TechData Sheet
Naval Facilities Engineering Service Center
Port Hueneme, California 93043-4370

TDS-2025-SHR
March 1996

Polymer Composite Utility Pipe Hangers

Highlights and Recommendations from NFESC Studies

This Techdata sheet summarizes the highlights of work carried out under the Engineering Investigation (EI) project. Further details will be available in a report and in future Techdata sheets.

It is known that steel corrosion by ocean water and salt spray costs the Navy millions of dollars per year in maintenance, repairs, and replacement. One of the areas where corrosion can have devastating effects is loss of suspension or support of utility pipes under the pier that carry steam, water, compressed air, fuel, and electrical cables from shore to ship. Many of the existing pipes under older piers, are supported by corroding steel pipe hangers that have been exposed to ocean water and salt spray for years. When the pipe hangers rust through at the bottom of the clamp or saddle, the pipes may lose support and drop and spill their contents into the ocean, creating environmental problems. A pipe hanger holding a pipe under the pier is shown in Figure 1. However, in Figure 2, the pipe hanger corroded and the pipe dropped into the ocean.

According to reports from the field, both painted steel and zinc galvanized steel hangers fare poorly in a marine environment. When zinc is consumed, the underlying steel becomes badly corroded and hangers quickly fail.

The Naval Facilities Engineering Service Center (NFESC), using EI funds provided by the Naval Facilities Engineering Command Headquarters, conducted tests to compare non-metallic polymer composite pipe hangers with carbon steel, galvanized steel, and stainless steel hangers under a variety of simulated ocean environments. Although polymer composites have been used in marine environments, such as fiberglass reinforced polymer (FRP) boat or ship hulls, there have been some questions on the long term environmental durability, such as effects of hot and cold temperatures, ocean spray, sunlight, and attachment by marine organisms (bacteria, algae, barnacles, marine boring worms).

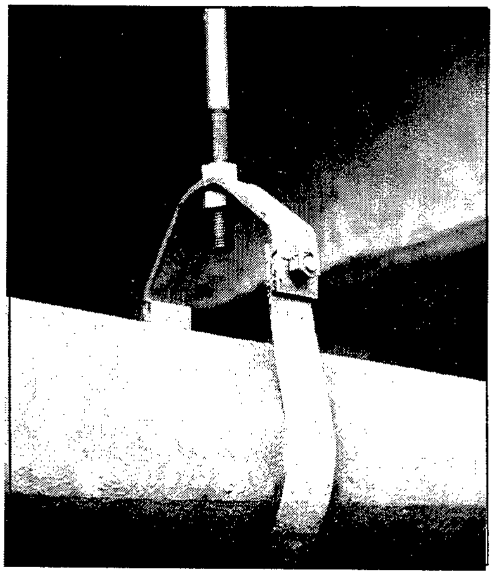

Figure 1. Carbon steel pipe hanger supporting steam pipes under the pier (NSY Norfolk, VA).

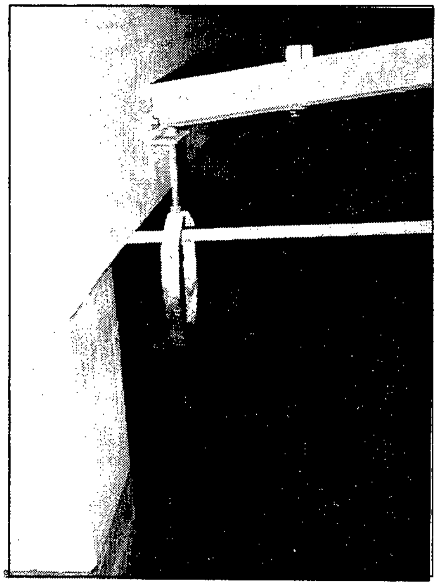

Figure 2. Corroded steel hanger failed and pipe dropped into the Atlantic Ocean (NSY Norfolk, VA).

