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TEST OF TANDEM PONTOONS, 150 - 200
POUND CAPACITY EACH, PROTOTYPES OF
25 TON MODEL

4 FEBRUARY 1948

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U. S. NAVY EXPERIMENTAL DIVING UNIT

NAVAL GUN FACTORY

WASHINGTON, D. C.

Project No. - SRD 1299/48; Priority "A"

Title - TEST OF TANDEM PONTOONS, 150 - 200 POUND CAPACITY EACH, PROTOTYPES OF 25 TON MODEL.

G.G. MOLUMPHY
Commander, USN
Officer in Charge

OBJECT

The object of this experiment is to test prototypes of 25 ton collapsible pontoons, designed to act in groups of three in tandem or singly, with regard to their strength, durability, case of handling, maximum load and their characteristics under various loads and conditions.

METHOD

The pontoons to be tested were of a rated capacity of 150-200 pounds each. They were manufactured by the Goodyear Tire and Rubber Company on contract number 45173. The date of their manufacture was May 1947.

They were about 36 inches from the top ring to the bottom shackle, deflated. The pontoon had twelve shrouds of about 1/16 inch wire connected to four circular rings which in turn were picked up by a shackle. This shackle carried the load. Leading up from this same shackle was the load transmitting wire. It led to a plate on top of the pontoon which had a ring to fit the shackle of the next pontoon. This wire cable was designed to transmit the load to the next pontoon. The shrouds were secured to the bottom of the pontoon at reinforced points.

Each pontoon was fitted with a 1/8 inch air connection and hose. The first nine tests were made with the pontoons connected in tandem. A single 5/16 inch I.D. hose was the source of air. The end of the air hose was fitted to receive the three 1/8 inch hoses. The air pressure used was about 90 lbs/in^2.

Test numbers 1 through 9 were carried out in the U.S. Naval Ordnance Tank at the U.S. Naval Gun Factory in about 50 feet of water. Tests number 1 through 8 were made with three pontoons connected in tandem under various loads and length of straps. The conditions are indicated on the data sheets. Test number 9 was made with one of the pontoons acting as an anchor and the controlling lift made by means of a 21 thread line passed through a shackle attached to the top pontoon. (See sketch on data sheet).

The remainder of the tests were made with a single pontoon in the open tank of the U.S. Naval School, Deep Sea Divers. Test number 10 was made by securing the pontoon to the ladder support near the bottom of the tank and then blowing the pontoon clean. The purpose of it was to determine the loss of buoyancy of a pontoon in a restricted position. The change of water volume in the tank before and after blowing was the resultant buoyant force.

The remainder of the tests were made to appraise the action of a pontoon in a position simulating a flooded compartment within a ship. The pontoon was to provide buoyancy by acting on the overhead of the compartment or deck. A weighted platform capable of being tilted to various angles of inclination was placed in the tank. The action of the pontoon under the platform at various angles and loads was observed.

Weights in all of these tests were added topside. Therefore, the underwater case of handling qualities were not evaluated.

DISCUSSION OF RESULTS

Tests 1 through 8 indicate that when three pontoons act in tandem, there is a large incidence of sinkings upon surfacing, regardless of load. The addition of a nine foot strap between pontoon 1 and 2 did not alter this characteristic as shown by test 7. In this discussion, the pontoons are numbered from the top down.

The placing of a 23 foot pendant between the weights and the third pontoon did little to reduce the sinkings. This was shown by tests 5 and 6. A similar reduction in total lift caused a marked improvement in the incidence of sinkings of a single pontoon. In most of the above cases, number 1 pontoon lost air partially or completely. In some of the lighter loads, pontoon 2 and 3 lost air also.

In all sinkings, the emerging velocity was sufficient to cause the top pontoon to lose its air. The air remaining in the pontoons was often greater than the weight. But the excess buoyancy was not great enough to counteract the kinetic energy of the descent.

The above is the basic reason for the high incidence of sinkings upon surfacing. The excess of buoyancy over the weight is the dominant force causing the velocity of the pontoons in their ascent. However, this excess buoyancy is not available in descent to check the fall of the weights because the air escaped from the top pontoons. This is an inherent fault of pontoons in tandem.

