2)
30540 Z13=MU(3)/MU(1)
30550 GAMMA12=2.0*SQRT(1.0+Z11)
30560 GAMMA34=2.0*SQRT(1.0+Z13)
30570 GRAT=GAMMA12/GAMMA34
30580 B=SQRT(1+Z11)*(GMU*ALP2/GAMMA34)*(SQRT(GRAT**2+3/
30590+ (GMU*ALP2))-GRAT)
30600C: IF BETA IS GREATER THAN 0.5 ASSUMPTION OF CRACK PATTERN A
30610C: NOT VALID AND CRACK PATTERN B IS ASSUMED TO OCCUR
30620 IF(B.LE.0.5)GOTO 105
30630C
30640C: CRACK PATTERN B
30650 KRAK=1
30660 B=SQRT(1.0+Z13)*(SQRT(1.0/GRAT**2+GMU*ALP2*3.0)-1.0/GRAT)
30670+ /(GMU*ALP2*GAMMA12)
30680 QUTERM=6.0*GAMMA12**2*ALP*GMU/(SQRT(3+1/(GMU*ALP2*GRAT**2))
30690+ -1.0/(SQRT(GMU)*ALP*GRAT))**2
30695 IF(KRAK.NE.1)PRINT 623
30696 623 FORMAT(/*CRACK PATTERN B -- RESULTS NOT FULLY CHECKED OUT*/
30700 GOTO 108
30710C
30720C: CRACK PATTERN A
30730 105 CONTINUE
30740 KRAK=0
30750 QUTERM=6.0*GAMMA34**2/(ALP*(SQRT(3+GMU*ALP2*GRAT**2)
30760+ -ALP*GRAT*SQRT(GMU))**2)
30765C
30770C SECONDARY RESISTANCE
30780 108 QS=QUTERM*MU(1)/(ZLS*ZLL)
30785C
30790C DETERMINE TRANSFORMATION FACTORS AND DYNAMIC REACTION COEFFICIENTS
30795C TRANSFORMATION FACTORS AND DYNAMIC REACTION COEFFICIENTS
30798 CALL TRANS (B,ZLS,ZLL,KRAK,ZKLMP,V1IP,V12P,V51P,V52P)
30800 DO 200 I=1,4
3081 R(I)=(AS(I)-APS(I))*FDY/(K3*FDC)

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PROGRAM RESTRAN (CONTINUED)

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30820 200 CONTINUE
30830C SET ELASTIC STRAIN TO ZERO
30840 EAX=0.0 $ EAZ=0 )
30850 SXP=SX+EAX $ SZP=SZ+EAZ
30852C
30853C CALCULATE DEFLECTION AT ULTIMATE RESISTANCE
30855 IYU=1
30858C Z-DIRECTION STRIPS
30860 TERM1=HS*(R(3)-R(1))/K1
30870 TERM2=0.5*ZLS*ZLS*(EPSC*(1.0+SZ)+SZP)
30872 GOTO 206
30873C X-DIRECTION STRIPS
30874 202 IYU=2
30880 TERM1=HS*(R(4)-R(2))/K1
30890 TERM2=B*ZL*L*ZLL*(EPSC*(2.0+B*SX-2.0*B*EAX+EAX)+SXP)
30900 206 IF(TERM2>TERM1)GOTO 210
30910 YU=TERM1-SQRT(TERM1**2-TERM2)
30920 IF(YU<LT.0.42*HS)GOTO 235
30925C EMPIRICAL UPPER BOUND OF 0.42 TIMES SLAB THICKNESS FOR YU
30930 210 YU=0.42*HS
30935 235 CONTINUE
30937C
30938C CALCULATE IN-PLANE COMPRESSIVE FORCES
30940 NUZO=0.5*K3*FDC*(HS-0.25*SZP*ZLS*ZLS/YU)*K1-R(1)-R(3))
30950 IF(NUZO.LT.0)NUZO=0
30960 IF(NUZO.EQ.0.AND.IYU.EQ.1)GOTO 202
30970 NUZI,S2=NUZO-0.25*K3*FDC*K1+YU
30980 IF(NUZLS2.LT.0)NUZLS2=0
30990 NUZAVG=0.5*(NUZO+NUZLS2)
31030 NUXO=0.5*K3*FDC*(HS-0.5*B*SXP*ZLL*ZLL/YU)*K1-R(2)-R(4))
31040 IF(NUXO.LT.0)NUXO=0
31050 NUXBLL=NUXO-0.25*K3*FDC*K1+YU
31060 IF(NUXBLL.LT.0)NUXBLL=0
31110 NUXAVG=0.5*(NUXO+NUXBLL)
31115C
31120C CALCULATE ULTIMATE COMPRESSIVE MEMBRANE RESISTANCE
31130 CALL MOMENT (NUXAVG,2,FDY,FDC,HS)
31140 MU2BAR=MU(2)
31150 CALL MOMENT (NUXAVG,4,FDY,FDC,HS)
31160 MU4BAR=MU(4)
31170 CALL MOMENT (NUZAVG,1,FDY,FDC,HS)
31180 MU1BAR=MU(1)
31190 CALL MOMENT (NUZAVG,3,FDY,FDC,HS)
31200 MU3BAR=MU(3)
31210 CALL MOMENT (NUZLS2,1,FDY,FDC,HS)
31220 MU1=MU(1)
31230 CALL MOMENT (NUZO,3,FDY,FDC,HS)
31240 MU3=MU(3)
31250 QU=12.0/(ZLS*ZLS*(3.0-2.0*B))**2/B)*(MU2BAR
31260 +MU4BAR-YU*(2.0*NUXBLL+NUXO)/6.0)**4.0*B*(MU1BAR+MU3BAR
31270 -YU*(2.0*NUZLS2+NUZO)/6.0)**2.0*(1.0-2.0*B)*(MU1+MU3-YU*NUZLS2))
31430C
31500C TENSILE MEMBRANE BEHAVIOR
31510 TZ=ASCZ*FDY
31520 TX=ASCX*FDY
31525 IF(TZ.EQ.0.OR.TX.EQ.0)GOTO 312
31530 C1=3.14159*SQR (TZ/TX)*ZLL/(2.0*ZLS)
31540 KT=0
31550 DO 310 JJ=1,13,1
31560 JJ2=JJ*2
31570 COSHJJ=0.5*(EXP(JJ*C1)+EXP(-JJ*C1))
31580 COSHJJ2=0.5*(EXP(JJ2*C1)+EXP(-JJ2*C1))
31590 C2=(1.0-1.0/COSHJJ)/JJ**3-(1.0-1.0/COSHJJ2)/JJ2**3
31600 310 KT=KT+C2
31610 KT=1.5*3.14159**3/(4.0*KT)
31612 GOTO 314
31614 312 KT=1.5*8.0
31616 IF(TZ.EQ.0)GOTO 316
31618C
31619C SECONDARY AND TENSILE MEMBRANE DEFLECTION
31620 314 YT=QS*ZLS*ZLS/(KT*TZ)
31630 YFAIL=0.15*ZLS
31640 QFAIL=YFAIL*KT*TZ/(ZLS*ZLS)
31642 GOTO 317

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PROGRAM RESTRAN (CONTINUED)

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31644 316 IF(TX.EQ.0)GOTO 318
31645C NO TENSILE MEMBRANE REINFORCEMENT -- SET YS=YT=YFAIL=HS
31646 YT=QS*ZLL*ZLL/(KT*TX)
31648 YFAIL=0.15*ZLL
31650 QFAIL=YFAIL*KT*TX/(ZLL*ZLL)
31651 317 IF(YT.LT.3.0*YU)YS=YT
31652 IF(YT.GT.3.0*YU)YS=3.0*YU
31653 GOTO 320
31654C NO TENSILE MEMBRANE REINFORCEMENT - SET YS=YFAIL=HS
31656 318 YS=HS $ YT=HS $ YFAIL=HS $ QFAIL=0.0
31658C
31660C ADJUST LOAD-DEFLECTION CURVE FOR SLAB DEAD LOAD
31670 320 QDL=150.0*HS/172.0
31672 YDL=YU-YU*(1.0-(QDL/YU)**1.8)**(1.0/1.8)
31674 YU=YU-YDL $ YS=YS-YDL $ YT=YT-YDL $ YFAIL=YFAIL-.1*DL
31676 QU=QU-QDL $ QS=QS-QDL $ QFAIL=QFAIL-QDL
31678 IF(KRAND.NE.1)PRINT 633,QDL,YDL
31680C
31700C OUTPUT LOAD-DEFLECTION CURVE
31710 IF(KRAND.EQ.1)GOTO 335
31720 IF(YS.EQ.YT)PRINT 660,QU,YU,QS,YS,QFAIL,YFAIL
31730 IF(YS.NE.YT)PRINT 660,QU,YU,QS,YS,QS,YT,QFAIL,YFAIL
31740 335 RETURN
31750C
31800 600 FORMAT(/*INPUT LS,LL,HS,F'C,FY,DIF(%),*)
31810 602 FORMAT(/*INPUT LONGITUDINAL EDGE DISPLACEMENT (PER UNIT */,
31811+ *LENGTH)*/*IN SHORT AND LONG DIRECTIONS,*)
31820 610 FORMAT(I6,*)
31830 620 FORMAT(/*PROPERTIES OF LONGITUDINALLY RESTRAINED *
31840+ *REINFORCED CONCRETE SLAB*,/* LS =*,F6.1,* IN. LL =*,F6.1,* IN.*/,
31850+ * F6.1,* IN. *,6X,*HS =*,F6.1,* IN. *,FDC =*,F7.1,* PSI*/,
31860+ * FDY =*,F8.1,* PSI*)
31870 630 FORMAT(/*REINFORCEMENT VALUES*, SECTION AS (P)*,
31880+ * 7X,*D*,6X,*A'S (P')*,7X,*D'*/*,RX,*(SQ IN./FT)*,10X,
31890+ * (IN.) (SQ IN./FT)*,10X,(IN.)*)
31895 633 FFORMAT(/*QDL =*,F6.2,* PSI YDL =*,F8.4,* IN.*)
31900 640 FORMAT(I5,F11.4,* (*,F5.4,*),F8.3,F10.4,* (*,F5.4,*),
31910+ * F8.3)
31915 660 FORMAT(/*LOAD-DEFLEC' N CURVE*,/*4X,*Q (PSI) Y (IN.)*,
31916+ /*(F9.2,F12.4))
31920 670 FORMAT(/*INPUT AS, D, APS, AND DP FOR FOLLOWING SECTIONS*)
31930 711 FORMAT(/*INPUT CONTINUOUS TENSILE MEMBRANE REINFORCEMENT */,
31940+ * (SQ IN./FT)*/*IN SHORT AND LONG DIRECTIONS,*)
31990C
32000C ENTRY 3. DETERMINE THE RESISTANCE (PER UNIT AREA)
32010C OF THE SLAB AS A FUNCTION OF Y(I)
32020C
32025 3 IF(Y(I).LT.0.OR.Y(I).GT.YFAIL)GOTO 530
32030 IF(Y(I).GE.YU)GOTO 510
32035 ZKLM=ZKLMP
32040C
32050C COMPRESSIVE MEMBRANE RESISTANCE
32060 Q=QU*(1.0-(1.0-Y(I)/YU)**1.8)**(1.0/1.8)
32090 RETURN
32100C
32110 510 IF(Y(I).GE.YS)GOTO 520
32120C
32130C SECONDARY RESISTANCE
32140 Q=0.5*(QU+QS+(QU-QS)*COS(3.1416*(Y(I)-YU)/(YS-YU)))
32170 RETURN
32180C
32190 520 IF(Y(I).GT.YT)GOTO 525
32192C
32194C PLASTIC RESISTANCE
32196 Q=QS
32198 RETURN
32200C
32210C TENSILE MEMBRANE RESISTANCE
32220 525 Q=QS*(Y(I)-YT)*(QFAIL-QS)/(YFAIL-YT)
32250 RETURN
32260C
32270C FAILURE (SET RESISTANCE TO VERY SMALL VALUE)
32280 530 Q=1E-11
32290 RETURN

```

PROGRAM RESTRAN (CONTINUED)

```

33000 END
35000 SUBROUTINE MOMENT (PV,I,FDY,FDC,HS)
35010C THIS SUBROUTINE CALCULATES THE ULTIMATE MOMENT CAPACITY FOR
35020C REQUIRED SECTIONS. INCLUDED ARE THE EFFECT OF IN-PLANE FORCES
35030C & AN ECCENTRICITY E(I) FROM THE CROSS SECTION CENTERLINE.
35040C JMMON /MOM/ AS(4),D(4),APS(4),DP(4),MU(4),R(4),
35050C K1,K2,K3,EPSC,ES,FPS,KUD,E(4)
35060 REAL MU,K1,K2,K3,KUD
35090C
35100 IF(AS(I).EQ.0)GOTO 170
35110C: ALL PROPERTIES ARE COMPUTED FOR A UNIT WIDTH
35120 TENS=AS(I)*FDY+PV
35130 IF(APS(I).LE.0)GOTO 150
35140C
35150C SECTION HAS COMPRESSION REINFORCEMENT
35160 C=K1*K3*FDC*DP(I)
35170 TERM1=0.5*(TENS/APS(I)+ES*EPSC)
35180 TERM2=ES*EPSC*(TENS-C)/APS(I)
35190C: DETERMINE LOCATION OF NEUTRAL AXIS
35200 IF(TENS.LE.C)GOTO 140
35210C
35220C: KUD > D'
35230 FPS=TERM1*K3*FDC/2.0-SQRT((TERM1*K3*FDC/2.0)**2
35240C - (TERM2*ES*EPSC*K3*FDC))
35250C: F'S MUST BE <= FDY
35260 IF(FPS.LT.FDY)GOTO 130
35270 FPS=FDY
35280 130 TPS=APS(I)*(FPS-K3*FDC)
35290 KUD=(TENS-TPS)/(K1*K3*FDC)
35300 MU(I)=AS(I)*FDY*(D(I)-K2*KUD)+APS(I)*FPS*(K2*KUD-DP(I))
35310C +PV*(0.5*HS-K2*KUD+E(I))
35320 RETURN
35330C
35340C: KUD < D'
35350 140 FPS=-TERM1+SQRT(TERM1**2-TERM2)
35360C: F'S MUST BE <= FDY
35370 IF(FPS.LT.FDY)GOTO 145
35380 FPS=FDY
35390 145 TERM3=TENS+APS(I)*FPS
35400 KUD=TERM3/(K1*K3*FDC)
35410 MU(I)=AS(I)*FDY*(D(I)-K2*KUD)-APS(I)*FPS*(K2*KUD-DP(I))
35420C +PV*(0.5*HS-K2*KUD+E(I))
35430 RETURN
35440C
35450C SECTION HAS NO COMPRESSION REINFORCEMENT
35460 150 TERM1=0.5*(ES*EPSC+PV/AS(I))
35470 FS=-TERM1+SQRT(TERM1**2+ES*EPSC*(K1*K3*FDC*D(I)-PV)/AS(I))
35480 IF(FS.LT.FDY)GOTO 160
35490 FS=FDY
35500 160 IF(FS.LT.-FDY)FS=-FDY
35510 KUD=(AS(I)*FS+PV)/(K1*K3*FDC)
35520 IF(KUD.GT.HS)PRINT,*KUD IS GREATER THAN HS*
35530 MU(I)=AS(I)*FS*(D(I)-K2*KUD)+PV*(0.5*HS-K2*KUD+E(I))
35540 RETURN
35560C
35565C SECTION HAS NO REINFORCEMENT
35570 170 KUD=PV/(K1*K3*FDC)
35580 MU(I)=PV*(0.5*HS-K2*KUD+E(I))
35590 RETURN
35600 680 FORMAT(*MU(*,11,*),=*,F10.1,5X,*FPS =*,F10.1,5X,
35610C *KUD =*,F10.3)
35620 685 FORMAT(*MU(*,11,*),=*,F10.1,6X,*FS =*,F10.1,5X,
35630C *KUD =*,F10.3)
35640 690 FORMAT(*MU(*,11,*),=*,F10.1)
35650 END
50000 SUBROUTINE TRANS (B,ZLV,ZLM,KRAK,ZKLMP,VL1P,VL2P,VS1P,VS2P)
50030C
50040C THIS SUBROUTINE DETERMINES LOAD AND MASS TRANSFORMATION FACTORS
50050C AND DYNAMIC REACTION COEFFICIENTS FOR TWO-WAY RESTRAINED SLABS.
50060C VALUES CORRESPONDING TO PLASTIC BEHAVIOR ARE USED.
50070C
50080C LOAD AND MASS TRANSFORMATION FACTORS
50090 IF(KRAK.EQ.1)GOTO 335
50835C

```

PROGRAM RESTRAN (CONTINUED)

```

50240C: CRACK PATTERN A
50250    CVS=0.5*B
50260    CVL=0.5*(1.0-B)
50270    XP=ZLH*B/3.0
50290    ZP=ZLV*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
50310    XBARP=0.5*B*ZLH
50320    ZBARP=ZLV*(1./24.-B/16.)/(1./8.--B/6.)
50330    GOTO 390
50340C: CRACK PATTERN B
50350 335 CVS=0.5*(1.0-B)
50360    CVL=0.5*B
50370    XP=ZLH*(1.0-4.0*B/3.0)/(4.0*(1.0-B))
50390    ZP=ZLV*B/3.0
50410    XBARP=ZLH*(1./24.-B/16.)/(1./8.--B/6.)
50420    ZBARP=0.5*B*ZLV
50770C
50780C: ALL CASES -- PLASTIC RANGE
50790 390 ZKMP=(1.0-B)/3.0
50800    ZKLP=0.5-B/3.0
50810    ZKLMP=ZKMP/ZKLP
50820C
50830C
50840C DYNAMIC REACTION COEFFICIENTS FOR SHORT (VS) AND LONG (VL) EDGES
50860C
51350C: ALL CASES -- PLASTIC RANGE
51360 460 VS1P=CVS*(1.0-XP/XBARP)
51370    VS2P=CVS*(XP/XBARP)
51380    VL1P=CVL*(1.0-ZP/ZBARP)
51390    VL2P=CVL*(ZP/ZBARP)
51400    RETURN
51410    END
70000    SUBROUTINE RANDOM (IENTRY)
70010C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
70020C VARIABLES; GENERATES RANDOM VALUES; CONTROLS REQUIRED
70030C NUMBER OF CASES TO BE RUN; AND OUTPUTS FINAL RESULTS AND SUMMARY
70040C
70050 COMMON KINC,LDTYPE,KRF,KRANE,TIME,I,Y(100),Q,QU,YU,YFAIL,FDC,
70052+ ZLS,HS,FDY,AREA,ZMASS,ZKLP,VS1,VS2,PS0,PDO,PR,PEXT,PC,TC,TO,
70054+ PO,DELAY,S,FPC,FY
70060    COMMON /RAND/ TIMEC
70090 DIMENSION CHI25(7),CHI975(7),TDIST(7)
70100C
70110C VALUES FOR 97.5% (F=19,24,29,34,39,44,49)
70120    DATA CHI25/.4688,.5167,.5533,.5825,.6065,.6267,.6440/
70130    DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
70140    DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
70150C
70160    GOTO(5,50,70),IENTRY
70165C
70170C ENTRY 1: INITIALIZE RANDOM NUMBER GENERATOR
70180    5 XDUMMY=XNORM1(-1.0,0.0,1.0)
70190    PRINT,/,/,+INPUT NRAND+
70200    READ,NRAND
70210    DO 47 I=1,KRND
70220    XDUMMY=XNORM1(0.0,0.0,1.0)
70230    47 CONTINUE
70240    INDEX=0$ SPS0=0$ SSPSO=0
70250    ICHECK=20
70260C
70270C INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
70275    IF(KRF.EQ.0)GOTO 30
70280    PRINT 87
70290    READ,SMEAN,SSD
70410C REINFORCED CONCRETE SLABS
70420 30 PRINT 86
70430    READ,FYMEAN,FYSD
70432    PRINT 85
70434    READ,FPCMEAN,FPCSD
70440    IF(KRF.EQ.1)PRINT 96
70445    IF(KRF.EQ.0)PRINT 97
70450    RETURN
70460C
70470C ENTRY 2: GENERATE RANDOM VALUES
70570 50 FY=XNORM1(0.0,FYMEAN,FYSD)

```

PROGRAM RESTRAN (CONTINU)

```

70580      IF(FY.LE.0)GOTO 50
70582  55  FPC=XNORM1(0.0,FPCMEN,FPCSD)
70583  IF(FPC.LE.0)GOTO 55
70585  IF(KRF.EQ.0)GOTO 65
70590  60  S=XNORM1(0.0,SMEAN,SSD)
70600  IF(S.LE.0)GOTO 60
70610  65  INDEX=INDEX+1
70620  RETURN
70625C
70630C ENTRY 3: SUM VALUES OF PSO AND PSO**2 FOR USE IN
70635C STATISTICAL ANALYSIS
70640  70  SPSO=SPSO+PSO
70650  SSPSO=SSPSO+PSO*PSO
70660C
70670C OUTPUT FINAL RESULTS
70680  76  IF(KRF.EQ.1)PRINT 92,FDY,FDC,S,PSO,TIMEC
70690  IF(KRF.EQ.0)PRINT 90,FDY,FDC,PSO,TIMEC
70700  80  IF(INDEX.LT.1CHECK)RETURN
70750C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PSO
70770  ZNO=INDEX
70780  ZMEAN=SPSO/ZNO
70790  SD=SQRT((SSPSO-ZNO*ZMEAN*ZMEAN)/ZNO)
70800  STDERR=SD/(SQRT(CHI25((INDEX-15)/5)))
70810C CHECK IF MAXIMUM OF 50 PSO SAMPLES OBTAINED
70820  IF(INDEX.EQ.50)GOTO 62
70830C CHECK IF 95% CONFIDENCE INTERVAL FOR A PSO VALUE IS
70840  IF(STDERR>TDIST((INDEX-15)/5).GT.0.10)GOTO 61
70850C
70860C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
70870C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
70880C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
70890  62  SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
70900C CHECK IF MAXIMUM OF 50 PSO SAMPLES OBTAINED
70910  IF(INDEX.EQ.50)GOTO 53
70920C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
70930C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
70940  IF(((SDU-SD)/ZMEAN).GT.0.10)GOTO 61
70950C
70960C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
70970C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
70980C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
70990C
71000C AND 10% AND 90% PROBABILITY VALUES
71010  53  ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
71020  ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
71030  SDL=SD/(SQRT(CHI975((INDEX-15)/5)))
71040  P10=ZMEAN-1.282*SD
71050  P10L=ZMEAN-1.282*SDU
71060  P10U=ZMEAN-1.282*SDL
71070  P90=ZMEAN+1.282*SD
71080  P90L=ZMEAN+1.282*SDL
71090  P90U=ZMEAN+1.282*SDU
71100  P90U=ZMEAN+1.282*SDU
71110  P90U=ZMEAN+1.282*SDU
71120C
71130C OUTPUT STATISTICAL PARAMETERS OF INCIPENT COLLAPSE PRESSURE
71140  PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
71150+  P90,P90L,P90U
71160  PRINT 105,INDEX,STDERR
71170  GOTO 999
71180C
71190C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90%
71200B
71210C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
71220  61  ICHECK=ICHECK+5
71230  RETURN
71240C
71260  65  FORMAT(/+INPUT MEAN AND STANDARD DEVIATION FOR F'C,,')
71270  66  FORMAT(/+INPUT MEAN AND STANDARD DEVIATION FOR FY,,')
71280  67  FORMAT(/+INPUT MEAN AND STANDARD DEVIATION FOR S,,')
71290  90  FORMAT(2F9.1,F10.2,F14.3)
71310  92  FORMAT(2F9.1,F11.2,F10.2,F14.3)
71350  96  FORMAT(///,5X,*FDY*,6X,*FDC*,8X,*S*,8X,*PSO*,6X,
```

PROGRAM RESTRAN (CONCLUDED)