Test Sites

Steel and composite hangers were tested at indoor and outdoor test sites. The outdoor test site included installation of the hangers, supporting pipe sections, attached to wooden fenders on a concrete bulkhead in the harbor at Port Hueneme, CA (at the Naval Construction Battalion Center). The indoor tests were conducted in the salt fog chamber and Polar Regions lab at NFESC.

The **Polar Regions** lab contains rooms where the temperature can be varied from -10°F to +140°F. One

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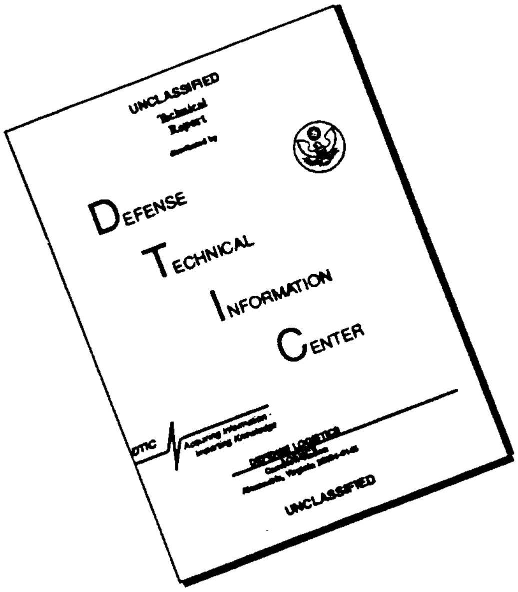
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room contains a 5-foot deep concrete tank where water or recirculating seawater can be pumped in. The hangers were attached to concrete slabs placed on bracket supports suspended over the pool (as shown in Figure 3). Each pipe was held by two composite hangers. The composite hangers included materials made of several reinforced plastics.

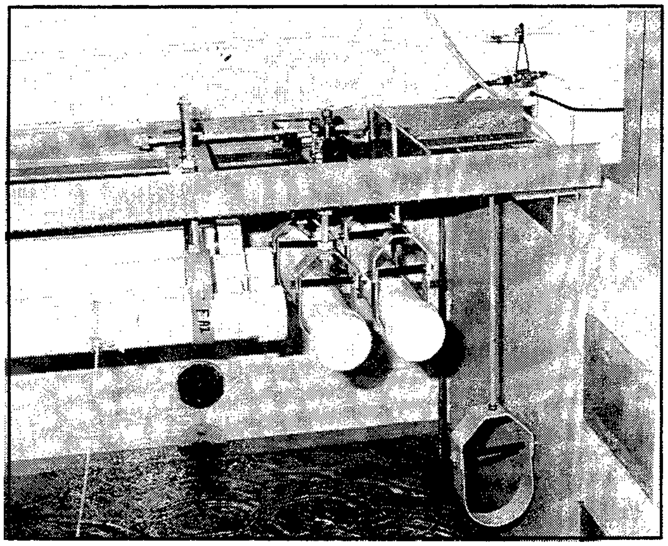

Figure 3. Tests on composite (yellow) and metal pipe hangers at NFESC seawater tank (environmental chamber).

Types of Materials Tested

We tested pipe hangers (Figure 4) made of the following materials:

- Carbon steel, alloy 1020
- Zinc, galvanized steel (hot dipped)
- Stainless steel, alloy 316
- Polyester, fiberglass reinforced (FRP)
- Vinylester, fiberglass reinforced (FRVE)
- Nylon, fiberglass reinforced (FRN)

Stainless steel pipe sections, 30 inches long and 4 inches in diameter, with screw caps at both ends, were painted with a tough, durable epoxy-polyamide coating (MIL-P-24441).

The pipes were filled with lead bricks to increase the weight of each unit from 32 to 101 pounds. The hangers were tested for:

- Strength
- Cold temperature stability (down to 33°F)
- Hot temperature stability (120°F)
- Impact resistance
- Vibration stability

The nuts on the composite hangers were also tested for torque resistance and breakage.