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In test number 4, the main wire on the shackle of number 3 pontoon slipped out of the clip. When this occured, two shrouds also failed. Some of the links were elongated. The bottom pontoon was replaced by a new one and the test was resumed. This occured when the weights were in the process of being lowered.

Test number 9 was made with one of the pontoons being used as an anchor for the standing part of the heaving line. The use of a 37 pound weight was necessary to keep it stable under no load conditions. The first lift was made with some difficulty. The standing and running parts of the line together with the air hose were badly snarled up. It was also evident that the bottom pontoon did not get enough air. The second lift was more successful. This time, the anchor pontoon was kept clear of the heaving line.

The above must be done because when the weight leaves the bottom, the anchor pontoon, the weights, the two lifting pontoons and the heaving line will tend to hang in a straight line, causing them to get snarled up.

Upon surfacing, the anchor pontoon was upset by the rising pontoons and lost its air. It is obvious that this system cannot be used to bring a load to the surface.

Since all the air hoses to the pontoons led from a common line, the top pontoons were filled first. This cannot be otherwise, unless separate lines are led to each pontoon or valves inserted in the line at the points of takeoff. The hoses were quite long and were coiled up. When air pressure was turned on, they expanded against the seizing. This cut off the air. The hoses furnished with the pontoons were too soft and too small. They kinked very easily. There was a tendency of the pontoons to spin somewhat. It is also evident that the anchor pontoon must be kept clear of the heaving line.

Test number 10 showed the comparison of capacities between the pontoon in a restricted and an unrestricted position. The pontoon was secured to a ladder support. Thus the ladder and the side of the tank restricted the pontoon. In this position, the buoyant force was 67% of the original. This was obtained by the change of the water levels of the tank before and after inflation.

In test number 11, a pontoon was placed under a steel table. It had no weights. The pontoon lodged in the corner. It inflated to its full capacity. But when it was pushed lightly, it rolled and lost its air.

In test number 12, the pontoon was inflated under a platform without any angle and no weight on the pontoon. It laid on the side and inflated to about 10% of its capacity. When the same test was performed with a 27 pound weight attached to the pontoon, it inflated to its full capacity and remained stable.

Test number 13 was made with a 27 pound weight on the pontoon and the platform tilted through various angles of inclination. At 10° it rolled out from under the platform and lost all the air. The same test was again performed. This time the pontoon started to roll and lost about 70% of the original air. When the platform was tilted to 2[illegible]°, the pontoon started to roll and lost about 80% of the original air. The shrouds on the low side of the pontoon were slack.

From the foregoing, it is evident that the pontoon must have a weight hung on it to remain stable under a deck or platform. If the platform is inclined, the weight must be heavier. The other alternative is to wedge it in a corner so that it cannot roll. It may be possible to secure the lower end of the pontoon so that it cannot roll.

The condition of the fabric was satisfactory following the tests. There is a tendency of the top ring to unscrew, especially when the load is spinning. The shroud rings tend to elongate on the last pontoon in tandem. The shackle is not a good collector of these shroud rings, since there is evidence of unequal stress distribution and a tendency of the rings to snarl. The failure of the load transmitting wire and the shrouds were discussed previously.

The length of the three pontoons deflated was about 5 feet from top ring to bottom shackle. This changed very little under load because the length of the load transmitting cable is the controlling factor.

The maximum lifting capacity of the three pontoons in tandem was 583 pounds, net.

CONCLUSIONS AND RECOMMENDATIONS

These pontoons when hooked up in tandem in groups of three, are capable of lifting but not sustaining the load on the surface upon flotation. This is caused by the loss of air of the uppermost pontoons. The excess buoyancy necessary to overcome the kinetic energy of descent is not available, causing the load to sink.

The reduction of the load does not alter this characteristic although this action is progressive. With a heavy load, only the number 1 pontoon may lose air. If the load is lighter, two and sometimes all of the pontoons lose air.

The reduction in the distance of the lift reduces this loss of air somewhat. With a lift of only 25 feet, at least 75% of the number one pontoon came out of the water. Another 11 inches of emergence would cause air loss.

The reduction of depth and size of load did not reduce the incidence of sinkings as it did in the case of the single pontoon.

This loss of air characteristic is expected to be accentuated with the increase in size of the pontoons.