```
71351+ *COLLAPSE TIME*)
71355 97 FORMAT(//,,4X,*FDY*,6X,*PSO*,8X,*COLLAPSE TIME*)
71360 100 FORMAT(//,,11X,*STATISTICAL PROPERTIES OF INCIPENT PSO*,
71370+ //,39X,*95% CONFIDENCE LIMITS*,/,7X,*ITEM*,18X,
71380+ *VALUE LOWER UPPER*,//,* MEAN*,F29.2,
71390+ 2F12.2,/,* STANDARD DEVIATION*,F15.2,2F12.2,/,
71400+ * 10% PROBABILITY VALUE*,3F12.2,/,
71410+ * 90% PROBABILITY VALUE*,3F12.2)
71420 105 FORMAT(//,5X,*NUMBER OF OBSERVATIONS **,13,/,5X,
71430+ *STANDARD ERROR **,F5.2)
71450 999 STOPS END
71460 FUNCTION XNORM1(X,A,B)
71470 IF(X>10,20,20
71480 10 X0=RANF(-1.0)
71490 20 X1=RANF(0.0)
71500 X2=RANF(0.0)
71510 Y=SQRT(-2.0*ALOG(X1))*(COS(6.283184*X2))
71520 XNORM1=A+Y*B
71530 RETURN
71540 END
```

**RCBEAM**

**Reinforced Concrete Support Beam**

PROGRAM RCBEAM

```

00100 PROGRAM RCBEAM1(INPUT,OUTPUT,TAPE1)
00105 CALL RETR(7HRCBEAM2,7HRCBEAM2)
00110C * THIS PARTITION OF THE PROGRAM INPUTS THE REQUIRED ELEMENT
00115C AND LOAD DATA AND INITIALIZES CERTAIN PARAMETERS *
00120C
00150 C0M40N KINC,LDTYPE,KRF,(RAND,TIME,I,.100),QT,QI,YU,YFAIL,
00152+ ZLB,BB,H9,FPC,FDY,ICASE,AS(4),APS(4),D(4),DP(4),FDC,
00154+ EC,ES,SAREA,PAREA,ZMASS,ZKLM,VL1,VL2,
00155+ M4M9,ASCS,VCL,QDLSLAB,(C3MP,HS,HS,NSLABS,NAMEF(2),L720,
00156+ W,P3,C0,L0C,S2LEV,C0,PSA,P03,PR,PEXT,PC,TC,TO,DELAY,
00157+ TT(80,2),PP(80,2),REAC(80,2),INDEX(2),BR(2),
00158+ VV1N,RH30,V3,L1,AA(8,2),VV(8),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
00160 LOGICAL L1
00165C
00170C * READ TITLE AND CONTROL PARAMETERS
00172 PRINT 67
00174 READ 68,TITLE
00176 PRINT 720
00178 READ,NSLABS,KL8AD
00180 PAREA=0
00182 IF(KL8AD.EQ.0)GOT9 40
00184C
00186C: INPUT SLAB REACTION DATA FILE DATA
00188 PRINT 725
00190 D2 39 J=1,NSLABS
00192 PRINT 735,J
00194 READ,NAMEF(J),ISIDE
00196 CALL PFUR(3HRE\,1,NAMEF())
00198 IF(ISIDE.EQ.1)READ(1,)SAREA,DUM,HS
00200 IF(ISIDE.EQ.2)READ(1,)DUM,SAREA,HS
00202 S10 INDEX(J)=1
00204 READ(1,)NP3INT
00206 IF(ISIDE.EQ.2)GOT9 520
00208 S15 READ(1,)(TT(JJ,J),PP(JJ,J),REAC(JJ,J),DUM,JJ=1,NP3INT)
00210 GOT0 525
00212 S20 READ(1,)(TT(JJ,J),PP(JJ,J),DUM,REAC(JJ,J),JJ=1,NP3INT)
00214 S25 BR(J)=(REAC(2,J)-REAC(1,J))/(TT(2,J)-TT(1,J))
00216 BP=(PP(2,J)-PP(1,J))/(TT(2,J)-TT(1,J))
00218 REWIND 1
00220 CALL DR3PI(1)
00221 QDLSLAB=QDLSLAB+150.0*SAREA*HS/1728.0
00222 39 PAREA=PAREA+SAREA
00224 KINC=0 $ LDTYPE=5 $ KRF=0 $ RAND=0
00226 GOT0 45
00228C
00230C INPUT TRIBUTARY SLAB DATA
00232 40 PRINT 730
00234 D3 42 J=1,NSLABS
00236 PRINT 735,J
00238 READ,SAREA,HS
00240 QDLSLAB=QDLSLAB+150.0*SAREA*HS/12.0
00242 42 PAREA=PAREA+SAREA*144.0
00244C
00246 PRINT 85
00248 READ,KINC,LDTYPE,KRF,KRAND
00250 45 C3\TINUE
00252 DELAY=0
00254 67 FORMAT(/*INPUT TITLE*/)
00256 68 FORMAT(A59)
00258 85 FORMAT(/*INPUT KINC,LDTYPE,KRF,KRAND(I=RAND34)*/)
00260 720 FORMAT(/*INPUT NUMBER OF SLABS SUPPORTED BY BEAM, AND IF *,*
00262+ *SLAB REACTIONS/*ARE TO BE CALCULATED (0) OR READ FROM *,*
00264+ *DATA FILE (1)*)
00266 725 FORMAT(/*INPUT REACTION DATA FILE NAME AND SIDE *,*
00268+ *(1=SHORT,2=LONG)*)
00270 730 FORMAT(/*INPUT CONTRIBUTORY AREA (SF FT) AND THICKNESS (IN.)*)
00272 735 FORMAT(6X,*FOR SLAB V2.0*,12,*)
00274C
00276C * INPUT AND ECHO BEAM AND REINFORCEMENT PROPERTIES *
00278 PRINT 615
00280 READ,ZLB,BB,H9,FPC,FDY,ICASE,(C3MP
00282 ICASE4=ICASE-4
00284 FDC=1.25*FPC
00286 EC=57619.0*SQRT(FPC)

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PROGRAM RCBEAM (CONTINUED)

```

00288 ES=29E6
00290 GAREA=ZLR*BB
00292 PAREA=PAREA+GAREA
00294 ECKIP=EC/1000.0 S ESKIP=ES/1000.0
00295 II PRINT 670
00298 D1 B I=1,3,2
00300 AS(I)=0
00302 IF(ICASE.EQ.5.AND.I.GT.1)GOTO 9
00304 PRINT 625,I
00306 READ,AS(1),D(1),APSC(1),DP(1)
00307 4 CONTINUE
00308 IF((C3MP.EQ.0))GOTO 9
00309 PRINT 616
00310 READ,SP,HS,ASSLAB,DSLAB
00311 BS=0.25*ZLR
00312 IF(BS.GT.(BS+16.0*HS))BS=BS+16.0*HS
00313 IF(BS.GT.SP)BS=SP
00314 9 PRINT 711
00315 READ,MEMB
00316 IF(MEMB.NE.1)GOT 15
00317 13 PRINT 705
00318 READ,ASCS
00320 15 CONTINUE
00322 PRINT 620,ICASE,ZLB,BB,HB,FPC,FDC,ECKIP,FDY,ESKIP
00323 IF((C3MP.NE.0))PRINT 621,BS,BS,SP
00324 PRINT 630
00326 D2 110 I=1,3,2
00328 IF(ICASE.EQ.5.AND.I.GT.1)GOTO 110
00330 P=AS(1)/(BS*D(1)) S PPR=APSC(1)/(BS*D(1))
00332 PRINT 640,I,AS(1),P,D(1),APSC(1),PPR,DP(1)
00333 110 CONTINUE
00334 IF((C3MP.EQ.0))GOTO 115
00335 PRINT 641,ASSLAB,DSLAB
00336 IF(ASSLAB.EQ.0.0)GOT 115
00337 ASSLAB=BS*ASSLAB/12.0
00338 DP(1)=(APSC(1)*DP(1)+ASSLAB*DSLAB)/(APSC(1)+ASSLAB)
00339 APSC(1)=APSC(1)+ASSLAB
00340 115 24AS=150.0*ZLB*HB*BB/(386.07*1728.0)
00342 VCL=2.2H*SQRT(FPC)/(1-2*D(1)/ZLB)+3000*(AS(1)/(BS*D(1)))/(1-D(1)/ZLB)
00343 VCLMAX=3.5SQRT(FPC)/(1-(2.0*D(1)/ZLB))
00344 IF(VCL.GT.VCLMAX)VCL=VCLMAX
00345 PRINT 78,VCL
00346
00348 615 FFORMAT(*INPUT LB,BB,HB,FPC,FDY,ICASE,(C3MP,*))
00349 616 FFORMAT(*INPUT BEAM SPACING, HS, AS(LAB), & D(DSLAB)*,*)
00350 625 FFORMAT(*INPUT AS,D,A'S,AS FOR SECTION*,I2,*)
00352 620 FFORMAT(*PROPERTIES OF REINFORCED CONCRETE SUPPORT BEAM --*,*
00354 * SUPPORT TYPE N3.,I2,*,
00356 * LB ==,F6.1,* IN. RB ==,F6.1,* IN.,*,6X,*IB ==,
00358 F6.1,* IN.,*, F'C ==,F7.1,* PSI FDC ==,F7.1,
00360 * PSI,,SX,,EC ==,F7.1,* KSI,,*, FDY ==,F8.1,* PSI*,
00362 3X,,ES ==,F9.1,* KSI*)
00364 630 FFORMAT(*REINFORCEMENT VALUES// SECTION AS (P)*,
00366 9X,,D,,SX,,A'S (P')*,SX,,D*/*9X,(S0 IN.)*,12X,
00368 *(IN.) (S0 IN.)*,12X,(IN.)*)
00370 670 FORMAT(1H )
00372 685 FFORMAT(*VCL ==,F6.1,* PSI*)
00374 705 FFORMAT(*INPUT CONTINUOUS REINFORCEMENT (S0 IN.)*,*)
00376 711 FFORMAT(*IS TEVILE MEMBRANE TO BE INCLUDED (0=NO)*,
00378 *1=YES)*,*)
00380 640 FORMAT(5,F1.4,* (*,F6.4,*),F9.3,F10.4,* (*,F6.4,*),F9.3)
00382 624 FORMAT(* HS ==,F6.1,* IN. RS ==,F5.1,* IN.*)
00384 * SX,*BEAM SPACING ==,F6.1,* IN.*)
00386 641 FFORMAT(* SLAB*,F10.4,* S0 IN./FT*,F9.3)
00565C
00570C INPUT LOAD PARAMETERS
00571 IF(LTYPE.F7.9)GOTO 20
00575C LOCATION 1. FRONT FACE LOADING (USED IN R334-FILLING PROCEDURE)
00580 IF((LLOAD.EQ.1))GOTO 25
00585 100 W=1000.0 S P3=14.7 S C3=1120.0
00590 IF((KRF.NE.1))GOTO 102
00595 LOC=1
00600 IF((RAND.EQ.1))GOTO 106
00605 PRINT 600

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PROGRAM RCBEAM (CONTINUED)

```

00610 READ,S
00615 GOTO 105
00620C LOCATI0N 2. T3? FACE LOADING
00625 102 CD=0 $ L0C=2
00630 ZLEV=ZLB/12.0
00635 105 IF(<INC.E0.1) GOTO 106
00640 PRINT 610
00645 READ,PS3
00650 PR=2.0*PS3*(7.0*P0+4.0*PS3)/(7.0*P0+PS3)
00655 600 FFORMAT/*INPUT S*,*/
00660 610 FFORMAT/*INPUT PS3*,*/
00665C
00670C * INPUT R33M-FILLING PARAMETERS *
00675 106 IF(KRF.E0.0) GOTO 20
00680 10 PRINT 700
00685 RH30=0.076 $ L1=.FALSE.
00690 DELAY=1E10
00695 READ,VWIV,V3
00700 AT=0$ AFR0VT=0$ A<1DE=0
00705 00 1R I=1,VWIV
00710 PRINT 710,I
00715 READ,AA(I,1),VV(I),AA(I,2)
00720 AA(I,2)=AA(I,2)/1000.0
00725 AT=AT+AA(I,1)
00730 M=VV(I)$ GOTO(12,14,14),M
00735 12 AFR0VT=AFR0VT+AA(I,1)
00740 GOTO 18
00745 14 ASIDE=ASIDE+AA(I,1)
00750 1R IF(AA(I,2).LT.DELAY)DELAY=AA(I,2)
00755 AFR0VT=AFR0VT+AT$ ASIDE=ASIDE/AT
00760 700 FFORMAT/*INPUT VWIV AND R33M VOLUME (CF)*,*/
00765 710 FFORMAT/*[INPUT AREA (S0 FT),LOCATION CODE & DELAY(MSEC)*
00770+   * FOR WINDROW,12,*)
00775 G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3 $ G5=G+1.
00780 PP2=.1912
00785 C=SQRT(G*P0*32.*144./RH30)
00790 TAU=2.*((V3**(.1/3.))/C
00795 DT=TAU/4.0
00800C
00905 20 CONTINUE
00910 25 CALL CHAIN(RCBEAM2)
00915 99 STOP
00820 END
01000 SEGMENT RCBEAM2 (INPUT,BOUTPUT,TAP5)
01005 THIS SEGMENT CALCULATES THE RESISTANCE FUNCTION AND
01020C LOADING AND SOLVES THE DYNAMIC EQUATIONS OF MOTION
01030C
01050 C2446V KINC,LDTYPE,(RF,KRAVD,TIME,I,Y(100),DT,OU,YU,YFAIL,
01052+ ZL8,BB,H6,FPC,FDY,[CASE,AS(4),APS(4),D(4),DP(4),FDC,
01054+ EC,ES,3AREA,PAREA,PMASS,ZL4,L1,L2,
01055+ 4MMA,ASCS,VCL,2ZLSLAB,4C94P,HS,BS,VSLABS,VAMEF(2),KL9AD,
01056+ 4,P0,C0,L0C,S,TLE,CD,PS3,PD0,PF,PEXT,PC,TC,T0,DELAY,
01057+ T(80,2),PP(80,2),REAC(80,2),INDEX(E),BR(2),
01058+ VWIV,RH30,V3,L1,AA(8,2),VV(8),AFR0VT,ASIDE,G,G2,G3,G4,PP2,DT
01078 C2446V /RAN0/ TIMEC
01080 C1405134 A(80),V(80),T(80),VS(80),VL(80),PV(80)
01100C
01250 IF(<INC.NE.1.BE.LDTYPE.E0.3)CALL FRCUE()
01260 14 IF(<RRAVD.NE.1)GOTO 35
01270     CALL FRCUE(4)
01280     CALL RAVD04(1)
01290 34     CALL RAVD04(2)
01300 35     CALL RESIST(J)
01305
01306C: YMAXUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
01330C: WHERE THE LOAD CAUSING INCIPIENT COLLAPSE IS TO BE FOUND
01340 13     IF(<INC.E0.0)GOTO 23
01350 PF=4.0
01360     PFMAX=0
01370     PFMIN=0
01380     GWT9 20
01390 14     PF=(PF*(4+PFMAX))/2.0
01400 20     CALL F3RCE(2)
01410 23     IF(<KRF.EC.C)GOTO 24

```

PROGRAM PCBEAM (CONTINUED)

```

01420      CALL FILL(PINT,2)
01430C
01440C: INITIALIZE VALUES FOR BETA METHOD (BETA=1/6), AND COMPUTE VALUES
01450C: FOR FIRST TIME INTERVAL ASSUMING ELEMENT INITIALLY AT REST
01460 24    I=1
01470      TIME=0
01480      V(I)=0 $ Y(I)=0
01490      DELTA=0.001
01500      IF((KRF.NE.1)GOT3 30
01510 27    IF((TIME.GE.(DELAY-.00001))GOT3 30
01520      TIME=TIME+DELTA
01530      CALL FILL(PINT,3)
01540      GOT3 27
01540 30    CALL RESIST(2)
01550      A(I)=0.0 $ VS(I)=0.0 $ VL(I)=0.0
01560      T(I)=TIME
01580C
01590C: PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
01600 1      I=I+1
01610      IF(I.LT.101)GOT3 11
01620      PRINT 98,TIME
01630 98    FORMAT(I=101) TIME ==,F6.3,; FAILURE ASSUMED TO NOT OCCUR)
01640      GOT3 6
01650 11    TIME=TIME+DELTA
01660      T(I)=TIME
01670      A(I)=A(I-1)
01680      IF((KRF.NE.0)GOT3 10
01690      CALL FORCE(3)
01700      PV(I)=PEXT
01710      GOT3 2
01720 100   DIMENSION A(100),V(100),T(100),VL(100),PV(100)
01730 10    CALL FILL(PINT,3)
01740      PV(I)=PINT
01750 2     IF((LLOAD.EQ.0)PT=PV(I)*PAREA
01760      PV(I)=PT
01770 101   IF((LLOAD.NE.0)PT=PV(I))
01780      D8 B JJ=I,10
01790      Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
01800      CALL RESIST(2)
01810 4     ANEW=(PT-PT)/(2*MASS*Z(L4))
01820      ADELTA=ANEW-A(I)
01830      A(I)=ANEW
01840 1985  IF(ANEW.EQ.0)PRINT * 1985*,TIME,PT,QT,2*MASS,Z(L4),Y(I),A(I-1)
01850 1990  IF(ABS(ADELTA/(ANEW+1E-10)).LT.0.01)GOT3 9
01860 9     CONTINUE
01870      A(I)=ANEW-ADELTA/2.0
01880 2000  PRINT 90,TIME,PT,A(I),Y(I)
01890 9     CONTINUE
01900 2040  Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
01910 2050  V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
01920 2070  VL(I)=VL1*PT*VL2*QT
01930C
01940C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE
01950C: IF MAXIMUM DEFLECTION REACHED, HALL DID NOT FAIL
01960C: IF(Y(I).LE.Y(I-1).AND.PV(I).LE.PV(I-1))GOT3 6
01970C: IF(Y(I).LT.0)GOT3 6
01980C: IF(Y(I).GE.YFAIL)GOT3 7
01990C: IF(TIME-DELAY.GE.0.010)DELTA=0.002
02000C: IF(TIME-DELAY.GE.0.020)DELTA=0.005
02010C: IF(TIME-DELAY.GE.0.100)DELTA=0.010
02020C: IF(TIME-DELAY.GE.0.300)DELTA=0.050
02030C: IF FAILURE DEFLECTION REACHED, ELEMENT FAILED
02040      GOT3 1
02050C
02060C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPENT
02070C: COLLAPSE FOR CASES WHERE DESIRED
02080C: ELEMENT DID NOT FAIL -- SET PFMAX TO PF
02090 6     CONTINUE
02100 280   IF(KINC.EQ.0)GOT3 18
02110 36    PFMAX=PF
02120 200   IF(FFMAX.GT.0)GOT3 16
02130      PF=2.0*PF
02140      GOT3 20
02150C: ELEMENT FAILED -- SET PFMAX TO PF
02160      CONTINUE

```

PROGRAM RCBEAM (CONTINUED)

```

02350      TIMEC=TIME
02370      IF((INC.EQ.0) GOTO 18
02380 37    PFMAX=PF
02390C:  CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
02400 17    IF((PFMAX-PFM14)/PFMAX.GT.0.01) GOTO 16
02410      IF((KRAND.NE.1)) GOTO 18
02420      CALL RAND34(3)
02430      GOTO 34
02440C
02450C:  OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
02460C:  OCCURANCE FOR A VVN-FAILING ELEMENT OR THE TIME AND VELOCITY
02470C:  AT COLLAPSE FOR A FAILING ELEMENT.  OPTIONAL OUTPUT IS THE
02480C:  ENTIRE BEHAVIOR TIME-HISTORY.
02490C
02500C:  OUTPUT LOAD DATA
02510 19    ALL FORCE(4)
02520C
02530C:  OUTPUT FINAL RESULTS
02540 IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
02550 IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
02577C  CHECK TO SEE IF ENTIRE TIME-HISTORY IS DESIRED
02580 PRINT 72
02590 READ,4
02600      IF(M.EQ.0) GOTO 25
02680 PRINT 76,(T(J),PV(J),A(J),V(J),Y(J),VL(J),J=1,I)
02690 25 PRINT 77
02710C
02740 70 FORMAT(/*NO FAILURE - MAX DEFLECTION OF*,F6.2,
02750*   * IV. REACHED AT*,F7.3,* SEC*)
02760 71 FORMAT(/*FAILURE OCCURRED AT*,F7.3,* SEC (FINAL VELOCITY **,
02770*   F7.2* IV./SEC*)*)
02780 72 FORMAT(/*IS TIME HISTORY DESIRED (YES=1, NO=0)*,1)
02830 76 FORMAT(/* TIME PRESSURE ACCELERATION VELOCITY *
02840*   *DISPLACEMENT VL*,1,
02850*   (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0))
02860 77  FORMAT(/*,7(*-----*)*)
02870 80 FORMAT(/*ACCELERATION NOT CONVERGING AT TIME **,F6.3,
02880*   * SEC (PF **,F7.3,* PSI)/* A(I) SET EQUAL TO**,
02890*   F8.1,* (AVG OF LAST 2 ITERATIONS)/* Y(I) **,
02900*   F8.4,* IV.*)
02930C
02960 999  STOP
02970  END
10000 SUBROUTINE FORCE(IENTRY)
10010C THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
10020C THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
10030C 1. IDEALIZED BLAST LOAD (FRONT OR SIDE FACE)
10150 C0M42N KINC(LDTYPE,XRF,KRAND,TIME,I,Y(100),GT,9U,YU,YFAIL,
10052+  ZLB,BB,HB,FPY,ICASE,AS(4),APS(4),DC(4),DP(4),FDC,
10054+  EC,ES,OAREA,PAREA,ZMASS,ZLM,VL1,VL2,
10055+  MEMB,ASC5,VCL,20L,SLAB,<C3MP,HS,BS,VSLABS,VAMEF(2),<L3AD,
10056+  W,P2,C3,L9C,S,ZLEV,CD,PS3,PD3,PR,P,PC,TC,TO,DELAY,
10057+  TT(S0,2),PP(C0,2),REAC(R0,2),INDEX(2),BR(2),
10058+  VVIV,RH00,V3,L1,QA(S,2),VV(R),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
10080C
10130 IF(LDTYPE.EQ.5) GOTO 700
10135 IF((L3AD.EQ.1)) GOTO 500
10140C
10150 GOTO(215,200,300,4),IENTRY
11000C
11010C CALCULATE LOAD PROPERTIES FOR GIVEN PEAK PRESSURE
11030 200 GOTO(205,210),L0C
11040 205 PS0=(PF-14.0*P0+SQRT(196.0*P0*P0+196.0*P0*PR+PR*PR))/16.0
11050 GOTO 215
11060 210 PS0=PR
11070 215 PD0=2.5*PS0*PS0/(7.0+P0+PS0)
11080 U=C0*SQRT(1.0*(6.0*PS0)/(7.0*P0))
11090 T0=W=0.3333/(2.2399+0.1886*PS0)
11100 G013(220,225),LCC
11110 220 TC=3.0*S/U
11120 PC=PS0*(1-TC/T0)*EXP(-TC/T0)+PD0*(1-TC/T0)**2*EXP(-2*TC/T0)
11130 CD=1.0
1114G RETURN