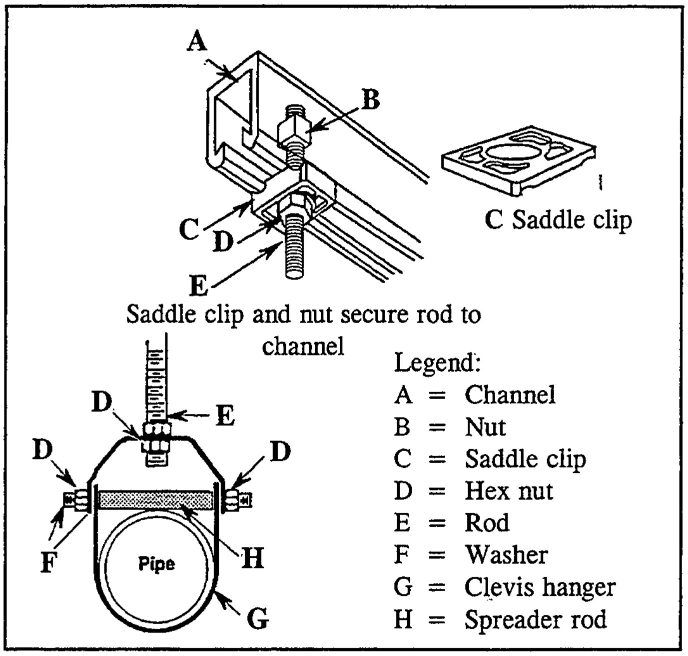

Figure 4. Pipe hangers.

RESULTS

The simulated exposure to cold and hot ocean environments provided the most information. The steel and composite hangers were photographed after 3 months exposure to hot salt spray simulating tropical oceans. Figures 5 and 6 show the effects of salt spray on stainless steel and galvanized zinc. Figures 7 and 8 show the effects of salt spray on the composite (polyester) and carbon steel hangers. Results for the four types of hangers after 3 months exposure in the salt spray chamber are listed in Table 1.

Table 1
Results of Hanger Condition after 3-Month Accelerated Exposure Tests

Type of Hanger	Weathering Resistance[a]	Unit Cost[b] ($)
316 Stainless Steel	10	130
304 Stainless Steel	Not tested	100
PVC Coated Steel	Not tested	60
Polyester (FRP)	10	40
Vinylester (FRVE)	10	30
Galvanized Steel (Zn)	2	26
Nylon (FRN)	6	23
Carbon Steel	1	21

[a] 1 = Poor; 5 = Fair; 7 = Good; 10 = Excellent
Visually rated on condition after 90 days in the salt fog tank at 120°F.

[b] Costs based on hangers purchased for the NFESC project only. These costs may or may not represent prices available from other manufacturers of steel and composite hangers.

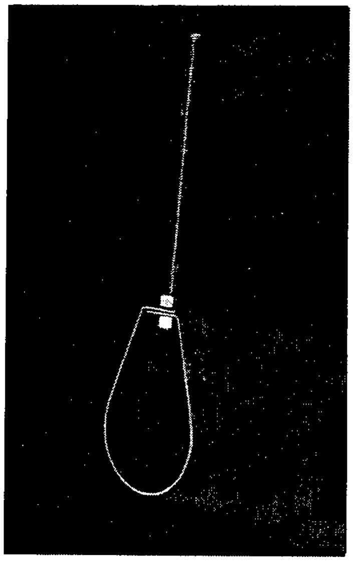

Figure 5. Stainless steel pipe hanger after 3 months in salt spray tank. Excellent condition.