Therefore, the use of these pontoons in tandem alone on free lifts or on lifts causing them to come out of the water, is precluded. Their use would be restricted to a supporting role in lifting operations where the primary lift is made with single pontoons and/or lifting craft. It is very important to notice that the excess buoyancy over the weight lifted that is so vital in overcoming the kinetic energy of descent will be available if the tandem pontoons are not permitted to break surface in these combined operations.

The proportion of the pontoons to break surface to those in tandem should be most judicious. The tandem pontoons must never by themselves possess enough buoyancy to surface the load. This would not only cause them to loose air, but all single pontoons hooked at higher positions would do likewise.

The use of these pontoons singly is feasible. It is obvious that in this use, they must be over disigned with regard to the load transmitting wire, shackles, etc. to conform to a load three times as great if the pontoons are to be interchangeable.

The use of a single air line feeding the three pontoons is unsatisfactory. The top pontoon always inflates first. This releases bubbles which continue throughout the process. It is difficult to tell when all pontoons are blown. Moreover, the two bottom pontoons cannot remain inflated because they will eventually exhaust their air into the top pontoon. If a single line is used, valves must be inserted to the lines going to the pontoon at the point of tie in. It is thought that individual air lines to each pontoon would be most practical.

The shackle and ring arrangement is poor and would be most unsatisfactory in the full size type.

The hose was too small and weak. It was easily kinked.

It is assumed that the full size type will use an adequate and kink resisting hose.

The top ring had a tendency to unscrew. A locknut is recommended at this point.

The failure of the wire clip forming the eye of the main load wire, indicates an under or poorly designed component. The failure of the two shrouds was probably caused by the shock load induced by the wire clip failure.

When one of the pontoons is used as an anchor, it must be kept free of the heaving line to prevent snarling. This system can be used only for partial lifts. Loads cannot be brought near the surface because the lifting pontoons will upset the anchor pontoon. Also as the anchor pontoon approaches the lifting pontoons, the angle must increase between the heaving line and the standing line leading to the anchor pontoon. The heaving force must also increase with this angle.

If the pontoon is to be used to obtain buoyancy in a flooded compartment by blowing it under the overhead, a weight must be attached to the pontoon. If this is not done, it will become unstable and lose air. If there is an angle of list, the pontoon will tend to roll and lose air. To counteract this, a larger weight must be added or the pontoon must be lodged so that it cannot roll.

TEST # 1

7 January 1948

WEIGHT (gross): 160 (lead); Weight (net): 149

Dist. top of pontoon to w.l. prior blowing	48 f.	48 f.	48 f.	48 f.
Inflation time	11 s.	10 s.	9 s.	9 s.
Time of ascent	9 s.	9.5 s.	10 s.	9 s.
Time required for vent	Sunk	Sunk	29 s.	Sunk
Time of descent	Sunk	Sunk	18 s.	Sunk
Approx. max. distance balloon out of water on surfacing				
Remarks:	2 spilled all air & turned over	2 spilled all air & turned over	All 3 came out of water;20# excess buoyancy. All lost little air	1st came out of water, 2nd came completely out, 3rd remained submerged.

Test of three pontoons of 150 - 200 lbs. lifting collapsible pontoon arragned in tandem. Contract NOBS 45173. Manufactured by Goodyear Tire and Rubber Company, May 1947. Air connection 3/16 inch I.D. oxygen hose to two tees at pontoons. From tees 1/8 inch I.D. individual hoses are run to each pontoon. 12 shrouds to each pontoon about 1/32 inch diameter piano wire, 8 inches long. Three shrouds picked up by one ring which is secured to shackle. Load connecting wire running from pick up shackle to top ring is about 1/8 inch piano wire. From top of pontoon to pick up shackle is 35 inches. Circumference at bottom 32 inches, maximum circumference is 64 inches. When pontoons are hooked together, they are 8 feet ? inches top to shackle. Maximum lift for three pontoons - 583 lbs., net.

TEST # 2

7 January 1948

WEIGHT (gross): 360 (lead); WEIGHT (net); 335

Dist. top of pontoon to w.i. prior blowing	48 f.	48 f.	48 f.	48 f.
Inflation time	16 s.	16 s.	21 s.	17 s.
Time of ascent	11 s.	9.5 s.	11 s.	10 s.
Time required for vent	Sunk	Sunk	57 s.	Sunk
Time of descent	Sunk	Sunk	12.5 s.	Sunk
Approx. max. distance balloon out of water on surfacing	1st pontoon completely out of water & lost all air.	2nd pontoon lost all air & sunk	1st pontoon lost all air. About 40# excess buoyancy remained.	2nd lost all air

Remarks: Very little spinning. When pontoon came out of water, they lost all air and laid flat on the water until they sunk. In trial #3, all pontoons lost some air, laid flat on the water and retained enough air to hold weight.