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PROGRAM RCBEAM (CONTINUED)

```

11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2TO=TA2/TO
11180 PA=PS3*(1-TA2TO)*EXP(-TA2TO)+CD*PD3*(1-TA2TO)**2*EXP(-2*TA2TO)
11190 RETURN
12000C
12010C CALCULATE L3AD
12030 300 G0T3(305,310),L3C
12040 305 TTO=TIME/TO
12050 IF(TIME.GT.TC)G0T3 320
12060 P=PC+(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/TO
12090 IF(TIME.GT.TA)G0T0 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(GT0.GE.1.0)G0T3 330
12130 P=PS3*(1-TTO)*EXP(-TTO)+CD*PD3*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C PRINT L3AD DATA
13020 4 IF((INC.EQ.0)G0T0 400
13030 PRINT 640,LDTYPE
13040 G0T0 410
13050 400 PRINT 645,LDTYPE
13060 410 CONTINUE
13070 415 G0T3(420,425),L3C
13080 420 PRINT 650
13090 G0T3 430
13100 425 PRINT 655
13110 430 PRINT 660,W,PB,C3
13120 IF(KRAND.NE.0)RETURN
13130 G0T3(435,440),L3C
13140 435 PRINT 665,S,TC,PR
13150 G0T3 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,U,TO,CD,PS3,PD3
13180 RETURN
13500C
13510C L3AD TYPE S -- ARBITRARY L3AD SHAPE
13520 700 G0T3(710,720,730,740),LENTRY
13530C
13540C INPUT L3AD DATA
13550 710 PRINT 750
13560 READ,NP3INT,(TT(J,1),PP(J,1),J=1,NP3INT)
13570 FACT3R=1.0
13580 IF((INC.EQ.0)G0T3 718
13590 P4K=PP(1,1)
13600 715 J=2,NP3INT
13610 715 IF(PP(J,1).GT.PMAX)PMAX=PP(J,1)
13620 714 PK=PP(2,1)-PP(1,1)
13630 TK=TT(2,1)-TT(1,1)
13640 J=1
13650 RETURN
13660C
13670C CALCULATE MAXIMUM L3AD
13680 720 FACT3R=PR/PMAX
13690 G0T3 719
13700 RETURN
13710C
13720C CALCULATE L3AD
13730 730 IF(TIME.LE.TT(J,1)+1.0)G0T3 735
13740 JJ=JJ+1
13750 PK=PP(JJ+1,1)-PP(JJ,1)
13760 TX=TT(JJ+1,1)-TT(JJ)
13765 IF(TX.EQ.0)TX=1E-10
13770 G0T3 730
13780 735 P=FACT3R*(PP(JJ,1)+(TIME-TT(JJ,1))*PK/TX)
13790 RETURN
13800C
13810C PRINT L3AD DATA
13815 740 IF((INC.EQ.1))PRINT 640,LDTYPE

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PROGRAM RCBEAM (CONTINUED)

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13820 IF(KINC.EQ.0)PRINT 645,LTYPE
13825 PRIVT 790
13830 D0 745 J=1,NPINT
13840 P=FACT3R*PPC(J,1)
13850 745 PRINT 795,TT(J,1),P
13860 RETRN
14000C
14070 640 F3RMAT(*L3AD CAUSING INCIDENT FAILURE IS AS F3LL3WS*,*
14071 /,SX,*L3AD TYPE NIMARR*,12)
14090 645 F3RMAT(*PR3PERTIES OF L3AD ACTING ON WALL ARE AS F3LL0WS*,*
140F.* /,SX,*L3AD TYPE NUMBER*,12)
14090 650 F3RMAT(4X,*CR3NT FACE*)
14100 655 F3RMAT(SX,*CSIDE OR T3P FACE*)
14110 660 F3RMAT(10X,*W **,F4.1,* T P3 **,F6.2,* PSI CD **,
14111* F7.1,* FPS*)
14120 665 F3RMAT(10X,*S **,F6.1,* FT TC **,F6.3,* SEC PR **,
14121* F7.3,* PSI*)
14130 670 F3RMAT(10X,*L **,F6.1,* FT TA **,F6.3,* SEC PA **,
14131* F7.3,* PSI*)
14140 675 F3RMAT(10X,*U **,F7.1,* FPS TO **,F6.3,* SEC CD **,
14141* FS=1./,BX,*PSI **,F7.3,* PSI PD3 **,F7.3,* PSI*)
14150 780 F3RMAT(*INPUT NUMBER OF L3AD POINTS AND THE TIME AND *
14151* *PRESSURE AT EACH POINT*)
14160 790 F3RMAT(*10X*TIME PRESSURE*)
14170 795 F3RMAT(F15.3,F12.2)
15000C
15002C: SLAB REACTION DATA
15010 500 G3TB(510,530,540,560),IENTRY
15020 S10 RETURN
15055C
15090 530 STOP
15095C
15100 540 P=0.0
15110 D0 555 J=1,VSLARS
15115 S45 JJ=INDEX(J)
15120 550 IF(TIME.LE.TT(JJ+1,J))G3T3 555
15125 INDEX(J)=INDEX(J)+1 $ JJ=INDEX(J)
15130 IF(JJ.LT.NPINT)G3T3 552
15132 PRIVT 690,TIME
15133 STOP
15135 552 BR(J)=(REAC(JJ+1,J)-REAC(JJ,J))/(TT(JJ+1,J)-TT(JJ,J))
15140 BP=(PP(JJ+1,J)-PP(JJ,J))/(TT(JJ+1,J)-TT(JJ,J))
15150 G2T0 550
15160 555 P=P+REAC(JJ,J)+(TIME-TT(JJ,J))*BR(J)
15165 P=P+QAREA*(PP(JJ,J)+(TIME-TT(JJ,J))*BP)
15170 RETURN
15180 560 PRINT 690
15190 D0 565 J=1,VSLARS
15200 565 PRINT 695,V4MEF(1)
15300 680 F3RMAT(*BEAM LOADED WITH REACTIONS FROM FILE(S)*)
15310 685 F3RMAT(10X,A7)
15315 690 F3RMAT(*END OF FILE -- BEAM HAS NOT FAILED AT*,F6.3,* SEC*)
15320 RETURN
15330 EVD
20000 SUBROUTINE FILL(P3,IENTRY)
20010C: COMPUTES AVERAGE AIR PRESSURE IN ROOM DUE TO BLAST WAVE
20020C: INCIDENT HEAD-ON UPON FRONT WALL.
20030C
20050 COMMON <INC,LTYPE,<RF,<RAND,TIME,II,Y(100),DT,DU,YU,YFAIL,
20052* ZLB,BB,HB,FPC,FDY,ICASE,4S(4),APS(4),G(4),DP(4),FDC,
20054* EC,FS,QAREA,PAREA,ZMASS,Z(L4),VL1,VL2,
20055* MEMB,ASCS,VCL,QDL,SLAB,<C3MP,HS,BS,VSLABS,V4MEF(2),<L8AD,
20056* W,PD,C3,L3C,S,ZLEV,CD,PS3,PD0,PR,PEXT,PC,TC,TO,DELAY,
20057* TT(R0,2),PP(R0,2),REAC(R0,2),INDEX(2),BR(2),
20058* VWIN,RH90,V3,L1,AA(R-2),VV(B),AFRANT,ASIDE,G,G2,G3,G4,PP2,DT
20090 L9ICAL L1,L2,L3
20095C
20100 G3TA(10,13,11),IENTRY
20110 10 RETURN
20310C
20320 13 P30=PA
20330 TT=0. $ T0=0.
20340 RH930=RH99
20350 L2=.FALSE. $ L3=.FALSE.

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PROGRAM RCBEAM (CONTINUED)

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20360 RETURN
20370C
20390 11 IF(L1)G3T3 S2
20395 IF(L2,A,L3)G3T3 9
20390 S2 DDT=(TIME-T)*0.5
20395 1ST3H=2
20400 S3 IF(DDT.LT.DT)G3T3 S1
20410 S0 DDT=0.5*UDT
20415 1ST3P=2*1ST3P
20420 G3 T3 S3
20430 J1 C3VTINUE
20440 D3 99 I=1,1ST3P
20450 TT=T3+I*DDT
20460 IF(TT.GT.TO)G3 T3 99
20470 DM=0. S WW=0. S VVW=0
20480 D3 S00 I=1,VVW
20490 M=VV<> S DLY=AA(<,2)+0.000001
20500 IF(DLY.GE.TT)G3 T3 S00
20510 G3T3(15,16,16),M
20520 15 CDF=1.0
20530 IF(TT-TC)20,20,21
20540 20 P11=(TC+TT)*(PR-PC)/TC+PC
20550 P11=P11+P3
20560 G3 T3 30
20570 16 CDF=-0.4
20600 21 R=TT/TO S RR=1.0-R
20610 PD=PD*RR*RR*EXP(-R)
20620 PS=PS*RR*EXP(-R)
20630 P11=PS+CDF*PD
20640 P11=P11+P3
20650 30 RH31=RH33*((P11/P3)**G2)
20660 IF(P11-P11)36,36,37
20670 36 JSIGN=-1
20680 L2=.TRUE.
20770 303 P2=P11
20780 RH32=((P2/P33)**G2)*RH33
20790 X=P30/RH33
20800 G2 T3 3H
20810 37 JSIGN=-1
20820 306 P2=PP2*P11
20830 RH32=((P2/P11)**G2)*RH31
20840 X=P11/RH31
20850 38 U22=G4*(X-P2/RH12)*32.+144.
20860 IF(U22)40,39,39
20870 40 PRINT,*'I22 NEGATIVE*',U22
20880 STOP
20890 39 U2=SQRT(U22)*JSIGN
20900 DD4=U2*RH32*AA(<,1)*DDT
20910 DM=DM+DDM
20920 WW=WW+P11*DDM/(G3*RH31)
20925C
20930 S00 C0NTINUE
20940 P33=P30*(G-1.)*WW/V3
20950 RH03B=RH03B*DM/V3
20960 99 C0NTINUE
20970 TO=TT
20980 P3=P30-P3
20982 IF(TIME.GE.TC)L3=.TRUE.
20983 RETURN
20984 9 R=TIME/TO S RR=1.0-R
20985 PD=PD*RR*RR*EXP(-R)
20986 PS=PS*RR*EXP(-R)
20987 P3=PS*PD*(AFRVT-0.4*ASIDE)
20990 999 RETURN
21020 END
30000 SUBROUTINE RESIST (IENTRY)
30010C: THIS SUBROUTINE DETERMINES THE RESISTANCE FUNCTION,
30020C: TRANSFORMATION FACTORS, AND REACTION COEFFICIENTS; AND
30030C: SUPPLIES THE REACTION VALUES FOR SPECIFIC DEFLECTIONS
30040C
30050 COMMON <INC>,LTYPE,KRF,KRAD,TIME,I,Y(100),D,DU,YFAIL,
30052: ZL9,BB,H9,FPC,FDY,ICASE,AS(4),APS(4),DC(4),DP(4),FDC,
30054: EC,ES,QAREA,PAREA,ZMASS,ZL14,VL1,VL2,
30055: MEMR,ASCS,VCL,QDL,SLAB,<COMP>,HS,BS,VSLABS,YAMEF(2),KL3AB,
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PROGRAM RCBEAM (CONTINUED)

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30056+ W,P0,C0,L0C,S,ZLEN,CD,PS0,PD0,PR,PEXT,PC,TC,TO,DELAY,
30057+ TT(RO,2),PP(RO,2),REAC(RO,2),INDEX(2),BR(2),
30058+ NWIV,RH02,V3,L1,AA(8,2),VV(8),AFR0VT,ASIDE,G,G2,G3,G4,PP2,DT
30100 REAL V,IC,IG,M4,4<1,4<2,4<3,MU(4),ICR(4),LT,ICC,ICS
30130 GOT2(4,500,45),IENTRY
30140 4 RETURN
30810C
30830C * ENTRY 2: DETERMINE RESISTANCE FUNCTION *
30840 45 V=ES/EC
30850 FR=5.0*SQRT(FDC)
30860 IG=BB*HB**3/12.+(V-1)*(ASC1)*(D1)-HB/2.)***2
30861+ +APSC1)*(HB/2.-DP1)**2
30870 M4=2.0*(GFR/HB
30872 IF(KC0MP,EQ.0)GOT0 50
30874 YBART=0.5*(HB*HB*BB+HS*(BS-BB))/(HS*(BS-BB)+HB*BB)
30875 IG=IG*(0.5*HB-YBART)**2+HS**3*(BS-BB)/12.0
30877+ +HS*(BS-BB)*(YBART-0.5*HS)**2
30878 M4=IG*FR/(HB-YBART)
30879 50 IF(CC0MP,EQ.0)BS=BB
30880 CALL M0MENT(FDC,FDY,ES,V,0,BS,AS,APS,D,DP,MU,ICR,IC,KC0MP,HS,BB)
31800C: DETERMINE M0MENT AND DEFLECTION COEFFICIENTS
31810C: FOR CRACKED PORTION OF SLAB BEHAVIOR
31820 106 B=0
31830 ICASE4=ICASE-4
31832 ICC=ICR(1) S ICS=ICR(3)
31834 CALL COEF(ICASE4,ASS,BSS,AF,BF,ICC,ICS)
31840 GOT0(182,185,190),ICASE4
31850 182 OUTERM=1.0/BSS
31860 GOT0 195
31870 185 OUTERM=(MU(3)/MU(1)+1.0)/BSS
31880 GOT0 195
31890 190 OUTERM=(0.5*4U(3)/4U(1)+1.0)/BSS
31900 195 GOT2(200,210,210),ICASE4
31910C
31920C: *****
31930C: * DETERMINE RESISTANCE (TOTAL) CURVE FOR WALL *
31940C: * (Q IS IN UNITS OF LB, KK IN LB/IN., AND Y IN INCHES) *
31950C: *****
31960C
31970C: CASE 5
31980 200 Q1=MN/(BSS*ZLB)
31990 K41=EC*IG/(ASS*ZLB**3)
32000 Y1=Q1/K41
32010 KK2=EC*ICR(1)/(ASS*ZLB**3)
32050 205 QU=OUTERM*4U(1)/ZLB
32060 208 YU=9U/KK2
32070 GOT0 280
32080C
32090C: CASES 6 AND 7
32100 210 Q1=44/(BF*ZLB)
32110 441=EC*IG/(AF*ZLB**3)
32120 Y1=Q1/K41
32130 Q2=MU(3)/(BF*ZLB)
32140 KK2=EC*ICR(3)/(AF*ZLB**3)
32150 Y2=Q2/KK2
32160 KK3=EC*ICR(3)/(ASS*ZLB**3)
32200 215 QU=OUTERM*4U(1)/ZLB
32210 220 YU=Y2+(QU-Q2)/KK3
32220 280 CNTINUE
32260 QFAIL=QU
32270 YT=999.9
32280C
32290C: CHECK FOR TYPE OF FAILURE - LIGHTLY REINFORCED OR CONVENTIONAL
32300 IF(MU(1).LT.1.5*44)GOT0 288
32310C
32320C: CONVENTIONAL TYPE FAILURE
32322 IF(ICASE.EQ.1.OR.ICASE.EQ.5)GOT0 272
32324 YE=Y2+YU*(1.0-Q2/QU)
32326 GOT0 273
32328 272 YE=YU
32330 273 YFAIL=YE*0.1/(ASC1)*(RB*D1)))
32340C: DUCTILITY FACTOR MUST BE << 30
32350 IF(YFAIL.GT.30.0*YE)YFAIL=30.0*YE
32370 GOT0 300

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PROGRAM RCBEAM (CONTINUED)

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32380C
32390C: LIGHTLY REINFORCED TYPE OF FAILURE
32400C: THE FOLLOWING EXPRESSION IS BASED ON A STEEL ELONGATION OF 20%
32410 288 JCDEF=30.
32412 PRINT 605
32414 READA VBAR
32420 'PHE=JCDEF=SORT(FDC)
32430 494R=3.14159*(VBAR/16.)**2
32440 290 YFAIL=SORT((3.2*494*FDC/(PHI+7L_B/2.))**2-(2LB/2.))**2
32460C
32470C TEENSILE MEMBRANE BEHAVIOR
32480 300 IF(CASE=4)GOTO 285
32630 312 KT=8.0*1.5
32635 TS=ASCS*FDY
32640 314 YT=2U*7LB/(KT*TS)
32642 OT=0U
32644 IF(YT>LE.YFAIL)GOTO 316
32646 YT=YFAIL
32648 9T=YT<T+TS/2LB
32650 316 IF(YFAIL.LT.0.15*2LB)YFAIL=0.15*2LB
32660 JFAIL=0.15*(T+TS)
32670C ADJUST LOAD-DEFLECTION CURVE FOR REINFORCED BEAMS
32680 245 DOL=10LSAR+150.0*494*7LB/1728.0
32700 IF(DOL.GE.0.1)GOTO 292
32710 YDL=DOL/100
32712 GOTO 295
32713 292 GOTO(273,294,294),ICASE4
32714 293 YDL=Y1+(DOL-0.1)*(YU-Y1)/(DU-0.1)
32715 294 IF(DOL=L.T.0)GOTO 295
32716 PRINT,0,DOL=0,YDL=0,DU=0,STOP
32717 294 YDL=Y1+(DOL-0.1)*(Y2-Y1)/(D2-0.1)
32718 IF(DOL.LT.0.2)GOTO 295
32719 YDL=Y1+(DOL-0.2)*(YU-Y2)/(DU-0.2) $ GOTO 291
32720 295 Y1=Y1-YDLS Y2=Y2-YDLS YJ=YJ-YDLS YT=YT-YDLS YFAIL=YFAIL-YDL
32725 31=01-DOLS 02=02-DOLS DU=DU-DOLS OT=OT-DOLS QFAIL=QFAIL-DOL
32730 IF(CASE=4)PRINT 673,DOL,YDL
32750C
32760C: 3 IF(JT L 140=DEFLECTION CURVE
32770 IF(CASE=5)GOTO 335
32780 PRINT 550
32790 IF(CASE=6)GOTO 327
32800 PRINT 660,01,Y1,02,Y2
32810 GOTO 330
32820 320 PRINT 660,01,Y1
32830 330 IF(CASE=6)GOTO 312
32840 PRINT 660,DU,YU,QFAIL,YFAIL
32850 GOTO 335
32855 332 IF(OT>4E-09)GOTO 333
32860 PRINT 660,DU,YU,OT,YT,QFAIL,YFAIL
32862 GOTO 335
32864 333 PRINT 660,DU,YU,DU,YT,OT,YT,QFAIL,YFAIL
32870 335 CONTINUE
32880C
32890 CALL TRANS(CASE4,ZKL4,ZKL4SE,ZKL4FE,ZKL4P,VL1S,VL2S,VL1F,
32900* VL2F,VL1P,VL2P)
32920 2SHRL=VCL*D(1)*RR
32970 340 IF(CASE=5)PRINT 695,2SHRL
32990 RETURN
33000C
33010C: *****
33020C: * ENTRY 3: DETERMINE THE RESISTANCE (PER UNIT AREA) *
33030C: * 3F THE WALL AS A FUNCTION OF Y(1) *
33040C: *****
33050C
33060 500 IF(Y(1).GE.YFAIL)GOTO 560
33070 IF(Y(1).GT.YU)GOTO 540
33080 GOTO(501,520,520,520,501,520,520),ICASE
33090 501 CONTINUE
33100C
33110C: ELASTIC RANGE -- CASES 1 AND 5
33120 ZKL4=ZKL4SE
33130 VL1=VL1S $ VL2=VL2S
33150 IF(Y(1).GT.YU)GOTO 510
33160C

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PROGRAM RCBEAM (CONTINUED)

```

33170C: UNCRACKED PORTION -- ALL CASES
33180 S05 Q=Y(I)*<<1
33190 RETURN
33200C
33210C: CRACKED PORTION -- CASES 1 AND 5
33220 S10 Q=91*(Y(I)-Y1)*(QU-01)/(YU-Y1)
33230 RETURN
33240C
33250 S20 IF(Y(I).GT.Y2)GOTO 530
33260C
33270C: ELASTIC RANGE -- CASES 2,3,4,6,7
33280 ZKL4=ZKL4FF
33290 VL1=VL1F $ VL2=VL2F
33310 IF(Y(I).LT.Y1)GOTO 505
33315C: CRACKED PORTION -- CASES 2,3,4,6,7
33320 Q=Q1+(Y(I)-Y1)*(Q2-Q1)/(Y2-Y1)
33325 RETURN
33330C
33340C: ELASTO-PLASTIC RANGE -- CASES 2,3,4,6,7
33350 S30 ZKL4=ZKL4SE
33360 VL1=VL1S $ VL2=VL2S
33380 Q=Q2+K13*(Y(I)-Y2)
33390 RETURN
33400C
33410C: PLASTIC RANGE -- ALL CASES
33420 S40 ZKL4=ZKLMP
33430 VL1=VL1P $ VL2=VL2P
33450 IF(Y(I).GT.YT)GOTO 550
33460 Q=QU
33470 RETURN
33480C
33490C: TENSILE MEMBRANE RANGE -- ALL CASES
33500 S50 Q=QT*(Y(I)-YT)*(QFAIL-QT)/(YFAIL-YT)
33510 RETURN
33520C
33530C: WALL COLLAPSED - NO RESISTANCE (TO AVOID NUMERICAL DIFFICULTIES
33540C: FOR CERTAIN CASES SET RESISTANCE EQUAL TO VERY SMALL VALUE)
33550 S60 Q=1E-10
33560 RETURN
33570C
33595 605 FORMAT(/*INPUT BAR NUMBER OF REINFORCEMENT*,*)
33683 633 FORMAT(/*QDL =*,F10.2,* LB      YDL =*,F8.4,* IN.*)
33700 650 FORMAT(//*L3AD-DEFLECTION CURVE*,/,*4X,*QT (LB)      Y (IN.)*)
33710 660 FORMAT(F10.2,F12.4)
33760 695 FORMAT(*QSHRL =*,F11.2,* LB*)
33850 END
35000 SUBROUTINE M3MENT(FDC,FDY,ES,PV,B,AS,APS,D,DP,MU,ICR,IC,
35001*           <C3MP,HS,BP>
35010C THIS SUBROUTINE DETERMINES THE ULTIMATE MOMENT CAPACITY AND
35020C CRACKED MOMENT OF INERTIA FOR REQUIRED SECTIONS
35040 REAL K1<2>,KUD,V,IC,ICTOT,MU(4),ICR(4),AS(4),APS(4),D(4),DP(4)
35050C
35060C: DETERMINE VALUES OF CONCRETE PARAMETERS
35070 45 K1=0.94-FDC/26E3
35080 K2=0.50-FDC/8E4
35090 K3=(3900.0+0.35*FDC)/(3E3+0.82*FDC-FDC*FDC/26E3)
35100 EPSC=0.004-FDC/65E5
35150C: ****
35160C: * DETERMINE ULTIMATE MOMENT CAPACITY AND CRACKED *
35170C: * MOMENT OF INERTIA FOR REQUIRED SECTIONS *
35180C: ****
35190C
35200 II=0$ ICTOT=0
35210 D9 170 I=1:4
35220 IF(AS(I).EQ.0)GOTO 170
35230 II=II+1
35240C: ALL PROPERTIES ARE COMPUTED FOR A WIDTH B
35250 TEVS=AS(I)*FDY*PV
35260 IF(APS(I).LE.0)GOTO 150
35270C
35280C: WALL HAS COMPRESSION REINFORCEMENT
35290 C=<1*<3*FDC*D*DP(I)
35300 TERM1=0.5*(TEVS/APS(I)*FS*EPSC)
35310 TERM2=ES*EPSC*(TEVS-C)/APS(I)