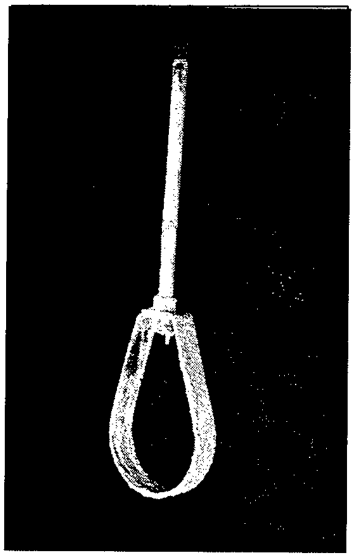

Figure 6. Galvanized zinc, hot-dipped, steel hanger after 3 months in salt spray tank. Fair condition.

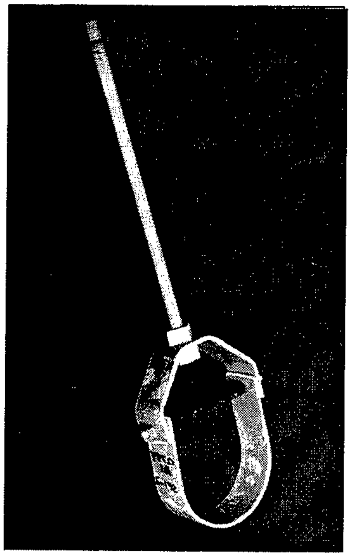

Figure 7. Fiberglass reinforced polyester hanger after 3 months in salt spray tank. Excellent condition.

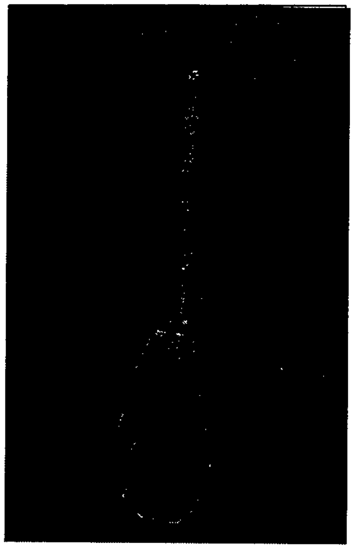

Figure 8. Carbon steel hanger after 3 months in salt spray tank. Poor condition.

Torque Tests

Torque was applied to the composite and steel nuts on the clamp or yoke of the clevis hangers (Figure 4). The results for nuts fastened to 5/8-inch diameter screws of each material are:

Material	Max Torque (at failure)
316 Stainless Steel	75-93 ft-lb
Polyurethane[a]	76 ft-lb
Nylon	25 ft-lb

The torque differs for each size of nut and screw combination, so this information only covers the size that was used for the specific 4-inch diameter clevis hanger. Torque applied at 50 percent of the maximum was suitable to hold the nut tightly without loosening, in both the composite and metal tests. Thus the polyurethane composite nuts tightened at 76/2 = 36 ft-lb torque did not loosen, even with temperature changes ranging from 40 to 120°F.

Cost of Materials

The relative costs of different materials for the hangers are listed in Table 1. The table also contains, for comparison purposes, the approximate cost for two other materials commonly used for pipe hangers. These were not part of this test program

Temperature Ranges

The useful temperature ranges for various polymer composites are listed in Table 2. Although polyester, vinylester, and nylon hangers were tested, the other materials are listed because they are used in components, such as channels (PVC, polypropylene, and Kynar® fluorocarbon) and nuts and washers (polyurethane, nylon, and PVC).

Table 2. Temperature Ratings of Polymer Composites

Material	Temperature Range (°F)
Polyester (FRP)	-30 to +150
Vinylester (FRVE)	-35 to +200
Nylon (FRN)	-20 to +150
Polyurethane	-40 to +130
Polyvinyl Chloride (PVC)	-25 to +130
Kynar® Fluorocarbon	-40 to +230

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[a] Nuts not available in polyester or vinylester.