TEST # 3

7 January 1948

WEIGHT (gross): 497 (lead); WEIGHT (net): 462

Dist. top of pontoon to w.l. prior blowing	48 f.	48 f.	48 f.	48 f.
Inflation time	22 s.	24 s.	23 s.	22 s.
Time of ascent	12 s.	12 s.	11 s.	10 s.
Time required for vent	Sunk	Sunk	Sunk	Sunk
Time of descent	Sunk	Sunk	Sunk	Sunk
Approx. max. distance balloon out of water on surfacing	1st lost all air, 2nd & 3rd remained submerged	1st lost all air	1st lost all air	1st lost all air

TEST # 4

9 January 1947

WEIGHT (gross): 227 steel + shackles, 400 lead; WEIGHT (net): 565

Dist. top of pontoon to w.l. prior blowing	48 f.	48 f.	48 f.	48 f.
Inflation time	27 s.	31 s.	27 s.	30 s.
Time of ascent	13 s.	13 s.	12 s.	15 s.
Time required for vent	Sunk	Sunk	Sunk	
Time of descent	Sunk	Sunk	Sunk	
Approx. max. distance balloon out of water on surfacing	Top pontoon lost air	Top pontoon lost air	Top pontoon lost air	Pontoon vented in ascent.

REMARKS: When the weights were in the process of being lowered, the main wire on the bottom shackle slipped out of the clip. Bottom pontoon was replaced with a new one. Two shrouds failed. Plate on top loose. Eye holding main pendant elongated. Load 693 lbs. when this happened. The 1/8 inch hoses were too long and were coiled up. When air pressure was put on, the hoses expanded and cut the air off. There was trouble with hose kinking and not getting air.

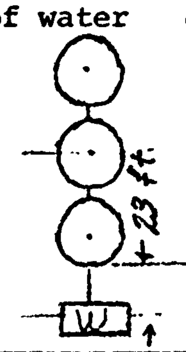
TEST # 5

9 January 1948

WEIGHT (gross): 227 steel + lead, 627; WEIGHT (net): 565

Dist. top of pontoon to w.l. prior blowing	26 f.	26 f.	26 f.	26 f.
Inflation time	15 s.	19 s.	15 s.	17 s.
Time of ascent	9 s.	9.5 s.	9.5 s.	8 s.
Time required for vent	30 s.	Sunk	30 s.	0
Time of descent	6.5 s.	Sunk	8 s.	K
Approx. max. distance balloon out of water on surfacing	1st pontoon came 75% out of water	1st pontoon came 75% out of water	1st pontoon came 75% out of water	1st pontoon came 75% out of water

Remarks: 23 ft. pendant used. Pontoons arranged in tandem as before.



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TEST # 6

9 January 1948

WEIGHT (gross): 450 (lead); WEIGHT (net): 420

Dist. top of pontoon to w.l. prior blowing	25 f.	25 f.	25 f.	25 f.
Inflation time	15 s.	12 s.	12 s.	12 s.
Time of ascent	6 s.	6 s.	5 s.	5 s.
Time required for vent	Sunk	Sunk	Sunk	Sunk
Time of descent	Sunk	Sunk	Sunk	Sunk
Approx. max. distance balloon out of water on surfacing.	Top pontoon lost air. All out of water. Second pontoon 1/2 out of water.			

12

TEST # 7

9 January 1948

WEIGHT (gross): 450 (lead); WEIGHT (net): 420

Dist. top of pontoon to w.l. prior blowing	40 f.	40 f.	40 f.	40 f.
Inflation time	25 s.	17 s.	19 s.	14 s.
Time of ascent	9 s.	9 s.	8 s.	9 s.
Time required for vent	Sunk	Sunk	Sunk	Sunk
Time of descent	Sunk	Sunk	Sunk	Sunk
Approx. max. distance balloon out of water on surfacing	Number 1 came out of water and lost all air.			
Remarks:	Nine foot strap between pontoons 1 and 2. The number 1 pontoon stayed about 10 seconds on surface before it started to go down. Was difficult to keep afloat even after blowing air when surfaced. When this was done, the two bottom ones would come up, slacking the wire and spilling air. All gear snarled up upon surfacing.			