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PROGRAM RCBEAM (CONTINUED)

```

35320C: DETERMINE LOCATION OF NEUTRAL AXIS
35330 IF(TENS>LT) GOTO 140
35340C
35350C: UJD > 0
35360 FPS=TERM1*(3*FDC/2.0-S)*RT((TERM1*(3*FDC/2.0)**2
35370+ -(TERM2*ES*EPSC*(3*FDC)))
35380C: F'S MUST BE <= FDY
35390 IF(FPS<FDY) GOTO 130
35400 FPS=FDY
35410 130 TPS=APS(I)*(FPS-(3*FDC))
35420 UJD=(TENS-TPS)/((1*(3*FDC)+)
35430 MU(I)=((TENS-TPS)*(D(I)-2*(UJD)+TPS*(D(I)-DP(I)))
35440 IC(I)=B*(UJD**3/3.0+V*AS(I)*(D(I)-UJD)**2
35450+ +(V-1)*APSC(I)*(UJD-OP(I)))**2
35460 GOTO 152
35470C
35480C: UJD < D'
35490 140 FPS=-TERM1*SRT(TERM1**2-TERM2)
35500C: F'S MUST BE <= FDY
35510 IF(FPS<FDY) GOTO 145
35520 FPS=FDY
35530 145 TERM3=TENS+APS(I)*FPS
35540 UJD=TERM3/(1*(3*FDC+B))
35550 MU(I)=TERM3*(D(I)-2*(UJD)-APS(I)*FPS*(D(I)-DP(I))
35560 IC(I)=B*(UJD**3/3.0+V*AS(I)*(D(I)-UJD)**2+V*APS(I)*(DP(I)-UJD)**2
35570 GOTO 152
35580C
35590C: WALL HAS NO COMPRESSION REINFORCEMENT
35600 150 UJD=TENS*((1*(3*FDC+B)
35610 MU(I)=TENS*(D(I)-2*(UJD)
35620 IC(I)=B*(UJD**3/3.0+V*AS(I)*(D(I)-UJD)**2
35630C
35640 '52 IF(<COMP>EQ.0) GOTO 155
35650 IF(I.EQ.3) GOTO 170
35660 IF(<UD>LT.HS) GOTO 170
35670C
35680C * TEE BEAM -- NEUTRAL AXIS OUTSIDE FLANGE *
35690C (USE EQUVALENT RECTANGULAR STRESS BLOCK)
35700 ASF=0.85*FDC*(B-RP)*45/FDY
35710 UJD=(AS(I)-ASF)*FDY/(0.85*FDC*RP)
35720 MU(I)=ASF*FDY*(D(I)-0.5*H)+(AS(I)-ASF)*FDY*(D(I)-0.5*UJD)
35730 IC(I)=RP*(UJD**3/3.0+(B-RP)*45**3/12.0+HS*(B-RP)*(UJD-0.5*H)**2
35740+ +V*AS(I)*(D(I)-UJD)**2
35750 155 ICTOT=ICTOT+ICR(I)
35760 170 CONTINUE
35770C
35780C: DETERMINE AVERAGE CRACK LENGTH OF INERTIA
35790 175 IC=ICTOT/II
35800 RETURN
35810 END
40000 SUBROUTINE CREF (ICASE4,ASS,BSS,AF,RF,ICEN,IUP)
40010C
40020C THIS SUBROUTINE DETERMINES DEFLECTION AND MOMENT COEFFICIENTS
40030C FOR TEE BEAMS WITH VARIABLE MOMENT OF INERTIA
40040C
40050 REAL ICEN,IUP
40060C: CASE 5. ONE-WAY SIMPLY SUPPORTED WALL
40070 ASS=5.0/34.0
40080 BSS=0.125
40090 RI=IUP/ICEN
40100 GOTO(270,60,70),ICASE4
40110C
40120C: CASE 6. ONE-WAY FIXED END WALL,
40130 60 BF=(-.00953+.03213*RI)/(.211+.289*RI)
40140 AF=.00132+.01169*RI-BF* (.0223+.1024*RI)
40150 RETURN
40160C
40170C: CASE 7. ONE-WAY PROPPED CANTILEVER WALL
40180 70 RF=(-.0109+.0308*RI)/(.1926+.1407*RI)
40190 AF=-.00439-.00342*RI+BF* (.08333+.02043*RI)
40200 270 RETURN
40210 END
50000 SUBROUTINE TRANS (ICASE4,ZKLM,ZKLMS,ZKLMFE,ZKLMFZ,VL1S,VL2S,
50010+ VL1F,VL2F,VL1P,VL2P)

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PROGRAM RCBEAM (CONTINUED)

```

50020C
50030C THIS SUBROUTINE DETERMINES TRANSFORMATION FACTORS AND
50040C DYNAMIC REACTION COEFFICIENTS FOR ONE-WAY BEAMS
50050C
50060C ALL CASES
50070 ZKLME=0.79
50080 ZKLMF=0.66
50090 VL1S=0.107
50100 VL2S=0.393
50110 VL1P=0.125
50120 VL2P=0.375
50130 G0T3(300,310,320),ICASE4
50140C
50150C CASE 5
50160 300 ZKLME=ZKLME
50170 VL1=VL1S
50180 VL2=VL2S
50190 RETURN
50200C
50210C CASE 6
50220 310 ZKLME=0.77
50230 VL1F=0.136
50240 VL2F=0.364
50250 G0T0 330
50260C
50270C CASE 7
50280 320 ZKLME=0.78
50290 VL1F=0.165
50300 VL2F=0.459
50310 330 ZKLME=ZKLME
50320 VL1=VL1F
50330 VL2=VL2F
50340 RETURN
50350 END
70000      SUBROUTINE RANDOM (IENTRY)
70010C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
70020C VARIABLES, GENERATES RANDOM VALUES, AND CONTROLS REQUIRED
70030C NUMBER OF CASES TO BE RUN, AND OUTPUTS FINAL RESULTS AND SUMMARY
70040C
70050 COMMON KINC,LDTYPE,KRF,(RND,TIME,I1,Y(100),QT,QU,YFAIL,
70052+ ZLB,BB,HB,FPC,FDY,ICASE,AS(-),APS(4),D(4),DP(4),FDC,
70054+ EC,ES,QAREA,PAREA,ZMAS,VL1,VL2,
70055+ MEML,ASCS,VCL,DLSLAP,(CGMP,HS,BS,VSARS,VAMEF(2),LJAD,
70056+ ,NP3,C3,L3C,S,ZLEV,CD,PS3,PD3,PR,PEXT,PC,TC,T0,DELAY,
70057+ TT(F0,2),FP(F0,2),REAC(R0,2),INDEX(2),BR(2),
70058+ VV1,VV2,V3,L1,AR(B,2),VV(B),AFRONT,ASIDE,G,G2,G3,G4,PP2,DT
70080      C0443N /RAND/ TIMEC
70090      DIMENSION CHI25(7),CHI975(7),TDIST(7)
70100C
70110C VALUES FOR 97.5% (F=19.24,29.34,39.44,49)
70120      DATA CHI25/.4,39,.5167,.5533,.5825,.6065,.6267,.6440/
70130      DATA CHI975/1.7295,1.6402,1.5766,1.5284,1.4903,1.4591,1.4331/
70140      DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
70150C
70160      G0T3(S,50,70),IENTRY
70170      S XUMMY=XNBRM1(-1.0,0,0,1,0)
70180C INITIALIZE RANDOM NUMBER GENERATOR
70190      PRINT 7,*'INPUT VRAND'
70200      READ,VRAND
70210      D3 47 I=1,VRAND
70220      XDUM4Y=XNBRM1(0,0,0,0,1,0)
70230      47 CNTINUE
70240      INDEX=0$ SPS3=0$ SSPS3=0
70250      ICSEC1=20
70260C
70270C INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
70275      IF(LJC.EQ.2)GOTO 30
70280      PRINT 87
70290      READ,SMEAN,SSD
70410C REINFORCED CONCRETE WALLS
70420 30 PRINT 86
70430      READ,FDYMEAN,FDYSU
70440      IF(LJC.EQ.1)PRINT 24
70445      IF(LJC.NE.1)PRINT 95

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PROGRAM RCBEAM (CONTINUED)

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71450      RETURN
70460C  GENERATE RANDOM VALUES
70570  50 FDY<XNORM(0.0,FDYMEAN+0.05)
70580  IF(FDY.LE.0)GOTO 50
70590  60 S=XNORM(0.0,0.05)
70600  IF(S.LE.0)GOTO 60
70610  65 INDEX=INDEX+1
70620  RETURN
70630C SUM VALUES OF PSJ AND PSJ+2 FOR USE IN STATISTICAL ANALYSIS
70640  70 SSPS2=SSPS1+PSJ
70650  SSPS2=SSPS1+PSJ+PSJ
70660C
70670C OUTPUT FINAL RESULTS
70730  76 IF(LJC.EQ.1)PRINT 92,FDY,N,PSJ,TIMEC
70735  IF(LJC.NE.1)PRINT 90,FDY,PSJ,TIMEC
70740  80 IF(INDEX.LT.1)CHECK RETURN
70750C
70760C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PSJ
70770  ZMEAN=SSPS2/INDEX
70780  SD=SQR((SSPS2-INDEX*ZMEAN*ZMEAN)/INDEX)
70790  STDERR=SD/(SQR(INDEX-1))
70800  CHECK IF MAXIMUM OF 50 PSJ SAMPLES OBTAINED
70920  IF(INDEX.EQ.50)GOTO 62
70830C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PSJ VALUE IS
70840  IF(STDERR*TDIST((INDEX-1)/5)/2*MEAN.GT.0.10)GOTO 61
70850C
70860C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT 66
70870C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
70890C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
70990  62 SDU=SD/(SQR(TCHI25((INDEX-1)/5)))
70900C CHECK IF MAXIMUM OF 50 PSJ SAMPLES OBTAINED
70910  IF(INDEX.EQ.50)GOTO 53
70920C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
70930C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
70940  IF(((SDU-SD)/2*MEAN).GT.0.10)GOTO 61
70950C
70960C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
70970C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
70980C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
70990,
71000C AND 10% AND 90% PROBABILITY VALUES
71010  53 ZMEANL=ZMEAN-STDERR*TDIST((INDEX-1)/5)
71020  ZMEANU=ZMEAN+STDERR*TDIST((INDEX-1)/5)
71030  SDL=SD/(SQR(TCHI975((INDEX-1)/5)))
71040  P10=ZMEAN-1.282*SD
71050  P10L=ZMEAN-1.282*SDU
71060  P10U=ZMEAN-1.282*SDU
71070  P90=ZMEAN+1.282*SD
71080  P90L=ZMEAN+1.282*SDU
71090  P90U=ZMEAN+1.282*SDU
71100  P90U=ZMEAN+1.282*SDU
71110  P90U=ZMEAN+1.282*SDU
71120C
71130C OUTPUT STATISTICAL PARAMETERS OF INCIPIENT COLLAPSE PRESSURE
71140  PRINT 100,ZMEAN,ZMEANL,ZMEANU,SD,SDL,SDU,P10,P10L,P10U,
71150*   P90,P90L,P90U
71160  PRINT 105,INDEX,STDERR
71170  GOTO 999
71180C
71190C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90%
71200B
71210C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
71220  61 ICHECK=ICHECK+5
71230  RETURN
71240C
71270  86 FFORMAT(/,INPUT MEAN AND STANDARD DEVIATION FOR FDY*,1)
71280  87 FFORMAT(/,INPUT MEAN AND STANDARD DEVIATION FOR S*,1)
71290  90 FFORMAT(F9.2,F10.2,F14.3)
71310  92 FFORMAT(F9.1,F11.2,F10.2,F14.3)
71340  95 FFORMAT(///,SX,*FDY*,7X,*PSJ*,6X,*COLLAPSE TIME*)
71350  96 FFORMAT(///,SX,*FDY*,7X,*PSJ*,6X,*COLLAPSE TIME*)

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PROGRAM RCBEAM (CONCLUDED)

```
71360 100 F3RFORMAT(//,11X,*STATISTICAL PROPERTIES OF INCIPIENT PS0*,  
71370* //,39X,*95% CONFIDENCE LIMITS*,/,7X,*1TE4*.18X/  
71380* *VALUE LOWER UPPER*,//,* MEAN*,F29.2,  
71390* 2F12.2,/* STANDARD DEVIATION*,F15.2,2F12.2,/  
71400* * 10% PROBABILITY VALUE*,3F12.2,/  
71410* * 90% PROBABILITY VALUE*,3F12.2)  
71420 105 F3RFORMAT(//,5X,*NUMBER OF OBSERVATIONS =*,13,/,5X,  
71430* *STANDARD ERROR =*,F5.2)  
71440C  
71450 999 ST3PS END  
71460 FUNCTION XNORM1(X,A,B)  
71470 IF(X>10,20,20  
71480 10 X0=RANF(-1.0)  
71490 20 X1=RANF(0.0)  
71500 X2=RANF(0.0)  
71510 Y=SORT(-2.0*ALOG(X1))*((COS(6.283184*X2))  
71520 XNORM1=A+Y*B  
71530 RETURN  
71540 END
```

STBEAM

Steel Support Beam

PROGRAM STBEAM

```

00100 PROGRAM STBEAM1(INPUT, JINPUT, TAPE1)
00105 CALL RETR(7HSTBEAM2, 7HSTBEAM2)
00110C * THIS PORTION OF THE PROGRAM INPUTS THE REQUIRED ELEMENT
00115C AND LOAD DATA AND INITIALIZES CERTAIN PARAMETERS *
00120C
00120C COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),DT,QJ,YJ,YFAIL,
00125C ZLB,H3,BFLG,TLG,TW,FDYS,LCASE,KPLATE,CCAMP,HP,BP,ES,
00130C HPC,HS,FPC,FOC,EC,BS,FDYK,AS,D,APS,DP,QAREA,PAREA,ZMASS,
00135C ZKL4,VL1,VL2,VSLABS,NAMEF(2),KL3AD,QDLSLAB,
00140C W,PB,CD,L3C,S,ZLEV,CD,PS3,PD3,PR,PEXT,PC,TC,TO,DELAY,
00145C TT(R0,2),PP(R0,2),REAC(R0,2),INDEX(2),BR(2),
00150C VV1,VV2,RH1,V3,L1,AA(B,2),VV(B),AFRONT,ASIDE,G,G2,G3,G4,PPB,DT
00160C LOGICAL L1
00165C
00170C * READ TITLE AND CONTROL PARAMETERS
J0172 PRINT 67
00174 READ 68,TITLE
00176 PRINT 720
00178 READ,VSLABS:KL3AD
00180 PAREA=0 S QDLSLAB=0
00182 IF(KL3AD.EQ.0)GOT3 40
00184C
00186C INPUT SLAB REACTION DATA FILE DATA
00188 PRINT 725
00190 D0 39 J=1,VSLABS
00192 PRINT 735,I
00194 READ,NAMEF(J),ISIDE
00196 CALL PFUR(3HRET,I,NAMEF(J))
00198 IF(ISIDE.EQ.1)READ(I,)SAREA,DUM,HS
00200 IF(ISIDE.EQ.2)READ(I,)DUM,SAREA,HS
00202 S10 INDEX(J)=I
00204 READ(I,)NPPOINT
00206 IF((ISIDE.EQ.2)GOT3 520
00208 S15 READ(I,)(TT(I,J),J),PP(J,J),REAC(J,J),DIM,JJ=1,NPPOINT
00210 DATA 525
00212 S20 READ(I,)(TT(I,J),J),PP(J,J),DIM,REAC(J,J),JJ=1,NPPOINT
00214 S25 BR(I)=(REAC(2,J)-REAC(1,J))/(TT(2,J)-TT(1,J))
00216 BP=(PP(2,J)-PP(1,J))/(TT(2,J)-TT(1,J))
00218 REWIND I
00220 CALL DR3P1(I)
00221 QDLSLAB=QDLSLAB+150.0*SAREA*HS/1728.0
00222 39 PAREA=PAREA+SAREA
00224 KINC=0 S LDTYPE=S S KRF=0 S KRAND=0
00226 GOT3 45
00228C
00230C INPUT TRIBUTARY SLAB DATA
00232 40 PRINT 730
00234 D0 42 J=1,VSLABS
00236 PRINT 735,J
00238 READ,SAREA,HS
00240 QDLSLAB=QDLSLAB+150.0*SAREA*HS/12.0
00242 42 PAREA=PAREA+SAREA+44.0
00244C
00246 PRINT 85
00248 READ,KINC,LDTYPE,KRF,KRAND
00250 45 CONTINUE
00252 DELAY=0
00254 67 FORMAT(*INPUT TITLE*,*)
00256 68 FORMAT(A59)
00258 69 FORMAT(*INPUT KINC,LDTYPE,KRF,KRAND(I=RAND34)*,*)
00260 720 FORMAT(*INPUT NUMBER OF SLABS SUPPORTED BY BEAM, AND IF *,
00262 *SLAB REACTIONS*/ARE TO BE CALCULATED (0) OR READ FROM *,
00264 *DATA FILE (1)*,*)
00266 725 FORMAT(*INPUT REACTION DATA FILE NAME AND SIDE *,
00268 *(I=SHRT,2L8VG)*)
00270 730 FORMAT(*INPUT CONTRIBUTORY AREA (SQ FT) AND THICKNESS (IN.)*)
00272 735 FORMAT(6x,*FOR SLAB NO.*I2,*)
00274C
00570C INPUT LOAD PARAMETERS
00571 IF(LDTYPE.EQ.5)GOT3 20
00575C LOCATION 1. FRONT FACE LOADING (USED IN ROOM-FILLING PROCEDURE)
00580 IF(KL3AD.EQ.1)GOT3 25
00585 100 W1000.0 S PD=14.7 S CR=1120.0
00590 IF(KRF.VE.1)GOT3 102

```

PROGRAM STBEAM (CONTINUED)

```

00595 L0C=1
00600 IF((RND.E0.1)GTJ 106
00605 PRINT 600
00610 READ,S
00615 GTJ 105
00620C L3CATIV 2. T3P FACE L3ADING
00625 102 CD=0 $ L3C=2
00630 ZLEN=ZLR/12.0
00635 105 IF((INC.E0.1)GTJ 106
00640 PRINT 610
00645 READ,PS3
00650 PR=2.0*PS0*(7.0*P3+4.5*PS0)/(7.0*P3+PS3)
00655 600 FORMAT(/*INPUT S*,*)
00660 610 FORMAT(/*INPUT PS3*,*)
00665C
00670C * INPUT R33M-FILLING PARAMETERS *
00675 106 IF((RF.E0.0)GTJ 20
00680 10 PRINT 700
00685 RH33=0.076 $ L1=.FALSE.
00690 UDELAY=1E10
00695 READ,VWIN,V3
00700 AT=0$ AFR3NT=0$ ASIDE=0
00705 D9 18 I=1,VWIN
00710 PRINT 710,I
00715 READ,AA(I,1),VV(I),AA(I,2)
00720 AA(I,2)=AA(I,2)/1000.0
00725 AT=AT+AA(I,1)
00730 M=VV(I)$ GTJ(12,14,14),M
00735 12 AFR3NT=AFR3NT+AA(I,1)
00740 GTJ 18
00745 14 ASIDE=ASIDE+AA(I,1)
00750 18 IF(AA(I,2).LT.-DELAY)DELAY=AA(I,2)
00755 AFR3NT=AFR3NT/ATS ASIDE=ASIDE/AT
00760 700 FORMAT(/*INPUT VWIN AND R33M VOLUME (CF)*,*)
00765 710 FORMAT(/*INPUT AREA (S0 FT),LOCATION C39E & DELAY(MSEC)*
00770+   * F3R WINDBW,I2,*)
00775 G=1.4 $ G2=1./G $ GR=1.-G2 $ G4=2./G3 $ GS=G+1.
00780 PP2=1912
00785 C=SQRT(G*P0*32.*144./RH33)
00790 TAU=2.*((V3**(.1/3.))/C
00795 DT=TAU/.4.0
00800C
00805 20 CONTINUE
00810 25 CALL CHAIN(STREAM2)
00815 99 STOP
00820 END
01000 SEGMENT STREAM2(INPUT,INPUT,TAPE)
01010C THIS SEGMENT CALCULATES THE RESISTANCE FUNCTION AND
01020C LEADING AND SOLVES THE DYNAMIC EQUATIONS OF MOTION
01030C
01050 C0441V KING,L0TYPE,(RF,KRND,TIME,I,Y(107),DT,DY,YI,YFAIL,
01052+ ZLR,HR,BFLG,TFLG,TW,FOYS,ICASE,(PLATE,CC34H,HP,RP,ES,
01054+ HPC,HS,FDC,EC,BS,FOYR,AS,DAFS,DF,CAREA,PAREA,Z44SS,
01055+ ZLM,VL1,VL2,VSLABS,NAMEF(2),L3AD,90LSL49,
01056+ W,P,C9,L3C,S,ZLEN,CD,PS3,P03,PF,PEXT,PC,TC,TO,DELAY,
01057+ TT(R0,2),PP(R0,2),REAC(R0,2),INDEX(2),H4(2),
01058+ VWIN,RH33,V3,L1,AA(9,2),VV(H),AFR3NT,ASIDE,G,G2,G3,G4,PP2,DT
01078 C0442V /RAND/ TIMEC
01090 DIMENSION A(100),V(100),T(100),VS(100),U(100),PV(100)
01100C
01240     CALL RESIST(1)
01250 IF((INC.NE.1.0.L0TYPE.E0.5)CALL F3RC(1)
01260 14 IF((RND.NE.1)GTJ 35
01270     CALL F3RC(4)
01280     CALL RAVD34(1)
01290 34 CALL RAVD34(2)
01300 35 CALL RESIST(3)
01310C
01320C MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
01330C WHERE THE LOAD CAUSING INPIENT COLLAPSE IS TO BE FOUND
01340 13 IF((INC.E0.0)GTJ 23
01350 PF=4.0
01360     PFMAX=0
01370     PFMIN=PF/2.0

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PROGRAM STBEAM (CONTINUED)