TEST # 8

9 January 1948

WEIGHT (gross): 400 lead + 227 steel, 627; WEIGHT (net): 565

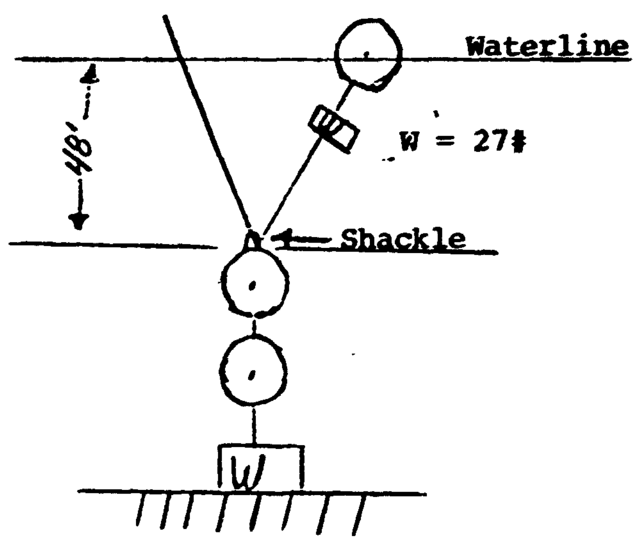
Dist. top of pontoon to w.l. prior blowing	To top of bottom of pontoon - 40 f.	40 f.	40 f.	40 f.
Inflation Time	22 s.	33 s.	29 s.	25 s.
Time of Ascent	13 s.	13 s.	13 s.	16 s.
Time Required for Vent	Sunk	15 s.	15 s.	0.k.
Time of Descent	Sunk	11 s.	11 s.	o.k.
Approx. Max. Distance Balloon Out of Water on Surfacing	#1 came 75% out of water Lost little if any air.	About 75% of pontoon came out of water.	About 75% of pontoon came out of water.	About 75% of pontoon came out of water.
Remarks:	Same set up as #7 except that load was increased.			

TEST # 9

12 January 1948

WEIGHT (gross): 400 lead + 227 steel, 627; WEIGHT (net): 565

Line used was 21 thread. Anchor pontoon with 27 lb. weight. Lifted off bottom about 15 ft. by three men. Rest of lift made by winch. When surfaced, anchor pontoon air was spilled. Hose and line badly snarled with about 4 turns. Shackle used for fair lead on top of pontoon Bottom pontoon evidently did not get air.



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TEST # 10

15 January 1948 — Pontoon secured to ladder support on side of tank.

Water after inflation 9 3/4 inches below datum.
Water before inflation 9 7/16 inches below datum.
Difference in tank level: 5/16 inches

Displacement: =

$$\frac{3.14 \times 60^2 \times 5.5 \times 62.4}{1{,}728 \times 16} = 128 \text{ lbs.}$$

Capacity of pontoon in an unrestricted position: 150 lbs.
Capacity of pontoon restricted by side of tank and ladder =

$$\frac{128}{190} = 67\% \text{ of original}$$

TEST # 11

16 January 1948 — Pontoon placed under table. No weights used. Pontoon was lodged in corner. When pushed slightly, it lost equilibrium and air. Test performed in Deep Sea Diving School open tank.

TEST # 12

16 January 1948 — Pontoon inflated under a platform 9 ft. long and 21 in. wide. Secured underwater. No inclination.

With no weight, the pontoon would not inflate except for about 10%. It just laid on side. With a 27 lb. weight, balloon inflated and remained stable.

TEST # 13

[illegible] January 1948

Pontoon was inflated under platform with various angles of inclination-with a 25 lb. weight.

TRIAL 1. Pontoon rolled out from under platform and lost all air at 10° angle.

TRIAL 2. Pontoon started to roll and lost about 70% of air. Shrouds on one side were loose and on the other taut. 10° angle used.

TRIAL 3. Angle of Inclination - 25°. Pontoon started to roll and lost 80% of air.