```

01390      G3T3 20
01390 16      PF=(PFMIN+PFMAX)/2.0
01400 20      CALL FORCE(2)
01410 23      IF(<RF.E0.0)G3T3 24
01420      CALL FILL(PINT,2)
01430C
01440C: INITIALIZE VALUES FOR BETA METHOD (BETA=1/6) AND COMPUTE VALUES
01450C: FOR FIRST TIME INTERVAL ASSUMING ELEMENT INITIALLY AT REST
01460 24      I=1
01470      TI4E=0
01480      V(I)=0 $ Y(I)=0
01490      DELTA=0.001
01500      IF(<RF.NE.1)G3T3 30
01510 27      IF(TIME.GE.(DELAY-.00001))G3T3 30
01520      TI4E=TIME+DELTA
01530      CALL FILL(PINT,3)
01540      G3T3 2
01540 30      CALL RESIST(2)
01550      A(I)=0.0 $ VS(I)=0.0 $ VL(I)=0.0
01560      T(I)=TIME
01570C
01580C: PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
01590 1      I=I+1
01600      IF(I.LT.10)G3T3 11
01610      PRINT 98, TIME
01620      98 FORMAT(*I=10!! TIME =*,F6.3,*! FAILURE ASSUMED TO NOT OCCUR)
01630      G3T3 6
01640 11      TIME=TIME+DELTA
01650      T(I)=TIME
01660      A(I)=A(I-1)
01670      IF(<RF.NE.0)G3T3 10
01680      CALL FORCE(2)
01690      PV(I)=PEXT
01700      G3T3 2
01710 10      CALL FILL(PINT,3)
01720      PV(I)=PINT
01730 2      IF(<LT30.E0.0)PT=PV(I)*PAREA
01740      IF('KLOAD.NE.0')P=2PV(I)
01750      98 R J(I),I
01760      Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTAT*(A(I-1)/3.+A(I)/6.)
01770      CALL RESIST(2)
01780      A(I)=ANEW*(PT-GT)/(2*ASSIZALM)
01790      ADD T4=ANEW-A(I)
01800      A(I)=ANEW
01810      IF(ANEW.E0.C)PRINT, #1985, TIME, PT, UT, IMAGEN, ZALM, Y(I), A(I)-1
01820      IF(CABS(ADELTA/CANEW).LE.1E-16 .LT.0.0) G3T3 9
02000 8      CONTINUE
02010      A(I)=ANEW-ADELTA/2.0
02020      PRINT 50, TIME, PF, A(I), Y(I)
02030 9      CONTINUE
02040      Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTAT*(A(I-1)/3.+A(I)/6.)
02050      V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
02070      VL(I)=VL1*PT+VL2*PT
02090C
02100C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE
02110C: IF MAXIMUM DEFLECTION REACHED, WALL DID NOT FAIL
02120      IF(Y(I).LE.Y(I-1).AND.PV(I).LE.PM(I-1))G3T3 6
02130      IF(Y(I).LT.0)G3T3 6
02135      IF(Y(I).GE.YFAIL)G3T3 7
02140      IF(TIME-DELAY.GE.0.010)DELTA=0.002
02160      IF(TIME-DELAY.GE.0.020)DELTA=0.005
02170      IF(TIME-DELAY.GE.0.100)DELTA=0.010
02180      IF(TIME-DELAY.GE.0.500)DELTA=0.050
02190C: IF FAILURE DEFLECTION REACHED, ELEMENT FAILED
02210      G3T3 1
02220C
02230C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
02240C: COLLAPSE FOR CASES WHERE DESIRED
02250C: ELEMENT DID NOT FAIL -- SET PFMIN TO PF
02260 6      CONTINUE
02270      IF(<IVC.E0.0)G3T3 18
02290 36      PFMIN=PF
02300 IF(PFMAX.GT.0)G3T3 16
02310      PF=2.0*PF

```

PROGRAM STREAM (CONTINUED)

```

02320      G1T4 20
02330C: ELEMENT FAILED -- SET PFMAX TO PF
02340    7  CONTINUE
02350    TIMEC=114E
02370    IF((INC>0.0))G1T4 18
02380    17  PFMAX=PF
02390C: CHECK TO SEE IF LTAD RANGE IS WITHIN DESIRED ACCURACY
02400    17  IF((PFMAX-PFMIN)/PFMIN>0.01)G1T4 16
02410    17  IF((RAN0.4E.1))G1T4 18
02420    CALL RND24(3)
02430    G1T4 34
02440C
02450C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
02460C: FAILURE FOR A NON-FAILING ELEMENT, OR THE TIME AND VELOCITY
02470C: AT COLLAPSE FOR A FAILING ELEMENT. OPTIONAL OUTPUT IS THE
02480C: ENTIRE BEHAVIOR TIME-HISTORY.
02490C
02500C: OUTPUT LOAD DATA
02510    18  CALL FORCE(4)
02520C
02530C: OUTPUT FINAL RESULTS
02540  IF(Y(I)<LT.YFAIL)PRINT 70,Y(I),T(I)
02550  IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
02577C
02578C CHECK TO SEE IF ENTIRE TIME-HISTORY IS DESIRED
02580 PRINT 72
02590 READ,4
02600    IF(M.EQ.0)GOTO 25
02680 PRINT 76,(T(J),PV(J),A(J),V(J),VL(J),J=1,I)
02690  25 PRINT 77
02710C
02740  70 FORMAT(/*N3 FAILURE - MAX DEFLECTION 3F*,F6.2,
02750*   * IN* REACHED AT*F7.3,* SEC*)
02760  71 FORMAT(/*FAILURE OCCURRED AT*,F7.3,* SEC (FINAL VELOCITY =*,
02770*   F7.2* IN./SEC*)*)
02780  72 FORMAT(/*IS TIME HISTORY DESIRED (YES=1, NO=0)*,*)
02830  76 FORMAT(/* TIME PRESSURE ACCELERATION VELOCITY *
02840*   *DISPLACEMENT VL*,*/,
02850*   (F6.3,F9.3,F12.1,F12.2,F12.4,F11.0))
02860  77  F29FORMAT(/,,7(*-----*)*)
02870  90 F29FORMAT(/*ACCELERATION VS CONVERGING AT TIME =*,F6.3,
02880*   * SEC (PF =*,F7.3,* PSI)*/* A(*) SET EQUAL T0*,
02890*   F8.1* (AVG 3F LAST 2 ITERATIONS)*/* Y(*) =*,F8.4* IN.*)
02900*   F8.4* IN.*)
02950C
02960  999  STOP
02970  END
10000 5 IRRATIVE FORCE(ENTRY)
10010C THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
10020C THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
10030C 1. IDEALIZED PLASTIC LOAD (FRONT OR SIDE FACE)
10050 COMMON KINC,LDTYPE,LRF,GRND,TIME,L,Y(100),DT,QU,YIM,YFAIL,
10052* ZLR,MS,BFL,G,TRL,G,FW,FDYS,ICASE,KPLATE,LCOMP,HP,BP,ES,
10054* MPC,MS,FPC,FDC,EC,BS,FDYR,AS,D,APS,DP,QAREA,PAREA,MASS,
10055* ZKL1,VL1,VL2,VSLAB,VAMEF(2),LLOAD,DLSSLA,
10056* N,P0,CB,LSC,S,ZLEN,CD,PS0,PD0,PN,P,PC,TC,T0,RELAY,
10057* TT(R0.2),PP(R0.2),REAC(R0.2),YDEX(2),BR(2)
10058* VWIN,PH00,V3,L1,AA(H,2),VV(H),AF'INT,ASIDE,G,C2,G3,G4,PP2,DT
10080C
10130  IF(LDTYPE.EQ.5)G1T3 700
10135  IF(LLOAD.EQ.1)G1T3 500
10140C
10150  G1T3(215,200,300,4),ENTRY
11000C
11010C CALCULATE LOAD PROPERTIES FOR GIVEN PEAK PRESSURE
11030  200 G1T3(205,210),L9C
11040  205 PS3*(PR-14.0*PT-SQRT(196.0*P3*P3+196.0*P3*PR+PR*PR))/16.0
11050  G1T3 215
11060  210 PS3*PP
11070  215 P03=2.5*PS3*PS3/(7.0*P3*PS3)
11080  1=C0*SQRT(1.0+(6.0*PS3)/(7.0*P3))
11090  T0=W=0.3333/(2.2399+0.1886*PS3)
11100  G1T3(220,225),L9C
11110  220 TC=3.0*S/I

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PROGRAM STBEAM (CONTINUED)

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11120 PC=PS3*(1-TC/T0)+EXP(-TC/T0)+PD0*(1-TC/T0)**2*EXP(-2*TC/T0)
11130 CD=1.0
11140 RETURN
11150 225 TA=ZLEN/J
11160 TA2=TA/2.0
11170 TA2T0=T42/T0
11180 PA=PS0*(1-T42T0)+EXP(-TA2T0)+CD*PD0*(1-T42T0)**2*EXP(-2*T42T0)
11190 RETURN
12000C
12010C CALCULATE L3AD
12030 300 G0T0(305,310),L3C
12040 305 TT=TIME/T0
12050 IF(TIME.GT.TC)G0T0 320
12060 P=PC+(TC-T14E)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/T0
12090 IF(TIME.GT.TA)G0T0 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.1.0)G0T0 330
12130 P=PS0*(1-TTO)*EXP(-TTO)+CD*PD0*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C PRINT L3AD DATA
13010 4 IF(LINC.EQ.0)G0T0 400
13030 PRINT 640,LDTYPE
13040 G0T0 410
13050 400 PRINT 645,LDTYPE
13060 410 CONTINUE
13070 415 G0T0(420,425),L3C
13080 420 PRINT 650
13090 G0T0 430
13100 425 PRINT 655
13110 430 PRINT 660,4,P0,C3
13120 IF(RAND.VE.0)RETURN
13130 G0T0(435,440),L3C
13140 435 PRINT 665,S,TC,PR
13150 G0T0 445
13160 440 PRINT 670,ZLEN,TA,PA
13170 445 PRINT 675,I,T0,CD,PS3,PD0
13180 RETURN
13500C
13510C LOAD TYPE 5 -- ARBITRARY LOAD SHAPE
13520 700 G0T0(710,720,730,740),IEVTRY
13530C
13540C INPUT L3AD DATA
13550 710 PRINT 780
13560 READ,VP3INT,(TT(J,1),PP(J,1),J=1,VP3INT)
13570 FACT3R=1.0
13580 IF((LVC.EQ.0)G0T0 718
13590 PMAX=PP(1,1)
13600 D0 715 J=2,VP3INT
13610 715 IF(PP(J,1).GT.PMAX)PMAX=PP(J,1)
13620 718 PK=PP(2,1)-PP(1,1)
13630 TX=TT(2,1)-TT(1,1)
13640 J=1
13650 RETURN
13660C
13670C CALCULATE MAXIMUM L3AD
13680 720 FACT3R=PR/PMAX
13690 G0T0 718
13700 RETURN
13710C
13720C CALCULATE L3AD
13730 730 IF(TIME.LE.TT(J+1,1))G0T0 735
13740 JJ=JJ+1
13750 PX=PP(JJ+1,1)-PP(JJ,1)
13760 TX=TT(JJ+1,1)-TT(JJ)
13765 IF(TX.EQ.0)TX=1E-10
13770 G0T0 730
13780 735 P=FACT3R*(PP(JJ,1)+(TIME-TT(JJ,1))*PX/TX)
13790 RETURN

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PROGRAM STBEAM (CONTINUED)

```

      00C
1310C PRINT L340 DATA
13115 740 IF((INC.C).1)PRINT 640,L3TYPE
13120 IF((INC.E).0)PRINT 645,L3TYPE
13125 PRINT 720
13130 D3 715 J=1,NPRINT
13140 P=FACT3R*PP(J,1)
13150 745 PRINT 745,TT(J,1),P
13160 RETURN
14070C
14070 640 FORMAT(/<L340 CAUSING INCIPENT FAILURE IS AS FOLLOWS:>
14071+ /*SX,<L340 TYPE N MBER,12)
14072 645 FORMAT(/<PROPERTIES OF L340 ACTING ON WALL ARE AS FOLLOWS:>
14073+ /*SX,<L340 TYPE N MBER,12)
14074 650 FORMAT(8X,<(FRONT FACE)>)
14100 655 FORMAT(SX,<(SIDE OR TOP FACE)>)
14110 660 FORMAT(10X,*W =*,F8.1,* FT P0 =*,F6.2,* PSI CD =*
14111+ F7.1,* FPS*)
14120 665 FORMAT(10X,*S =*,F6.1,* FT TC =*,F6.3,* SEC PR =*
14121+ F7.3,* PSI*)
14130 670 FORMAT(10X,*L =*,F6.1,* FT TA =*,F6.3,* SEC PA =*
14131+ F7.3,* PSI*)
14140 675 FORMAT(10X,*U =*,F7.1,* FPS TO =*,F6.3,* SEC CD =*
14141+ F5.1,* ,8X,*PSI =*,F7.3,* PSI PD0 =*,F7.3,* PSI*)
14150 740 F34AT(/<INPUT NUMBER OF L340 PRINTS AND THE TIME AND *
14151+ *PRESSURE AT EACH PRINT*>)
14160 790 FORMAT(/10X,*TIME PRESSURE*)
14170 795 FORMAT(F15.3,F12.2)
15000C
15002C: SLAB REACT3N DATA
15010 500 G3T3(S10,530,540,560),IENTRY
15020 S10 RETURN
15085C
15090 530 STOP
15095C
15100 540 P=0.0
15110 D3 555 J=1,VSLABS
15115 545 J=INDEX(J)
15120 550 IF(TIME.LT.TT(J)+1,J)G3T3 555
15125 INDEX(J)=INDEX(J)+1 S JJ=INDEX(J)
15130 IF(JJ.LT.NPRINT)G3T3 552
15132 PRINT 690,TIME
15133 STOP
15135 552 BR(J)=(REAC(J+1,J)-REAC(J,J))/(TT(J+1,J)-TT(J,J))
15140 RP=(PP(J+1,J)-PP(J,J))/(TT(J+1,J)-TT(J,J))
15150 G3T3 550
15160 555 PP=REAC(J,J)+(TIME-TT(J,J))*RR(J)
15165 P=P+QAREA*(PP(J,J)+(TIME-TT(J,J))*RP)
15170 RETURN
15180 560 PRINT 680
15190 D3 565 J=1,VSLABS
15200 565 PRINT 685,VAMEF(J)
15300 680 FORMAT(/<BEAM LOADED WITH REACTIONS FROM FILE(S)>)
15310 685 FORMAT(10X,A7)
15315 690 FORMAT(/<END OF FILE -- BEAM HAS NOT FAILED AT*,F6.3,* SEC*>)
15320 RETURN
15330 END
20000 SUBROUTINE FILL(P3,IENTRY)
20010C: COMPUTES AVERAGE AIR PRESSURE IN ROOM DUE TO BLAST WAVE
20020C: INCIDENT HEAD-ON IMPACT FRONT WALL.
20030C
20050 C3MM3N <INC,L3TYPE,KRF,KRAND,TIM3> I3,Y(100),DT,DU,YU,YFAIL,
20052+ ZLB,MB,BFL,G,FBL,G,TW,FIYS,I(CASE),PLATE,<C34P,HP,RP,ES,
20054+ HPC,HS,FPC,FDC,EC,BS,FDYR,AS,D,APS,DP,QAREA,PAREA,ZMASS,
20055+ ZLM,VL1,VL2,VSLABS,VAMEF(2),<L340,CD,SLAB,
20056+ W,P3,C3,L3C,S,ZL3N,CD,PS3,P03,PR,PCXT,PC,TC,TO,DELAY,
20057+ TT(80,2),PP(80,2),RFAC(80,2),INDEX(2),RR(2),
20058+ VV(80,2),RH33,V3,L1,AA(8,2),VV(8),AFR3NT,ASIDE,G,G2,G3,G4,PP2,DT
20090 L340,L1,L2,L3
20095C
20100 G3T3(10,13,11),IENTRY
20110 I0 RETURN
20310C
20320 I3 P3B=P3

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PROGRAM STBEAM (CONTINUED)

```

20330 TT=0. $ T0=0.
20340 RH033=RH00
20350 L2=.FALSE. $ L3=.FALSE.
20360 RETURN
20370C
20380 11 IF(L1)G3T3 52
20385 IF(L2.A.L3)G3T0 9
20390 52 DDT=(TIME-T3)*0.5
20395 1ST3P=2
20400 S1 IF(DDT.LT.DT)G3T0 S1
20410 S0 DDT=0.5*DDT
20415 1ST3P=2*1ST3P
20420 S0 T0 53
20430 S1 CONTINUE
20440 D1 99 I=1,1ST3P
20450 TT=T0+I*DDT
20460 IF(TT.GT.T0)G0 T3 99
20470 DM=0. $ WM=0. $ VM=0
20480 DB 500 I=1,VMIN
20490 VM=VM(X) $ DLY=AA(I,2)+0.000001
20500 IF(DLY.GE.TT)G1 T3 500
20510 G3T0(15,16,16),4
20520 15 CDF=1.0
20530 IF(TT-TC)20,20,21
20540 20 P11=(TC-TT)*(PR-PC)/TC+PC
20550 P11=P11+P9
20560 G0 T0 30
20570 16 CDF=-0.4
20600 21 R=TT/T0 $ RR=1.-R
20610 PD=PD0*RR*RR*EXP(-2.*R)
20620 PS=PS0*RR*EXP(-R)
20630 P11=PS*CDF*PD
20640 P11=P11+P3
20650 30 RH01=RH00*((P11/PS)*G2)
20660 IF(P11-P30)36,36,37
20670 36 JSIGN=-1
20680 L2=.TRUE.
20770 303 P2=P11
20780 RH02=((P2/P30)**G2)*RH033
20790 X=P33/RH033
20800 G0 T3 38
20810 37 JSIGN=+1
20820 306 P2=PP2*P11
20830 RH02=((P2/P11)**G2)*RH01
20840 X=P11/RH01
20850 38 U22=G4*(X-P2/RH02)*32.*144.
20860 IF(U22)40,39,39
20870 40 PRINT*,U22 NEGATIVE*,U22
20880 STOP
20890 39 U2=SQRT(U22)*JSIGN
20900 DDM=U2*RH02*AA(I,1)*DDT
20910 DM=DM+DDM
20920 WW=WW+P11*DDM/(G3*RH01)
20925C
20930 500 C3NTIVUE
20940 P30=P30+(G-1.)*WW/V3
20950 RH030=RH030+DM/V3
20960 99 C3NTIVUE
20970 T3=TT
20980 P3=P30-P3
20982 IF(TIME.GE.TC)L3=.TRUE.
20983 RETURN
20984 9 R=TIME=1.0-R
20985 PD=PD0*RR*RR*EXP(-2.0*R)
20986 PS=PS0*RR*EXP(-R)
20987 P3=PS+PD*(AFROVT-0.4*ASIDE)
20990 999 RETURN
21020 END
30000 SUBROUTINE RESIST (ENTRY)
30010C THIS SUBROUTINE DETERMINES THE RESISTANCE FUNCTION,
30020C TRANSFORMATION FACTORS, AND REACTION COEFFICIENTS; AND
30030C SUPPLIES THE REACTION VALUES FOR SPECIFIC DEFLECTIONS
30040C
30050 C0443V <INC,LDTYPE,KRF,<RAND,TIME,I,Y(100),QT,QU,YU,YFAIL,
```

PROGRAM STBEAM (CONTINUED)

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30052+ ZLR,HB,BFLG,TFLG,TW,FDYS,ICASE,KPLATE,C3MP,H,L,BP,ES,
30054+ HPC,HS,FPC,FDC,EC,RS,FDYR,AS,D,APS,BP,QAREA,PAREA,Z4SC,
30055+ ZLW,VL1,VL2,VLABS,V4MF(2),XL3AD,NDLSLA9,
30056+ W,PB,CJ,L3C,S,ZLEV,CD,PSA,P03,PR,PEXT,PC,TC,TU,DELAY,
30057+ 'R0,2),PP(R0,2),REAC(R0,2),INDEX(2),PR(2),
30058+ 4400,V3,L1,AA(B,2),VV(B),AFRNT,ASIDE,G,G2,G3,G4,PP2,DT
30100 REAL RISTEEL,ICC,ICS,IAVS,<<1><2>,<S1>,<S2
30120 GJT9(4,500,45),IENTRY
30130C
30140C * ENTRY 1: INPUT BEAM DATA *
30150 4 PRINT 615
30160 READ,ZLR,HB,BFLG,TFLG,TW,FDYS,ICASE,KPLATE,C3MP
30165 ZLEV=ZLR/12.0
30170 ICASE4=ICASE-4
30180 ES=29E6
30185 BP=0 $ HP=0
30190 IF(<KPLATE.E2.0)GOT2 11
30200 PRINT 616
30210 READ,BP,HP
30220 11 IF(<C3MP.E).0)GOT3 13
30230 PRINT 618
30240 READ,4BP,HS,FPC
30250 FDC=1.25*FPC
30260 EC=57619.0*SORT(FPC) $ EC<IP=EC/1000.0
30270 V=ES/EC
30280C * EFFECTIVE WIDTH OF CONCRETE *
30290 BS=ZLB/4.0
30300 IF(BS.GT.BFLG+16.0*HS)BS=BFLG+16.0*HS
30310 IF(ICASE.E2.5)GOT3 13
30320 PRINT 619
30330 READ,FDYR,AS,D,APS,BP
30340 13 CONTINUE
30350 QAREA=ZLB+BFLG
30360 PAREA=PAREA+QAREA
30370C
30380C * OUTPUT BEAM DATA *
30390 PRINT 620,ICASE,ZLR,49,BFLG,TFLG,TW,FDYS
30400 IF(<KPLATE.E2.0)PRINT 625,BP,HP
30410 IF(<C9MP.E2.0)GOT2 15
30420 PRINT 630,HB,HS,BS,FPC,FDC,EC,IP
30430 IF(ICASE.GT.5)PRINT 635,AS,D,FDYR,APS,BP
30440 AS=AS*BS/12.0 $ APS=APS*BS/12.0
30450 15 CONTINUE
30460C
30470C * DETERMINE BEAM PROPERTIES INDEPENDENT OF FDY *
30500 CALL TRANS(ICASE4,ZLW,ZLWSE,ZLWFE,ZLYMP,VL1S,VL2S,
30510+ VL1F,VL2F,VL1P,VL2P)
30530C * PROPERTIES FOR STEEL SECTION *
30540 AFLG=BFLG+TFLG
30550 AB=2.0*AFLG+TW*(HB-2.0*TFLG)
30560 AP=HP*RP
30570 ASTEEL=AB+AP
30575 ZMASS=490.0*ASTEEL*ZLB/1724.0
30580 1982.0*(AFLG+TFLG)*3/12.0+AFLG*(0.5*(HB-TFLG))**2
30590+ +TW*(HB-2.0*TFLG)**3/12.0
30600 YS=0.5*(HB-HP)*AP/ASTEEL
30610 YTS=0.5*HB*HP-YS
30620 YTS=0.5*HB*YS
30630 HI=HBP+YTS
30640 ISTEEL=IB+AB*YS+BS*HP+3/12.0+AP*(YBS-0.5*HP)**2
30650 ZS=AFLG*(HB-TFLG)+TW*((0.5*HB-TFLG)**2-YS*YS)+AP*(YBS-0.5*HP)
30670 IF(<C3MP.E2.1)RETURN
30680 ZCC=ZS $ ZCS=ZS
30690 ICC=ISTEEL $ ICS=ISTEEL
30700 RETURN
30710C
30750C * ENTRY 3: DETERMINE BEAM PROPERTIES DEPENDENT ON FDY *
30760 45 IF(<C3MP.E2.1)GOT3 79
30770C * PROPERTIES FOR COMPOSITE SECTION *
30780 ASR=AS*FDYR/FOYS $ APSR=APS*FDYR/FOYS
30790C
30800C * NEGATIVE MAMENT SECTION *
30810 IF(ICASE.E2.5)GOT3 50
30820 YC=(ASR*(HS-D)+APSR*(HS-D)+(ASTEEL*41))/(ASR+APSR+ASTEEL)

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PROGRAM STBEAM (CONTINUED)

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30830 ICS=ASR*(YC-HS+U)**2+APSR*(YC-HS+DP)**2+ISTEEL
30840+   +ASTEEL*(HBP*YTS-YC)**2
30850 ASTELP=0.5*(ASTEEL-ASR+APSR)
30860 ZTC=TFLG*(ASTELP-AFLG)/TW
30870 E=YTS+HBP+HS+D
30880 EP=YTS+HBP+HS+DP
30890 EPP=YTS-0.5*TFLG
30900 EPPP=EPP-0.5*ZTC
30910 ZCS=ASR+E+APSR+EP+2.0*AFLG+EPP+2.0*(ASTELP-AFLG)+EPPP
30930C
30940C * POSITIVE MEMENT SECTION *
30950C * ELASTIC MEMENT 3F INERTIA *
30960 SO TERM1=Y*ASTEEL/BS
30970 YC=-TERM1+SQRT(TERM1*TERM1+2.0*TERM1*H1)
30980 IF(YC.GT.HS) G0T2 55
30990C * NEUTRAL AXIS IN SLAB *
31000 ICC=ISTEEL+ASTEEL*(H1-YC)**2+BS*YC**3/(3.0*N)
31010 G0T2 60
31020C * NEUTRAL AXIS BELOW SLAB *
31030 55 YC=(BS*HS*HS+2.0*N*ASTEEL*H1)/(2.0*(RS*HS+N*ASTEEL))
31040 ICC=ISTEEL+ASTEEL*(H1-YC)**2+BS*HS**3/(12.0*N)
31050+   +BS*HS*(YC-0.5*HS)**2/V
31060C * PLASTIC SECTION MODULUS *
31070 60 BSU=0.85*FDC*BS/FDYS
31090 ZC=ASTEEL/BSU
31100 IF(ZC.GT.HS) G0T2 65
31110 IF(ZC.GT.HBP) G0T2 62
31120C * NEUTRAL AXIS IN SLAB (ABOVE BEAM FLANGE) *
31130 ZCC=ASTEEL*(YTS+HBP-0.5*ZC)
31140 G0T2 75
31150C * NEUTRAL AXIS BELW BEAM FLANGE (ENCASED BEAM) *
31160 62 ACU=BSU*HS
31170 E=YTS+HBP-0.5*HS
31180 G0T2 68
31190C * NEUTRAL AXIS BELW SLAB *
31200 65 ACU=BSU*HS
31210 E=YTS+HBP-0.5*HS
31220 68 ASTELP=0.5*(ASTEEL-ACU)
31230 IF(ASTELP.GT.4FLG) G0T2 70
31240C * NEUTRAL AXIS IN BEAM FLANGE *
31250 ZC=HBP+ASTELP/BFLG
31260 ZCC=ACU+E*2.0*ASTELP*(YTS-0.5*(ZC-HBP))
31270 G0T2 75
31280C * NEUTRAL AXIS IN BE : WEB *
31290 70 ZC=(ASTELP-AFLG)/TW+FB-TFLG
31300 EP=YTS-0.5*TFLG
31310 EPP=EP-0.5*(ZC-HBP)
31320 ZCC=ACU+E*2.0*AFLG+EP+L-J*(ZC-AFLG)+EPP
31330 75 CONTINUE
31350C
31360C * DETERMINE RESISTANCE * - S (TOTAL) FOR BEAM *
31370C * (0 IS IN UNITS OF LB, L- IN LB/IN. AND Y IN INCHES ) *
31375 78 CALL CREF(ICASE4,ASS,PSS,AF,BF,ICC,ICS)
31390 IF(ICASE.GT.5) G0T2 80
31390C
31400C CASE 5
31410 QU=ZCC*FDYS/(BSS*ZLB)
31420 K1=ES*ICC/(ASS*ZLB**3)
31430 YU=QU/K1
31440 QFAIL=2S*FDYS/(BSS*ZLB)
31450 YFAIL=26.4*QFAIL/(ES*ISTEEL/(ASS*ZLB**3))
31460 G0T2 100
31470C
31480C CASES 6 AND 7
31490 80 Q1=ZCS*FDYS/(BF*ZLB)
31500 1AVG0.5*(ICC+ICS)
31510 K1=ES*ICS/(AF*ZLB**3)
31520 Y1=Q1/K1
31530 IF(ICASE.EQ.7) G0T2 85
31540 QU=FDYS*(ZCC+ZCS)/(BSS*ZLB)
31550 QFAIL=2.0*FDYS*ZS/(BSS*ZLB)
31555 QSI=FDYS*ZS*12.0/ZLB
31556 KSI=ES*ISTEEL*384.0/ZLB**3
31560 G0T2 90

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PROGRAM STBEAM (CONTINUED)

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31570 95 QJ=F0YS*(ZCC+0.5*ZCS)/(BSS*ZLB)
31580 QFAIL=1.5*FDYS*ZS/(BSS*ZLB)
31595 QSI=FDYS*ZS/ZLB
31596 KSI=ES*ISTEEL*155.0/ZLB**3
31598 90 <K2=ES*AVG(ASS*ZLB**3)
31600 YJ=YI+(QJ-QSI)/K2
31630 YSI=QSI/KSI
31640 <S2=ES*ISTEEL/(ASS*ZLB**3)
31660 YSU=YSI+(QFAIL-QSI)/<S2
31670 YFAIL=26.4*(YSI+YSU*(1.0-QSI/QFAIL))
31680C
31690C * ADJUST RESISTANCE CURVE FOR SLAB DEAD LOAD *
31730 100 QDL=QUL*SLAB+490.0*ASTEEL*ZLB/1728.0
31730 YDL=QDL/<K1
31740 IF(<KRDYD.NE.1)PRINT 633,QDL,YDL
31750 YI=YI-YDLS YU=YU-YDLS YFAIL=YFAIL-YDL
31760 QI=QI-QDLS QJ=QJ-QDLS QFAIL=QFAIL-<QDL
31770C
31780C * INPUT RESISTANCE CURVE *
31790 IF(KRDYD.EQ.1)GOTO 335
31800 PRINT 650
31810 IF(ICASE.EQ.5)GOTO 320
31820 PRINT 660,QI,YI
31830 320 PRINT 660,QJ,YU,QFAIL,YFAIL
31840 335 C9NTINUE
31850 RETURN
31860C
31870C * ENTRY 2: DETERMINE THE RESISTANCE (TOTAL) OF THE BEAM
31880C      AS A FUNCTION OF Y(I) *
31890C
31900 500 IF(Y(I).GT.YFAIL)GOTO 560
31910 IF(Y(I).GT.YU)GOTO 540
31920 IF(ICASE.GT.5)GOTO 520
31930C
31940C * ELASTIC RANGE - CASE 5 *
31950 ZKL4=ZLMSE
31960 VL1=VL1S $ VL2=VL2S
31970 QT=Y(I)*<K1
31980 RETURN
31990C
32000 520 IF(Y(I).GT.YI)GOTO 530
32010C
32020C * ELASTIC RANGE - CASES 6 & 7 *
32030 ZKL4=ZLMFE
32040 VL1=A1F $ VL2=VL2F
32050 QT=Y(I)*<K1
32060 RETURN
32070C
32080C * ELASTIC-PLASTIC RANGE - CASES 6 & 7 *
32090 530 ZLM=ZLMSE
32100 VL1=VL1S $ VL2=VL2I
32110 QI=QI*<K2*(Y(I)-YI)
32120 RETURN
32130C
32140C * PLASTIC RANGE - ALL CASES *
32150 540 ZKL4=ZLMP
32160 VL1=VL1P $ VL2=VL2P
32170 QT=QI*(Y(I)-YI)*(QFAIL.-QII)/(YFAIL.-YI)
32180 RETURN
32190C
32200C * BEAM COLLAPSED (SET RESISTANCE TO SMALL VALUE) *
32210 560 QT=1E-10
32220 RETURN
32230C
32240 615 F0RMAT(/>INPUT LB,HQ,RF,TF,TW,FDYS,ICASE,<PLATE,<C3MP>)
32250 616 F0RMAT(/>INPUT SP & HP (F0R BJT34 COVER PLATE)*,*)
32260 618 F0RMAT(/>INPUT HRP,HS,F'C (F0R C3MP3 SITE REAM)*,*)
32270 619 F0RMAT(/>INPUT FDYR & AS,D,APS,UP AT REAM SUPPORT*,*)
32280 620 F0RMAT(/>PROPERTIES OF STEEL SUPPORT BEAM -- SUPPORT TYPE V3.0,
32290*   I2.7,*  LR =*,F6.1,*  IV.0,*  SX,*  HR =*,F6.2,*  IV.0,*  6X,*  RF =*,F6.3,*  IV.0,*  4X,
32300*   F7.3,*  IV.0,*  /,*  TF =*,F6.3,*  IV.0,*  SX,*  TW =*,F6.3,*  IV.0,*  4X,
32310*   &FDYS =*,FR.1,*  PSI*)
32320 625 F0RMAT(/>  RP =*,F6.2,*  IV.0,*  SX,*  HP =*,F6.3,*  IV.0,*  F6.2,*  IV.0,*  4X,
32330 630 F0RMAT(/>  H,P =*,F6.2,*  IV.0,*  SX,*  HS =*,F6.2,*  IV.0,*  4X,

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PROGRAM STBEAM (CONTINUED)

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32340+   * AS =*,F6.2,* IN.*,/,* F'C =*,F7.1,* PSI    FUC ==
32350+   F7.1,* PSI*,5X,*EC ==,F7.1,* (SI*)
32360 635 F3RMAT// AS ==,F7.4,* S0 IN./FT*,6X,*D ==,F7.3,* IN.*/,
32370+   4X,*FDYR ==,F8.1,* PSI*,/,*,A'S ==,F7.4,* S0 IN./FT*,4X,
32380+   *D' ==,F7.3,* IN.*/
32390 633 F3RMAT//**D ==,F10.2,* LR    YDL ==,F8.4,* IN.*/
32400 650 F3RMAT//**L3AD-DEFLECTION CURVE/,/ 5X,*DT (LR)      Y (IN.)
32410 660 F3RMAT(F12.2,F12.4)
32420 END
40000 SJHR3UTINE CIEF (ICASE4,ASS,BSS,AF,BF,ICEN,ISUP)
40010C
40120C THIS SUBROUTINE DETERMINES DEFLECTION AND MOMENT COEFFICIENTS
40030C FOR TEE BEAMS WITH VARIABLE MOMENT OF INERTIA
40040C
40050 REAL ICEN,ISUP
40060C CASE 5. ONE-WAY SIMPLY SUPPORTED WALL
40070  ASS=5.0/384.0
40080  BSS=0.125
40090 RI=ISUP/ICEN
40100  G0T9(270,60,70),ICASE4
40110C
40120C CASE 6. ONE-WAY FIXED END WALL
40130 60 BF=(-.00953+.03213*RI)/(.211+.239*RI)
40140  AF=-.00132+.01169*RI-BF*(.0223+.1028*RI)
40150 RETURN
40160C
40170C CASE 7. ONE-WAY PREPARED CANTILEVER WALL
40180 70 RF=(-.0109+.0304*RI)/(.1926+.1407*RI)
40190  AF=-.00439+.00342*RI+BF*(.08333+.02033*RI)
40200 270 RETIRV
40210  END
50000 SJBRUTINE TRANS (ICASE4,ZKL4,ZKL4SE,ZKL4FE,ZKL4P,VL1S,VL2S,
50010+  VL1F,VL2F,VL1P,VL2P)
50020C
50030C THIS SUBROUTINE DETERMINES TRANSFORMATION FACTORS AND
50040C DYNAMIC REACTION COEFFICIENTS FOR ONE-WAY BEAMS
50050C
50060C ALL CASES
50070 ZKL4SE=0.78
50080 ZKL4P=0.66
50090 VL1S=0.107
50100 VL2S=0.393
50110 VL1P=0.125
50120 VL2P=0.375
50130 G0T9(300,310,320),ICASE4
50140C
50150C CASE 5
50160 300 ZKL4=ZKL4SE
50170  VL1=VL1S
50180  VL2=VL2S
50190 RETIRV
50200C
50210C CASE 6
50220 310 ZKL4FE=0.77
50230  VL1F=0.136
50240  VL2F=0.364
50250  G0T9 330
50260C
50270C CASE 7
50280 320 ZKL4FE=0.78
50290  VL1F=0.165
50300  VL2F=0.459
50310 330 ZKL4=ZKL4FE
50320  VL1=VL1F
50330  VL2=VL2F
50340 RETIRV
50350 END
70000  SJROUTINE RANDM (IENTRY)
70010C THIS SUBROUTINE INPUTS MEAN AND STANDARD DEVIATIONS FOR RANDOM
70020C VARIABLES; GENERATES RANDM VALUES; AND CONTROLS REQUIRED
70030C NUMBER OF CASES TO BE RUN; AND OUTPUTS FINAL RESULTS AND SUMMARY
70040C
70050 COMIN <INC,LOTTYPE,<RF,<RAND,TIME>,I,Y(100),OT,OU,YU,YFAIL>
70052+  ?LB+HB,BFLG,TFLG,TH,FDYS,ICASE,<PLATE,<C3MP,HP,BP,ES>
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PROGRAM STBEAM (CONTINUED)

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700540 HPC, HS, FPC, FDC, SC, DS, FDYD, AS, D, APC, DP, DAREA, PAREA, PMASS,
700550 /KL1, VL1, VL2, VSLARC, NAMEF(2), KLJAD, TOLSLAR,
700560 , JPJ, C3, L3C, S, ZLE, CD, PSJ, PDT, PR, PEXT, PC, TC, TO, DISPLAY,
700570 TT(R0,2), PP(R0,2), RFAC(R0,2), INDEX(2), BH(2),
700580 NWIV, RH19, VR, L1, AA(4,2), JV(4), AFPRINT, ASIDE, G, G2, G3, G4, PP2, DT
70080 CMM43V /RAVD/ TIMEC
70090 DIMENSION CH125(7), CH1975(7), TDIST(7)
70100C
70110C VALUES FOR 97.5% (F=19,24,27,34,39,44,49)
70120 DATA CH125/.4643, .5167, .5533, .5325, .6065, .6267, .6400/
70130 DATA CH1975/1.729, 1.640, 1.576, 1.524, 1.490, 1.459, 1.433/
70140 DATA TDIST/2.093, 2.064, 2.045, 2.022, 2.022, 2.016, 2.010/
70150C
70160 GBT3(S, SO, 70), LENTRY
70170 S=XNORM1(-1.0, 0.0, 1.0)
70180C INITIALIZE RANDOM NUMBER GENERATOR
70190 PRINT //,*INPUT VRAND*,,
70200 READ, VRAND
70210 D9 47 I=1,VRAND
70220 XDUMMY=XNORM1(0.0, 0.0, 1.0)
70230 47 CONTINUE
70240 INDEX=0$ SPSJ=0$ SSPSD=0
70250 ICHECK=20
70260C
70270C INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
70275 IF(LJC.EQ.2)GBT3 30
70280 PRINT 87
70290 READ, SMEAN, SSD
70300C STEEL (VBN-COMPOSITE AND COMPOSITE) SUPPORT BEAMS
70310 30 PRINT 86
70320 READ, FDYSMEV, FDYSSD
70330 IF((C3MP.EQ.1.AND.ICASE.GT.5)GBT3 40
70340 IF(LJC.EQ.1)PRINT 96
70345 IF(LJC.NE.1)PRINT 95
70350 RETURN
70355 40 PRINT 88
70360 READ, FDYR4EN, FDYRSO
70365 IF(LJC.EQ.1)PRINT 97
70370 IF(LJC.NE.1)PRINT 98
70375 RETURN
70380C GENERATE RANDOM VALUES
70385 50 FDYS=XNORM1(0.0, FDYSMEV, FDYSSD)
70390 IF(FDYS.LE.0)GBT3 50
70395 51 IF((C3MP.NE.1.BR.AND.ICASE.EQ.5)GBT3 59
70400 55 FDYR=XNORM1(0.0, FDYRMEV, FDYRSO)
70405 56 IF(FDYR.LE.0.AND.FDYRMEV.NE.0)GBT3 55
70410 58 CONTINUE
70415 IF(LJC.EQ.2.DR.SMEAN.EQ.0)GBT3 65
70420 60 S=XNORM1(0.0, SMEAN, SSD)
70425 61 IF(S.LE.0)GBT3 60
70430 65 INDEX=INDEX+1
70435 RETURN
70440C SUM VALUES OF PSJ AND PSJ**2 FOR USE IN STATISTICAL ANALYSIS
70445 70 SPSJ=SPSJ+PSJ
70450 75 SSPSD=SSPSD+PSJ*PSJ
70460C
70470C INPUT FINAL RESULTS
70475 76 IF((C3MP.EQ.1.AND.ICASE.GT.5)GBT3 79
70480 IF(LJC.EQ.1)PRINT 92,FDYS,S,PSJ,TIMEC
70485 IF(LJC.NE.1)PRINT 90,FDYS,PSJ,TIMEC
70490 GBT3 40
70495 73 IF(LJC.EQ.1)PRINT 93,FDYS,FDYR,S,PSJ,TIMEC
70500 74 IF(LJC.NE.1)PRINT 94,FDYS,FDYR,PSJ,TIMEC
70505 80 IF(ICHECK.LT.1)CHECK)RETURN
70510C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PSJ
70515 81 INDEX
70520 82 MEAN=SPSJ/ZN
70525 83 SD=SQRT((SSPSD-ZN*(ZMEAN*ZN*FAN))/ZN)
70530 84 SDERR=SD/(SQRT(ZN-1))
70535 85 CHECK IF MAXIMUM OF 50 PSA SAMPLES OBTAINED
70540 86 IF(INDEX.EQ.50)GBT3 62
70550C CHECK IF +/- CONFIDENCE INTERVAL FOR MEAN PSJ VALUE IS

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PROGRAM STBEAM (CONCLUDED)

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70240      IF(STDEERR>T01STDC((INDEX-15)/5))/MEAN.GE.0.10)GOTO 61
70350C
70360C CONFIDENCE INTERVAL IS WITHIN 10% -- DETERMINE UPPER LIMIT OF
70370C 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
70380C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
70390    62 SD=SD/(SQR(CHI25((INDEX-15)/5)))
70400    63 CHECK IF MAXIMUM OF 50 PT SAMPLES RETAINED
70410      IF(INDEX<50)GOTO 63
70420    64 CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL IS MEAN
70430    65 DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
70440      IF((SD-SD)/ZARAV).GE.0.10)GOTO 61
70450C
70460C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 95%
70470C PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES RETAINED
70480C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
70490C
71000C AND 10% AND 90% PROBABILITY VALUES
71010    63 ZMEAN=MEAN-STDEERR*T01STDC((INDEX-15)/5)
71020    64 ZMEAN=MEAN+STDEERR*T01STDC((INDEX-15)/5)
71030    65 SOL=SQRT(CHI275((INDEX-15)/5))
71040    P10=ZMEAN-1.242*SD
71050    P10L=ZMEAN-1.242*SD
71060    P10U=ZMEAN+1.242*SD
71070    P20=ZMEAN+1.232*SD
71080    P20L=ZMEAN+1.232*SD
71090    P90=ZMEAN+1.232*SD
71100    P90L=ZMEAN+1.232*SD
71110    P90U=ZMEAN+1.232*SD
71120
71130C INPUT STATISTICAL PARAMETERS IN INCIDENT COLLAPSE PROBLEMS
71140      PRINT 100,ZMEAN,(MEAN,ZMEAN,100),SD,S1,P10,P10L,P10U,
71150      P90,P90L,P90U
71160      PRINT 105,INDEX,STDEERR
71170      *111 993
71180
71190C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 95%
71200
71210C VAL INC -- THEREFORE RETAIN 5 ADDITIONAL SAMPLES
71220      61 ICHECK=ICHECK+5
71230      RETURN
71240C
71250    46 FORMAT//(*INPUT MEAN AND STANDARD DEVIATION = 12.0D2,2)
71260    47 F1FORMAT//(*INPUT MEAN AND STANDARD DEVIATION = 12.0D2,2)
71270    48 F1FORMAT//(*INPUT MEAN AND STANDARD DEVIATION = 12.0D2,2)
71280    49 F1FORMAT(24.2,F13.2,F14.3)
71290    50 F1FORMAT(24.2,F11.2,F10.2,F14.3)
71300    51 F1FORMAT(24.2,F11.2,F10.2,F14.3)
71310    52 F1FORMAT(24.2,F11.2,F10.2,F14.3)
71320    53 F1FORMAT(24.2,F11.2,F10.2,F14.3)
71330    54 F1FORMAT(24.2,F11.2,F10.2,F14.3)
71340    55 F1FORMAT(///,4X,4F7.3), 4X,4F7.3,4X,4F7.3,4X,4F7.3,4X,4F7.3
71350    56 F1FORMAT(///,4X,4F7.3), 4X,4F7.3,4X,4F7.3,4X,4F7.3,4X,4F7.3
71360    57 F1FORMAT(///,4X,4F7.3), 4X,4F7.3,4X,4F7.3,4X,4F7.3,4X,4F7.3
71370    58 F1FORMAT(///,4X,4F7.3), 4X,4F7.3,4X,4F7.3,4X,4F7.3,4X,4F7.3
71380    59 VAL IS LOWER UPPER,4E14,4E14,4E14,4E14,4E14,4E14,4E14,4E14
71390    60 1.2*SD//,*, STANDARD DEVIATION = 12.0D2,2D2,2
71400    61 1.06 PROBABILITY VAL = 12.0D2,2D2,2
71410    62 0.93 PROBABILITY VAL = 12.0D2,2D2,2
71420    63 F1FORMAT(///,4X,4F7.3), 4X,4F7.3,4X,4F7.3,4X,4F7.3
71430    64 F1FORMAT(///,4X,4F7.3), 4X,4F7.3,4X,4F7.3,4X,4F7.3
71440
71450    65 STOP END
71460    FUNCTION Z01STDC(X)
71470    66 Z01STDC=20.20
71480    67 X=ZARAV*(1.0)
71490    68 X=ZARAV*(1.0)
71500    69 X=ZARAV*(1.0)
71510    70 Z01STDC=20.20
71520    71 Z01STDC=20.20
71530    72 Z01STDC=20.20
71540    73 Z01STDC=20.20
71550    74 Z01STDC=20.20
71560    75 Z01STDC=20.20
71570    76 Z01STDC=20.20
71580    77 Z01STDC=20.20
71590    78 Z01STDC=20.20
71600    79 Z01STDC=20.20
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71620    81 Z01STDC=20.20
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71660    85 Z01STDC=20.20
71670    86 Z01STDC=20.20
71680    87 Z01STDC=20.20
71690    88 Z01STDC=20.20
71700    89 Z01STDC=20.20
71710    90 Z01STDC=20.20
71720    91 Z01STDC=20.20
71730    92 Z01STDC=20.20
71740    93 Z01STDC=20.20
71750    94 Z01STDC=20.20
71760    95 Z01STDC=20.20
71770    96 Z01STDC=20.20
71780    97 Z01STDC=20.20
71790    98 Z01STDC=20.20
71800    99 Z01STDC=20.20
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71850    104 Z01STDC=20.20
71860    105 Z01STDC=20.20
71870    106 Z01STDC=20.20
71880    107 Z01STDC=20.20
71890    108 Z01STDC=20.20
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71910    110 Z01STDC=20.20
71920    111 Z01STDC=20.20
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71940    113 Z01STDC=20.20
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71960    115 Z01STDC=20.20
71970    116 Z01STDC=20.20
71980    117 Z01STDC=20.20
71990    118 Z01STDC=20.20
72000    119 Z01STDC=20.20
72010    120 Z01STDC=20.20
72020    121 Z01STDC=20.20
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72040    123 Z01STDC=20.20
72050    124 Z01STDC=20.20
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72080    127 Z01STDC=20.20
72090    128 Z01STDC=20.20
72100    129 Z01STDC=20.20
72110    130 Z01STDC=20.20
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72130    132 Z01STDC=20.20
72140    133 Z01STDC=20.20
72150    134 Z01STDC=20.20
72160    135 Z01STDC=20.20
72170    136 Z01STDC=20.20
72180    137 Z01STDC=20.20
72190    138 Z01STDC=20.20
72200    139 Z01STDC=20.20
72210    140 Z01STDC=20.20
72220    141 Z01STDC=20.20
72230    142 Z01STDC=20.20
72240    143 Z01STDC=20.20
72250    144 Z01STDC=20.20
72260    145 Z01STDC=20.20
72270    146 Z01STDC=20.20
72280    147 Z01STDC=20.20
72290    148 Z01STDC=20.20
72300    149 Z01STDC=20.20
72310    150 Z01STDC=20.20
72320    151 Z01STDC=20.20
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72340    153 Z01STDC=20.20
72350    154 Z01STDC=20.20
72360    155 Z01STDC=20.20
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72380    157 Z01STDC=20.20
72390    158 Z01STDC=20.20
72400    159 Z01STDC=20.20
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72490    168 Z01STDC=20.20
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72790    198 Z01STDC=20.20
72800    199 Z01STDC=20.20
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72830    202 Z01STDC=20.20
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72870    206 Z01STDC=20.20
72880    207 Z01STDC=20.20
72890    208 Z01STDC=20.20
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72920    211 Z01STDC=20.20
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72970    216 Z01STDC=20.20
72980    217 Z01STDC=20.20
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73010    220 Z01STDC=20.20
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74780    397 Z01STDC=20.20
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74880    407 Z01STDC=20.20
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75480    467 Z01STDC=20.20
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75580    477 Z01STDC=20.20
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75600    479 Z01STDC=20.20
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75620    481 Z01STDC=20.20
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75660    485 Z01STDC=20.20
75670    486 Z01STDC=20.20
75680    487 Z01STDC=20.20
75690    488 Z01STDC=20.20
75700    489 Z01STDC=20.20
75710    4
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**FLAT**

**Flat Slab or Flat Plate**

PROGRAM FLAT

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01000 PROGRAM FLAT(INPUT,OUTPUT)
01010C THIS ROUTINE IS THE CONTROLLING ROUTINE FOR THE PROGRAM
01020C USED IN THE ANALYSIS OF REINFORCED CONCRETE FLAT SLABS
01030C
01050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,IY(100),Q,QU,YU,YFAIL,
01052+ ZLS,HS,FDY,AREA,ZMASG,ZKLM,VS1,VS2,PS0,PD0,PF,PEXT,PC,TC,T0,
01054+ P0,DELAY,S
01060 DIMENSION A(60),V(80),T(80),VS'80),QQ(80),PNC(80)
01070 COMMON /SHEAR/ ISHEAR,JSHEAR,V,L,EAR,EMEB
01080 COMMON /RAND/ TIMEC
01100C
01110C * READ TITLE AND CONTROL PARAMETERS *
01120 S PRINT 67
01130 READ 68,TITLE
01140 PRINT 65
01150 READ,KINC,LDTYPE,KRF,KRAND
01160 DELAY=0
01180 CALL RESIST(1)
01190 CALL FORCE(1)
01200 IF(KRF.EQ.0)GOTO 14
01210 CALL FILL(PINT,1)
01260 14 IF(KRAND.NE.1)GOTO 35
01270 CALL FORCE(4)
01280 CALL RANDOM(1)
01290 34 CALL RANDOM(2)
01300 35 CALL RESIST(3)
01310C
01320C MINIMUM, MAXIMUM, AND STARTING VALUES ARE DETERMINED FOR CASES
01330C WHERE THE LOAD CAUSING INCIPENT COLLAPSE IS TO BE FOUND
01340 13 IF(KINC.EQ.0)GOTO 23
01350 PF=QU
01360 PFMAX=0
01370 PFMIN=PF/2.0
01380 GOTO 20
01390 16 PF=(PFMIN+PFMAX)/2.0
01400 20 CALL FORCE(2)
01410 23 IF(KRF.EQ.0)GOTO 24
01420 CALL FILL(PINT,2)
01430C
01440C INITIALIZE VALUES FOR YETA METHOD (BETA=1/6) AND COMPUTE VALUES
01450C FOR FIRST TIME INTERVAL ASSUMING ELEMENT INITIALLY AT REST
01460 24 I=1
01470 TIME=0
01480 V(1)=0 S Y(1)=0
01490 DELTA=0.001
01495 JSHEAR=0
01500 IF(KRF.NE.1)GOTO 30
01510 27 IF(TIME.GE.(DELAY-.00001))GOTO 30
01520 TIME=TIME+DELTA
01530 CALL FILL(PINT,3)
01540 GOTO 27
01640 30 CALL RESIST(2)
01650 A(1)=0.0 S VS(1)=0.0
01660 T(1)=TIME
01L "
01L * PROCEDURE FOR ALL SUBSEQUENT TIME INTERVALS
01L I=I+1
01710 IF(I.LT.81)GOTO 11
01720 PRINT 98,TIME
01730 98 FORMAT(/I=81/ TIME =*,F6.3,* FAILURE ASSUMED TO NOT OCCUR)
01740 GOTO 8
01750 11 TIME=TIME+DELTA
01760 T(.)=TIME
01770 A(.)=A(I-1)
01775 IF(KRF.NE.0)GOTO 10
01750 CALL FORCE(3)
01790 PNC(:)=PEXT
01800 GOTO 2
01830 10 CALL FILL(PINT,3)
01890 PNC(:)=PINT
01910 2 CONTINUE
01920 DO 8 J=1,10
01920 Y(.)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
01940 CALL RESIST(2)

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PROGRAM FLAT (CONTINUED)

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01960 4      ANEW=AREA*(PN(I)-0)/(ZMASS*ZKLM)
01970      ADELTA=ANEW-A(I)
01980      A(I)=ANEW
01985 IF(ANEW.EQ.0)PRINT *1985*,TIME,PN(I),0,ZMASS,ZKLM,Y(I),A(I-1)
01990      IF(ABS(ADELTA/(ANEW+IE-10)).LT.0.01)GOTO 9
02000 8      CONTINUE
02010      A(I)=ANEW-ADELTA/2.0
02020 PRINT 80,TIME,P,A(I),Y(I)
02030 9      CONTINUE
02040      Y(I)=Y(I-1)+DELTA*V(I-1)+DELTA*DELTA*(A(I-1)/3.+A(I)/6.)
02050      V(I)=V(I-1)+DELTA*(A(I)+A(I-1))/2.0
02060      VS(I)=AREA*(VS1*PN(I)+VS2*0)
02070      QU(I)=0
02080 IF(JSHEAR.EQ.1.AND.VS(I).GT.VSHEAR)JSHEAR=1
02085 IF(JSHEAR.EQ.1.AND.MEM5.EQ.0)GOTO 7
02090C
02100C: CHECK FOR MAXIMUM DEFLECTION OR FAILURE
02110C: IF MAXIMUM DEFLECTION REACHED, WALL DID NOT FAIL.
02120      IF(Y(I).LE.Y(I-1).AND.PN(I).LE.PN(I-1))GOTO 6
02130      IF(Y(I).LT.0)GOTO 6
02135      IF(Y(I).GE.YFAIL)GOTO 7
02140      IF(TIME-DELAY.GE.0.010)DELTA=0.002
02160      IF((TIME-DELAY.GE.0.020)DELTA=0.005
02170      IF((TIME-DELAY.GE.0.100)DELTA=0.010
02180      IF((TIME-DELAY.GE.0.500)DELTA=0.050
02190C: IF FAILURE DEFLECTION REACHED, ELEMENT FAILED
02210      GOTO 1
02220C
02230C: INTERVAL HALVING PROCEDURE TO DETERMINE LOAD CAUSING INCIPIENT
02240C: COLLAPSE FOR CASES WHERE DESIRED
02250C: ELEMENT DID NOT FAIL -- SET PFMIN TO PF
02260 6      CONTINUE
02280      IF(KINC.EQ.0)GOTO 18
02290 36      PFMIN=PF
02300 IF(PFMAX.GT.0)GOTO 16
02310      PF=2.0*PF
02320      GOTO 20
02330C: ELEMENT FAILED -- SET PFMAX TO PF
02340 7      CONTINUE
02350      TIMEC=TIME
02370      IF(KINC.EQ.0)GOTO 18
02380 37      PFMAX=PF
02390C: CHECK TO SEE IF LOAD RANGE IS WITHIN DESIRED ACCURACY
02400 17      IF((PFMAX-PFMIN)/PFMIN.GT.0.01)GOTO 16
02410      IF(KRAND.NE.-1)GOTO 15
02420      CALL RANDOM(3)
02430      GOTO 34
02440C
02450C: OUTPUT DATA INCLUDES THE MAXIMUM DEFLECTION AND TIME OF
02460C: OCCURANCE FOR A NON-FAILING ELEMENT OR THE TIME AND VELOCITY
02470C: AT COLLAPSE FOR A FAILING ELEMENT. OPTIONAL OUTPUT IS THE
02480C: ENTIRE BEHAVIOR TIME-HISTORY.
02490C
02500C: OUTPUT LOAD DATA
02510 18      CALL FORCE(4)
02520C
02530C: OUTPUT FINAL RESULTS
02535 IF(JSHEAR.EQ.1.AND.MEMB.EQ.0)GOTO 40
02540 IF(Y(I).LT.YFAIL)PRINT 70,Y(I),T(I)
02550 IF(Y(I).GE.YFAIL)PRINT 71,T(I),V(I)
02560 IF(JSHEAR.EQ.1)PRINT 96
02570 GOTO 42
02577C
02578C CHECK TO SEE IF ENTIRE TIME-HISTORY IS DESIRED
02579 40 PRINT 97,T(I),V(I)
02580 42 PRINT 72
02590 READ,M
02600      IF(M.EQ.0)GOTO 25
02680 PRINT 76,(T(J),PN(J),A(J),V(J),Y(J),QU(J),VS(J),J=1,I)
02690 25 PRINT 77
02700 GOTO 5
02710C
02720 67 FORMAT(*INPUT TITLE*,*)
02730 68 FORMAT(A59)

```

PROGRAM FLAT (CONTINUED)

```

02740 TO F1 FORMAT(/*NO FAILURE - MAX DEFLECTION OF*,F6.2,
02750+   * IN. REACHED AT*,F7.3,* SEC*)
02760 71 F1,XA1/*FAILURE OCCURRED AT*,F7.3,* SEC (FINAL VELOCITY **,
02770+   * IN./SEC*)*/
02780 72 F6,XA7 /* S TIME HISTORY DESIRED (YES=1, NO=0)**,*/
02830 76 F1,* TIME PRESSURE ACCELERATION VELOCITY *
02840+   *,*,F12NT QU VS*,*/,
02850+   (F1.3,-9.3,F12.1,F12.2,F12.4,F10.2,F9.0))
02860 77 FORMAT(//,*-----*)
02870 80 FORMAT(/*ACCELERATION NOT CONVERGING AT TIME **,F6.3,
02880+   * SEC (PF **,F7.3,* PS1*)/* A(I) SET EQUAL T0*/,
02890+   F8.1,* (AVG OF LAST 2 ITERATIONS)/* Y(I) **,
02900+   F8.4,* IN.*)
02910 85 FORMAT(/*INPUT KINC,LDTYPE,KRF,KRAND(I=RAND0M)*,*/
02930 90 F0KFORMAT(/*ARE REACTIONS TO BE OUTPUT TO FILE (Q=NO,I=YES)*,*/
02940 95 FORMAT(/*INPUT NAME OF SLAB REACTION DATA FILE*),
02945 96 FORMAT(/*SHEAR FAILURE -- TENSILE MEMBRANE RESISTANCE*,
02946+   * CONTINUED*)
02948 97 FORMAT(/*SHEAR FAILURE AT*,F7.3,* SEC (FINAL VELOCITY **,
02949+   F7.2* IN./SEC*)*/
02950C
02960 999 STOP
02970 END

10000 SUBROUTINE FORCE(IENTRY)
10010C THIS SUBROUTINE INPUTS THE LOAD PARAMETERS AND DETERMINES
10020C THE LOAD AT A GIVEN TIME FOR THE FOLLOWING LOAD TYPES:
10030C 1. IDEALIZED BLAST LOAD (FRONT OR SIDE FACE)
10050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,
10052+ ZLS,HS,FDY,AREA,ZMASS,ZKLM,V31,V52,PS0,P0,PR,P,PC,TC,T0,
10054+ P0,DELAY,S
10060 DIMENSION TT(20),PP(20)
10120C
10130 IF(LDTYPE,EQ,5)GOTB 500
10140C
10150 GOTB(100,200,300,4),IENTRY
10160C
10170C * INPUT LOAD PARAMETERS *
10180C LOCATION 1. FRONT FACE LOADING (USED IN ROOM-FILLING PROCEDURE)
10190 100 W=1000.0 S P0=14.7 S C0=1120.0
10200 IF(KRF,NE,1)GOTB 102
10210 LOC=1
10220 IF(KRAND,EQ,1)RETURN
10230 PRINT 600
10240 READ,S
10250 GOTB 105
10260C LOCATION 2. TOP FACE LOADING
10265 102 CD=0 S LOC=2
10270 ZLEN=ZLS/12.0
10275 105 IF(CD,NE,1)RETURN
10280 PRINT 610
10285 READ,PS0
10290 PR=2.0*PS0*(7.0*P0+4.0*PS0)/(7.0*P0+PS0)
10295 GOTB 215
11000C
11010C CALCULATE LOAD PROPERTIES FOR GIVEN PEAK PRESSURE
11030 200 GOTB(205,210),LOC
11040 205 PS0=(PR-14.0*P0+SQRT(196.0*P0*P0+196.0*P0*PR+PR*PR))/16.0
11050 GOTB 215
11060 210 PS0=PR
11070 215 P0=(2.5*PS0+PS0)/(7.0*P0+PS0)
11080 U=C0*SQRT(1.0*(6.0*PS0)/(7.0*P0))
11090 T0=W=0.3333/(2.2399*0.1886*PS0)
11100 GOTB(220,225),LOC
11110 220 TC=3.0*S/U
11120 PC=PS0*(1-TC/T0)*EXP(-TC/T0)+P0*(1-TC/T0)**2*EXP(-2*TC/T0)
11130 CD=1.0
11140 RETURN
11150 225 TA=ZLEN/U
11160 TA2=TA/2.0
11170 TA2T0=TA2/T0
11180 PA=PC0*(1-TA2T0)*EXP(-TA2T0)+CD*P0*(1-TA2T0)**2*EXP(-2*TA2T0)
11190 RETURN
12000C
12010C CALCULATE LOAD

```

PROGRAM FLAT (CONTINUED)

```

12030 300 G0T0(305,310),L0C
12040 305 TTO=TIME/T0
12050 IF(TIME.GT.TC)G0T0 320
12060 P=PC*(TC-TIME)*(PR-PC)/TC
12070 RETURN
12080 310 TTO=(TIME-TA2)/T0
12090 IF(TIME.GT.TA)G0T0 320
12100 P=PA*TIME/TA
12110 RETURN
12120 320 IF(TTO.GE.-1.0)G0T0 330
12130 P=PS0*(1-TTO)+EYP*(-TTO)*CD*PD0*(1-TTO)**2*EXP(-2*TTO)
12150 RETURN
12160 330 P=0
12170 RETURN
13000C
13010C PRINT LOAD DATA
13020 4 IF(KINC.EQ.0)G0T0 400
13030 PRINT 640,LDTYPE
13040 G0T0 410
13050 400 PRINT 645,LDTYPE
13060 410 CONTINUE
13070 415 G0T0(420,425),L0C
13080 420 PRINT 650
13090 G0T0 430
13100 425 PRINT 655
13110 430 PRINT 660,W,PO,CO
13120 IF(KRAND.NE.0)RETURN
13130 G0T0(435,440),L0C
13140 435 PRINT 665,S,TC,PR
13150 G0T0 445
13160 440 PRINT 670,ZLEN,T,A,PA
13170 445 PRINT 675,U,T0,CD,PS0,PD0
13180 RETURN
13500C
13510C LOAD TYPE 5 -- ARBITRARY LOAD SHAPE
13520 500 G0T0(510,520,530,540),IENTRY
13530C
13540C INPUT LOAD DATA
13550 510 PRINT 580
13560 READ,NP0INT,(TT(J),PP(J),J=1,NP0INT)
13570 FACTOR=1.0
13580 IF(KINC.EQ.0)G0T0 518
13590 PMAX=PP(1)
13600 D0 515 J=2,NP0INT
13610 515 IF(PP(J).GT.PMAX)PMAX=PP(J)
13620 518 PX=PP(2)-PP(1)
13630 TX=TT(2)-TT(1)
13640 JJ=1
13650 RETURN
13660C
13670C CALCULATE MAXIMUM LOAD
13680 520 FACTOR=PR/PMAX
13690 G0T0 518
13700 RETURN
13710C
13720C CALCULATE LOAD
13730 530 IF(TIME.LE.TT(JJ+1))G0T0 535
13740 JJ=JJ+1
13750 PX=PP(JJ+1)-PP(JJ)
13760 TX=TT(JJ+1)-TT(JJ)
13765 IF(TX.EQ.0)TX=1E-10
13770 G0T0 530
13780 535 P=FACTOR*(PP(JJ)+(TIME-TT(JJ))*PX/TX)
13790 RETURN
13800C
13810C PRINT LOAD DATA
13815 540 IF(KINC.EQ.1)PRINT 640,LDTYPE
13820 IF(KINC.EQ.0)PRINT 645,LDTYPE
13825 PRINT 690
13830 D0 545 J=1,NP0INT
13840 P=FACTOR*PP(J)
13850 545 PRINT 695,TT(J),P
13860 RETURN
14000C

```

PROGRAM FLAT (CONTINUED)

```

14010 600 FORMAT(/INPUT S*)
14020 610 FORMAT(/INPUT PS*)
14070 640 FORMAT(/LOAD CAUSING INCIPIENT FAILURE IS AS FOLLOWS:,
14071* /,SX,*LOAD TYPE NUMBER*,I2)
14080 645 FORMAT(/PROPERTIES OF LOAD ACTING ON WALL ARE AS FOLLOWS:,
14081* /,SX,*LOAD TYPE NUMBER*,I2)
14090 650 FORMAT(8X,*FRONT FACE*)*
14100 655 FORMAT(SX,*SIDE OR TOP FACE*)*
14110 660 FORMAT(10X,0W **,F8.1,* KT    PB **,F6.2,* PSI      CB **,
14111*   F7.1,* FPS*)
14120 665 FORMAT(10X,S **,F6.1,* FT      TC **,F6.3,* SEC      PR **,
14121*   F7.3,* PSI*)
14130 670 FORMAT(10X,0L **,F6.1,* FT      TA **,F6.3,* SEC      PA **,
14131*   F7.3,* PSI*)
14140 675 FORMAT(10X,0U **,F7.1,* FPS    TO **,F6.3,* SEC      CD **,
14141*   F5.1,/,8X,0PS0 **,F7.3,* PSI    PD0 **,F7.3,* PSI*)
14150 680 FORMAT(/INPUT NUMBER OF LOAD POINTS AND THE TIME AND *
14151*   *PRESSURE AT EACH POINT*)
14160 690 FORMAT(/10X,0TIME      PRESSURE*)
14170 695 FORMAT(F15.3,F12.2)
15000 END
20000 SUBROUTINE FILL(P3,IENTRY)
20010C COMPUTES AVERAGE AIR PRESSURE IN ROOM DUE TO BLAST WAVE
20020C INCIDENT HEAD-ON UPON FRONT WALL.
20030C
20050 COMMON KINC,LDTYPE,KRF,KRND,TIME,II,Y(100),Q,QU,YFAIL,
20052* ZLS,HS,FDY,AREA,ZMASS,ZKLM,VSI,VSE,PS0,PD0,PR,PEXT,PC,TC,TO,
20054* P0,DELAY,S
20080 DIMENSION AA(8,2),NN(8)
20090 LOGICAL L1,L2,L3
20095C
20100 GOT0(10,13,11),IENTRY
20105C
20110 10 PRINT 700
20120 READ,NWIN,V3
20122 RH00=0.076 $ LI=.FALSE.
20123 DELAY=1E10
20125 AT=0 $ AFRONT=0 $ ASIDE=0
20130 DO 16 I=1,NWIN
20140 PRINT 710,I
20150 READ,AA(I,1),NN(I),AA(I,2)
20160 AA(I,2)=AA(I,2)/1000.0
20161 AT=AT+AA(I,1)
20162 M>NN(I) $ GOT0(12,14,14),M
20163 12 AFRONT=AA(I,1)
20164 GOT0 18
20165 14 ASIDE=ASIDE+AA(I,1)
20170 18 IF(AA(I,2).LT.DELAY)DELAY=AA(I,2)
20175 AFRONT=AFRONT/AT $ ASIDE=ASIDE/AT
20180 700 FORMAT(/INPUT NUMBER OF OPENINGS AND ROOM VOLUME (CF)*,)
20200 710 FORMAT(/INPUT AREA (SQ FT),LOCATION CODE & DELAY(MSEC) */
20210*   *FOR WIND*,I2,*)
20230 G=1.4 $ G2=1./G $ G3=1.-G2 $ G4=2./G3
20240 PPE=.1912
20250 C=SQRT(G*P0+32.*144./RH00)
20260 TAU=2.**(V3**(.1./3.))/C
20270 DT=TAU/4.0
20280 RETURN
20310C
20320 13 P30=PB
20330 TT=0.8 TB=0.
20340 RH030=RH00
20350 L2=.FALSE. $ L3=.FALSE.
20360 RETURN
20370C
20380 11 IF(L1)GOT0 52
20385 IF(L2.A.L3)GOT0 9
20390 52 DDT=(TIME-TB)*0.5
20395 ISTOP=2
20400 53 IF(DDT.LT.DT)GOT0 51
20410 50 DDT=0.5*DDT
20415 ISTOP=2*ISTOP
20420 GO TO 53
20430 51 CONTINUE

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PROGRAM FLAT (CONTINUED)

```

20440 D0 99 I=1,ISTOP
20450 TI=T0+I*DDT
20460 IF(TT.GT.T0)G0 T0 99
20470 DM=0. S WW=0. S NW=0
20480 D0 500 K=1,NWIN
20490 M=NN(K) S DLY=AA(K,2)+0.000001
20500 IF(DLY.GE.TI)G0 T0 500
20510 G0T0(15,16,16),M
20520 15 CDF=1.0
20530 IF(TT-TC)20,20,21
20540 20 P11=(TC-TT)*(PR-PC)/TC+PC
20550 P11=P11+P0
20560 G0 T0 30
20570 16 CDF=-0.4
20600 21 M=TT/T0 S RR=1.-R
20610 PD=PD0*RR*RR*EXP(-2.*R)
20620 PS=PS0*RR*EXP(-R)
20630 P11=PS+CDF*PD
20640 P11=P11+P0
20650 30 RH01=RH00*((P11/P0)**G2)
20660 IF(P11-P30)36,36,37
20670 36 JSIGN=-1
20680 L2=.TRUE.
20770 303 P2=P11
20780 RH02=((P2/P30)**G2)*RH030
20790 X=P30/RH030
20800 G0 T0 36
20810 37 JSIGN=+1
20820 306 P2=PP2*P11
20830 RH02=((P2/P11)**G2)*RH01
20840 X=P11/RH01
20850 38 U22=G4*(X-P2/RH02)*32.+144.
20860 IF(U22,40,39,39
20870 40 PKINT,*U22 NEGATIVE*,U22
20880 STOP
20890 39 U2=SQRT(U22)*JSIGN
20900 DDM=U2*RH02*AA(K,1)*DDT
20910 DM=DM+DDM
20920 WW=WW+P11*DDM/(G3*RH01)
20925C
20930 500 CONTINUE
20940 P30=P30+(G-1.)*WW/V3
20950 RH030=RH030+DM/V3
20960 99 CONTINUE
20970 T0=TT
20980 P3=P30-P0
20982 IF(TIME.GE.1C)L3=.TRUE.
20983 RETURN
20984 9 R=TIME/T0 S RR=1.0-R
20985 PD=PD0*RR*RR*EXP(-2.0*R)
20986 PS=PS0*RR*EXP(-R)
20987 P3=PS+PD*(AFR0NT-0.4*ASIDE)
20990 999 RETURN
21020 END
30000 SUBROUTINE RESIST(IENTRY)
30010C * THIS SUBROUTINE DETERMINES THE RESISTANCE FUNCTION,
30020C TRANSFORMATION FACTORS, AND REACTION COEFFICIENTS FOR
30030C A REINFORCED CONCRETE SLAB
30040C
30050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,I,Y(100),Q,QU,YU,YFAIL,
30052C ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PS0,PD0,PR,PEXT,PC,TC,T0,
30054C P0,DELAY,S
30070 COMMON /SHEAR/ ISHEAR,JSHEAR,VSHEAR,MEMB
30080 REAL N,IG,MU(4),IC(4),IC,IAVG,KE
30090 DIMENSION AS(4),APS(4),D(4),DP(4)
30100C
30110 G0T0(4,500,45),IENTRY
30120C
30130C * ENTRY 1. INPUT AND ECHO SLAB AND REINFORCEMENT PROPERTIES *
30140 4 PRINT 600
30150 READ,ZLS,C2,HS,FPC,FDY,ZLD,HD
30160 FDC=1.25*FPC
30170 EC=57619.0*SQRT(FPC)
30180 ES=29E6

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PROGRAM FLAT (CONTINUED)

```

30190 AREA=ZLS*ZLS-C2*C2
30200 ECKIP=EC/1000.0 S ESKIP=ES/1000.0
30210 PRINT 670
30220 DO 8 I=1,4
30230 PRINT 610,I
30240 8 READ,AS(I),D(I),APS(I),DP(I)
30242 PRINT 720
30244 READ,ISHE4R
30250 PRINT 711
30260 READ,MEMB
30270 IF(MEMB.EQ.0)GOTO 15
30280 PRINT 706
30290 READ,ASCS
30300 ASCS=ASCS/12.0
30310C
30320C * DETERMINE PROPERTIES INDEPENDENT OF FDY *
30330 15 N=ES/EC
30340 ZMASS=150.0*AREA*HS/(150.0*1728.0)
30350 PRINT 620,ZLS,C2,HS,FPC,FDC,ECKIP,FDY,ESKIP,ZLD,HD
30360 PRINT 630
30370 DO 110 I=1,4
30380 P=AS(I)/(12.0*D(I)) S PP=APS(I)/(12.0*D(I))
30390 PRINT 640,I,AS(I),P,D(I),APS(I),PP,DP(I)
30400C * CHANGE UNITS OF REINFORCEMENT FROM SQ IN./FT TO SQ IN./IN.
30410 AS(I)=AS(I)/12.0 S APS(I)=APS(I)/12.0
30420 110 CONTINUE
30430 IG=HS*3/12*(N-1)*(AS(I)*(D(I)-HS/2)**2+APS(I)*(HS/2-D(I))**2)
30460 RETURN
30470C
30480C * ENTRY 2. DETERMINE WALL PROPERTIES DEPENDENT ON FDY *
30490 45 CALL MEMENT(FDC,FDY,ES,N,0,1,0,AS,APS,D,DP,MU,ICR,IC)
30500 SUMMP=MU(1)+MU(2)+MU(3)+MU(4)
30510 IAVB=0.5*(IG+ICR())
30520C
30530C * DETERMINE RESISTANCE CURVE FOR SLAB *
30540 QU=4.0*(ZLS*C2)*SUMMP/ZLS*AREA
30550 KE=189.0*EC*IAVG/(ZLS-0.5*C2)**4
30560 YU=QU/KE
30570 YT=999.9
30590 YFAIL=YU*0.1/(AS(I)/D(I))
30600 IF(YFAIL.GT.30.0*YU)YFAIL=30.0*YU
30610 IF(MEMB.NE.1)GOTO 25
30620C * TENSILE MEMBRANE BEHAVIOR *
30630 20 TS=ASCS*FDY
30640 YT=QU*ZLS*ZLS/(20.25*TS)
30642 QT=QU
30644 IF(YT.LE.YFAIL)GOTO 22
30646 YT=YFAIL
30648 QT=20.25*YT*TS/(ZLS*ZLS)
30650 22 IF(YFAIL.LT.0.15*ZLS)YFAIL=0. -ZLS
30660 QFAIL=0.15*20.25*TS/ZLS
30670C
30680C * ADJUST LOAD-DEFLECTION CURVE FOR SLAB DEAD LOAD *
30690 25 QDL=150.0*HS/1728.0
30700 YDL=QDL/KE
30710 QU=QU-QDL QT=QT-QDL QFAIL=QFAIL-QDL
30720 YU=YU-YDL YT=YT-YDL YFAIL=YFAIL-YDL
30730 IF(KRAND.NE.1)PRINT 633,QDL,YDL
30740C
30750C OUTPUT LOAD-DEFLECTION CURVE
30760 IF(KRAND.EQ.1)GOTO 335
30770 PRINT 650
30780 'F:MEMS-EQ.1)GOTO 332
30790 PRINT 660,QU,YU,QU,YFAIL
30800 GOTO 335
30805 332 IF(QT.NE.QU)GOTO 333
30810 PRINT 660,QU,YU,Q1,YT,QFAIL,YFAIL
30812 GETB 335
30814 333 PRINT 660,QU,YU,QU,YT,QT,YT,QFAIL,"FAIL
30820 335 CONTINUE
30822C
30824C * CALCULATE MINIMUM SHEAR RESISTANCE *
30826 VPS=3.0*SQRT(FPC)
30828 Bd=C2*D(4)

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PROGRAM FLAT (CONTINUED)

```

30830 QSHR1=4.0*B0*(HS+HD)*VPS/(ZLS*ZLS-B0*B0)
30832 B0=ZLD*(D(4)-HD)
30834 QSHR2=4.0*B0*HS*VPS/(ZLS*ZLS-B0*B0)
30836 VBS=2.0*SQRT(F'C)
30838 QSHR3=HS*VBS/(0.5*(ZLS-C2)-D(3))
30840 QSHEAR=QSHR1
30841 IF(KRAND.NE.1)PRINT 957,QSHR1,QSHR2,QSHR3
30842 IF(QSHR2.LT.QSHEAR)QSHEAR=QSHR2
30844 IF(QSHR3.LT.QSHEAR)QSHEAR=QSHR3
30846 QSHEAR=QSHEAR-QDL
30850 IF(KRAND.NE.1)PRINT 695,QSHEAR
30852 VSHEAR=QSHEAR*AREA*0.25
30860 RETURN
30870C
30880C * ENTRY 3. DETERMINE THE RESISTANCE AS A FUNCTION OF Y(I) *
30885 500 IF(JSHEAR.EQ.1)G0T0 520
30890 IF(Y(I).GT.YU)G0T0 510
30900C
30910C ELASTIC RANGE
30920 Q=Y(I)*KE
30930 ZKLM=0.64
30940 VS1=0.04 S VS2=0.21
30950 RETURN
30960C
30970C PLASTIC RANGE
30980 510 IF(Y(I).GT.YFAIL)G0T0 530
30990 ZKLM=7.0/12.0
31000 VS1=1.0/28.0 S VS2=6.0/28.0
31010 IF(Y(I).GT.YT)G0T0 520
31020 Q=QU
31030 RETURN
31040C
31050C TENSILE MEMBRANE RANGE
31060 520 Q=QT*(Y(I)-YT)*(QFAIL-QT)/(YFAIL-YT)
31070 RETURN
31080C
31090C FAILURE (SET RESISTANCE TO VERY SMALL VALUE)
31100 530 Q=1E-11
31110 RETURN
31120C
31130 600 FORMAT(*INPUT LS,C2,1_7PC,FDY,LD,HD*,1)
31140 610 FORMAT(*INPUT AS,D,A'S,1_7PC FOR SECTION#,I2,1)
31150 620 FORMAT(*PROPERTIES OF R/C SLAB OR PLATE*,1
31160 * LS ==,F6.1,* IN. C2 ==,F6.1,* IN.0,6X,0HS ==,
31170 * F6.1,* IN.0,6X,0 F'C ==,F7.1,* PSI FDC ==,F7.1,
31180 * PSI0,5X,0EC ==,F7.1,* KSI0,5X,0 FDY ==,F8.1,* PSI0,
31190 * 3X,0ES ==,F8.1,* KSI0,5X,0 LD ==,F6.1,* IN. HD ==,F6.1,
31191 * IN.0)
31200 630 FORMAT(*REINFORCEMENT VALUES*/ SECTON AS (P)*,
31210 * 9X,0D,8X,0,S (P')*,8X,0D'*,,/8X,0(SQ IN./FT)*,,10X,
31220 * *(IN.) (SQ IN./FT)*,,10X,* (IN.)*)
31230 633 FORMAT(*QDL ==,F6.2,* PSI YDL ==,F8.2,* IN.0)
31240 640 FORMAT(I5,F11.4,* (*,F6.4,*),F9.3,F10.4,* (*,F6.4,*),F9.3)
31250 650 F1(MAT(*LOAD-DEFLECTION CURVE*,4X,00 (PSI) Y (IN.)*)
31260 660 FORMAT(F9.2,F12.4)
31270 670 FORMAT(IH )
31280 695 FORMAT(*QSHEAR ==,F9.2,* PSI*)
31290 706 FORMAT(*INPUT CONTINUOUS REINFORCEMENT (SQ IN./FT)*,1)
31300 711 FORMAT(*IS TENSILE MEMBRANE TO BE INCLUDED *,1
31310 * (0=N;1=YES)*,1)
31320 720 FORMAT(*IS SHEAR FAILURE TO BE CONSIDERED*,1
31330 * (0=N;1=YES)*,1)
31338 957 FORMAT(*QSHR1 ==,F10.3,,*QSHR2 ==,F10.3,,*QSHR3 ==,F10.3)
31340 END
35000 SUBROUTINE MMENT(FDC,FDY,ES,N,PV,B,AS,APS,D,DP,MU,ICR,IC)
35010C THIS SUBROUTINE DETERMINES THE ULTIMATE MOMENT CAPACITY AND
35020C CRACKED MOMENT OF INERTIA FOR REQUIRED SECTIONS
35040 REAL K1,K2,K3,KUD,N,IC,ICTBT,NU(4),ICR(4),AS(4),APS(4),D(4),DP(4)
35050C
35060C1 DETERMINE VALUES OF CONCRETE PARAMETERS
35070 45 K1=0.94-FDC/26E3
35080 K2=0.50-FDC/8E4
35090 K3=(3900+0.35*FDC)/(3E3+0.82*FDC-FDC*FDC/26E3)
35100 EPSC=0.004-FDC/65E5

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PROGRAM FLAT (CONTINUED)

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35150C: **** DETERMINE ULTIMATE MOMENT CAPACITY AND CRACKED ****
35160C: * MENT OF INERTIA FOR REQUIRED SECTIONS *
35170C: **** MENT OF INERTIA FOR REQUIRED SECTIONS *
35180C: **** MENT OF INERTIA FOR REQUIRED SECTIONS *
35190C
35200 II=05 ICTOT=0
35210 D0 170 I=1..4
35215 MU(I)=0
35220 IF(AS(I).EQ.0)GOTO 170
35230 II=II+1
35240C: ALL PROPERTIES ARE COMPUTED FOR A WIDTH B
35250 TENS=AS(I)*FDY+PV
35260 IF(APS(I).LE.0)GOTO 150
35270C
35280C: WALL HAS COMPRESSION REINFORCEMENT
35290 C=K1*K3+FDC*B*DP(I)
35300 TERM1=0.5*(TENS/APS(I)+ES*EPSC)
35310 TERM2=ES*EPSC*(TENS-C)/APS(I)
35320C: DETERMINE LOCATION OF NEUTRAL AXIS
35330 IF(TENS.LC.C)GOTO 140
35340C
35350C: KUD > D'
35360 FPS=TERM1+K3+FDC/2.0-SQRT((TERM1-K3+FDC/2.0)**2
35370+ -(TERM2+ES*EPSC*K3+FDC))
35380C: F'S MUST BE <= FDY
35390 IF(FPS.LT.FDY)GOTO 130
35400 FPS=FDY
35410 130 TPS=APS(I)*(FPS-K3+FDC)
35420 KUD=(TEN-TPS)/(K1*K3+FDC*B)
35430 MU(I)=(TENS-TPS)*(D(I)-K2*KUD)+TPS*(D(I)-DP(I))
35440 ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2
35450+ +(N-1)*APS(I)*(KUD-DP(I))**2
35460 GOTO 152
35470C
35480C: KUD < D'
35490 140 FPS=-TERM1+SQRT(TERM1**2-TERM2)
35500C: F'S MUST BE <= FDY
35510 IF(FPS.LT.FDY)GOTO 145
35520 FPS=FDY
35530 145 TERM3=TENS+APS(I)*FPS
35540 KUD=TERM3/(K1*K3+FDC*B)
35550 MU(I)=TERM3*(D(I)-K2*KUD)-APS(I)*FPS*(D(I)-DP(I))
35560 ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2+N*APS(I)*(DP(I)-KUD)**2
35570 GOTO 152
35580C
35590C: WALL HAS NO COMPRESSION REINFORCEMENT
35600 150 KUD=TENS/(K1*K3+FDC*B)
35610 MU(I)=TENS*(D(I)-K2*KUD)
35620 ICR(I)=B*KUD**3/3.0+N*AS(I)*(D(I)-KUD)**2
35630C
35640 152 ICTOT=ICTOT+ICH(I)
35650 170 CONTINUE
35660C
35670C: DETERMINE AVERAGE CRACKED MOMENT OF INERTIA
35680 175 IC=ICTOT/II
35690 RETURN
35700 END
70000      SUBROUTINE RANDOM (IENTRY)
70010C THIS SUBROUTINE INPUT MEAN AND STANDARD DEVIATIONS FOR RANDOM
70020C VARIABLES; GENERATES RANDOM VALUES; AND CONTROLS REQUIRED
70030C NUMBER OF CASES TO E N; AND OUTPUTS FINAL RESULTS AND SUMMARY
70040C
70050 COMMON KINC,LDTYPE,KRF,KRAND,TIME,II,Y(100),Q,QU,YU,YFAIL,
70052+ ZLS,HS,FDY,AREA,ZMASS,ZKLM,VS1,VS2,PSB,FD8,PR,PEXT,PC,TC,TO,
70054+ P0,DELAY,S
70070 COMMON /SHEAR/ ISHEAR,JSHEAR,VSHEAR,MEMB
70080      COMMON /RAND/ TIMEC
70090 DIMENSION CHI25(7),CHI975(7),TDIST(7)
70100C
70110C VALUES FOR 97.5% (P=19,24,29,34,39,44,49)
70120      DATA CHI25/.4688,.5167,.5533,.5825,.6065,.6267,.6440/
70130      DATA CHI975/1.7295,1.6402,1.5766,1.5884,1.4903,1.4591,1.4331/
70140      DATA TDIST/2.093,2.064,2.045,2.032,2.022,2.016,2.010/
70150C

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PROGRAM FLAT (CONTINUED)

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70160      G0T0(5,50,70),IENTRY
70170      S XDUMMY=XNORM1(-1.0,0.0,1.0)
70180C INITIALIZE RANDOM NUMBER GENERATOR
70190      PRINT,/,*INPUT NRAND*,  

70200      READ,NRAND
70210      DO 47 I=1,NRAND
70220      XDUMMY=XNORM1(0.0,0.0,1.0)
70230      47 CONTINUE
70240      INDEX=0$  SPS0=0$  SSP0=0
70250      ICHECK=20
70260C INPUT MEAN AND STANDARD DEVIATION FOR RANDOM VARIABLES
70275      IF(KRF.EQ.0)G0T0 30
70280      PRINT 87
70290      READ,SMEAN,SSD
70310C REINFORCED CONCRETE WALLS
70320      30 PRINT 86
70330      READ,FDYMEAN,FDYS0
70340      IF(KRF.EQ.1)PRINT 96
70345      IF(KRF.EQ.0)PRINT 97
70350      RETURN
70360C GENERATE RANDOM VALUES
70370      50 FDY=XNORM1(0.0,FDYMEAN,FDYS0)
70380      IF(FDY.LE.0)G0T0 50
70385      IF(KRF.EQ.0)G0T0 65
70390      60 S=XNORM1(0.0,SMEAN,SSD)
70400      IF(S.LE.0)G0T0 60
70410      65 INDEX=INDEX+1
70420      RETURN
70430C SUM VALUES OF PS0 AND PS0**2 FOR USE IN STATISTICAL ANALYSIS
70440      70 SPS0=SPS0+PS0
70450      SSPS0=SSPS0+PS0*PS0
70460C
70470C OUTPUT FINAL RESULTS
70480      76 IF(KRF.EQ.1)PRINT 92,FDY,S,PS0,TIMEC
70490      IF(KRF.EQ.0)PRINT 90,FDY,PS0,TIMEC
70500      77 IF(JSHEAR.EQ.1)PRINT 110
70510      IF(JSHEAR.NE.1)PRINT 120
70520      80 IF(INDEX.LT.ICHECK)RETURN
70530C DETERMINE MEAN, STANDARD DEVIATION, AND STANDARD ERROR FOR PS0
70540      ZNB=INDEX
70550      ZMEAN=SPS0/ZNB
70560      SD=SQRT((SSPS0-ZNB*ZMEAN*ZMEAN)/ZNB)
70570      STDERR=SD/(SQRT(ZNB-1))
70580C CHECK IF MAXIMUM OF 50 PS0 SAMPLES OBTAINED
70590      IF(INDEX.EQ.50)G0T0 62
70600C CHECK IF 95% CONFIDENCE INTERVAL FOR MEAN PS0 VALUE IS
70610      IF(STDERR*TDIST((INDEX-15)/5)/ZHEAN.GT.0.10)G0T0 61
70620C
70630C CONFIDENCE INTERVAL IS WITHIN 10% - DETERMINE UPPER LIMIT OF
70640      62 95% CONFIDENCE INTERVAL FOR STANDARD DEVIATION
70650C PROBABILITY VALUE AND ITS 95% CONFIDENCE INTERVAL UPPER LIMIT
70660      63 SDU=SD/(SQRT(CHI25((INDEX-15)/5)))
70670C CHECK IF MAXIMUM OF 50 PS0 SAMPLES OBTAINED
70680      IF(INDEX.EQ.50)G0T0 53
70690C CHECK IF UPPER VALUE OF 95% CONFIDENCE INTERVAL FOR STANDARD
70700C DEVIATION IS WITHIN 0.10*MEAN OF THE STANDARD DEVIATION
70710      IF(((SDU-SD)/ZMEAN).GT.0.10)G0T0 61
70720C
70730C 95% CONFIDENCE INTERVAL IS WITHIN 10% FOR BOTH MEAN AND 90%
70740      64 PROBABILITY VALUE -- THEREFORE SUFFICIENT SAMPLES OBTAINED
70750C DETERMINE 95% CONFIDENCE INTERVALS FOR MEAN, STANDARD DEVIATION
70760C
70770      65 71000C AND 10% AND 90% PROBABILITIES
70780      53 ZMEANL=ZMEAN-STDERR*TDIST((INDEX-15)/5)
70790      54 ZMEANU=ZMEAN+STDERR*TDIST((INDEX-15)/5)
70800      55 SDL=SD/(SQRT(CHI1975((INDEX-15)/5)))
70810      56 P10=ZMEAN-1.282*SD
70820      57 P10L=ZMEAN-1.282*SDL
70830      58 P10U=ZMEAN+1.282*SDL
70840      59 P90=ZMEAN+1.282*SD
70850      60 P90L=ZMEAN-1.282*SDL

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PROGRAM FLAT (CONCLUDED)

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71090      P90=ZMEAN+1.282*SD
71100      P90U=ZMEAN+1.282*SDU
71110      P90L=ZMEAN+1.282*SDL
71120C
71130C OUTPUT STATISTICAL PARAMETERS OF INCIPENT COLLAPSE PRESSURE
71140      PRINT 100,ZMEAN,ZMEANU,ZMEANL,SD,SDL,SDU,P10,P10L,P10U,
71150      P90,P90L,P90U
71160      PRINT 105,INDEX,STDERR
71170      GOTO 999
71180C
71190C 95% CONFIDENCE INTERVAL IS NOT WITHIN 10% FOR BOTH MEAN AND 90
71200B
71210C VALUES -- THEREFORE OBTAIN 5 ADDITIONAL SAMPLES
71220      61 ICHECK=ICHECK+5
71230      RETURN
71240C
71270      86 FORMAT(//INPUT MEAN AND STANDARD DEVIATION FOR FDY*)
71280      87 FORMAT(//INPUT MEAN AND STANDARD DEVIATION FOR S*)
71290      90 FORMAT(F9.1,F10.2,F14.3,*)
71310      92 FORMAT(F9.1,F11.2,F10.2,F14.3,*)
71350      96 FORMAT(//,5X,*FDY*,9X,*S*,8X,*PS0*,6X,*COLLAPSE TIME*)
71355      97 FORMAT(//,4X,FDY,9X,PS0,4X,*COLLAPSE TIME*)
71360      100 FORMAT(//,11X,*STATISTICAL PROPERTIES OF INCIPENT PS0*,
71370      //,39X,*95% CONFIDENCE LIMITS*,//,7X,*ITEM*,18X,
71380      *VALUE      LOWER      UPPER*,//,* MEAN*,F29.2,
71390      2F12.2,/* STANDARD DEVIATION*,F15.2,2F12.2,/*
71400      * 10% PROBABILITY VALUE*,3F12.2,/*
71410      * 90% PROBABILITY VALUE*,3F12.2)
71420      105 FORMAT(//,5X,*NUMBER OF OBSERVATIONS  *,I3,/,5X,
71430      *STANDARD ERROR =.F5.2)
71440      110 FORMAT(5X,*:SHEAR FAILURE*)
71445      120 FORMAT(* *)
71450      999 STOPS END
71460 FUNCTION XNORM1(X,A,B)
71470 IF(X)10,20,20
71480 10 X0=RANF(-1.0)
71490 20 X1=RANF(0.0)
71500 X2=RANF(0.0)
71510 Y=SQRT(-2.0*ALOG(X1))*(COS(6.283184*X2))
71520 XNORM1=A+Y*B
71530 RETURN
71540 END

```

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## NOMENCLATURE

Area of concrete section, sq in.	$p_h$	Lateral static soil pressure, psf
Area of tension steel in reinforced concrete slab per unit width, sq in./in.	$p_r$	Reflected overpressure, psi
Area of window, sq ft	$p_{s,0}$	Peak incident overpressure, psi
Width of cross section, in.	$P_T$	Total lateral load acting on wall, lb
Width of wall between edge of door opening and areaway support wall, in.	$P_v$	Total vertical force per unit width, lb/in.
Distance from compressive face of reinforced concrete slab to centroid of tension steel, in.	$q$	Unit resistance for uniformly loaded member, psi
Compressive strength of 6- by 12-in. concrete cylinder, psi	$s$	Clearing distance, ft
Dynamic compressive strength of concrete, psi	$t_s$	Clearing time, front face, sec
Dynamic yield strength of reinforcing steel, psi	$t_o$	Duration of positive overpressure, sec
Ultimate compressive strength of masonry unit wall, psi	$t_w$	Thickness of wall, in.
Modulus of rupture, psi	$V$	Total shear per unit width, lb/in.
Static yield strength of reinforcing steel, psi	$(V_c)_s$	Total shear capacity per unit width at support, lb/in.
Soil depth, ft	$(V_c)_u$	Unit shear capacity per unit width at support, psi
Lateral soil coefficient	$w$	Weapon yield
Span length, in.	$\gamma$	Unit weight, pcf
Horizontal length (width) of wall, in.	$\sigma$	Unit weight of soil, pcf
Vertical length (height) of wall, in.	$\phi$	Coefficient of flexure
Bending moment per unit width, in.-lb/in.		
Ultimate moment capacity per unit width, in.-lb/in.		
Steel ratio, tension steel		
( $\sigma$ ) Unit pressure exerted against any surface varying with time, psi		