RESULTS

The results from Table 3 (and shown in Figure 9) are tensile tests for the entire hanger and channel system. The failure always occurred in the lips of the channel, which hold the rod and nut of the composite hangers, that is, the hangers did not break. However, it can be seen that the type of material used for the channel does matter when selecting the strongest system. According to the tensile test strength for Strut 1, which is a vinylester hanger, the channel strengths vary from Kynar®>polyester>polyvinyl chloride. The materials follow the same order for costs, that is Kynar® ($80.00)>polyester ($40.00)>polyvinyl chloride ($26.00). The amount in parentheses is what we paid for each 10-foot length of channel.

Although we did not perform long term weathering and tensile tests on the composite channel materials, it can be deduced from the present data that Kynar® is probably the strongest and most durable material, as well as the most expensive. PVC is the weakest and least durable, although the least expensive. Designers faced with balancing cost and durability may wish to consider using polyester channels, which are in the intermediate price and strength range.

The data in Table 4 were obtained from the nylon hangers (Strut 3) that were used with plates bolted to the concrete, rather than channels. Strut 3 was compared with Strut 1, which can also be attached to the composite plate. The tensile tests, as shown in Table 4, clearly demonstrate that Strut 1 assembly is more than three times stronger that Strut 3. In these tensile tests the hangers eventually ripped or tore. The point of failure occurred at different points (Figure 10), suggesting that the vinylester hanger is uniformly strong. The tensile test strengths are far in excess of the values needed to support the 10-foot long, 4-inch diameter steel pipes filled with water.

CONCLUSIONS AND RECOMMENDATIONS

The information provided in this Techdata sheet should be valuable for planners and designers concerned with reducing corrosion or pipe hanger systems in pier construction. It should be stressed that the weathering tests were done under laboratory conditions simulating various marine climates and conditions. Our studies show that the composite hangers, especially those based on vinylester and polyester resins, appear to be just as strong as hangers made of carbon steel or galvanized steel, and they are roughly in the same price range.

We cannot predict the overall performance of these hangers over 40 or 50 years because the scope of our tests was limited to 3 years. We also cannot comment on the durability of the hangers attached under the pier in high storm conditions, such as a hurricane, since we did not run any full scale field tests. However, we will provide consultation to Naval activities considering installing composite piper hangers.

FURTHER INFORMATION

Additional TechData Sheets will be published in the future describing hanger specifications, types of mechanical attachments, and other details. In the meantime, contact ***Dr. Tom Novinson, Waterfront Materials Division, Code ESC63 at DSN 551-1056, (805) 982-1056, or tnovins@nfesc.navy.mil for further information.***

Table 3. Tensile Strengths of Channels with Hangers

Hanger[a]	PVC Channel (average of two)	PE Channel (average of two)	Kynar® Channel (average of two)
Strut 1 (VE)	263.0 kg (580 lb)	412.7 kg (910 lb)	462.7 kg (1,020 lb)
Strut 2 (PE)	213.2 kg (470 lb)	226.8 kg (500 lb)	N/T[b]
Strut 3 (NL)	N/T[b]	N/T[b]	N/T[b]

[a] The hangers, all from different manufacturers, were identified as: Strut 1 = vinylester, Strut 2 = polyester, and Strut 3 = nylon. The channels were made from polyvinylchloride (PVC), polyester, and Kynar®, a fluorocarbon manufactured by Pennwalt Corp.

[b] N/T = not tested because of the shortage of samples. Strut 3 was not tested with the channels because the hanger unit is sold for use with composite plates that are bolted (through four holes at the corners) to the concrete.

Table 4. Tensile Strength of Hangers Attached to Plates[a]

Hanger	Steel Test Plate - New Hanger (average of two)	Steel Test Plate - Weathered Hanger (average of two)
Strut 1 (VE)	911.7 kg (2,010 lb)	893.6 kg (1,970 lb)
Strut 3 (NL)	299.3 kg (660 lb)	N/T[b]

[a] The hangers were placed through a hole in the steel plate and secured with a nut. The nylon hangers are designed to be held by a plate.

[b] N/T = Not tested because weathered samples were not available.

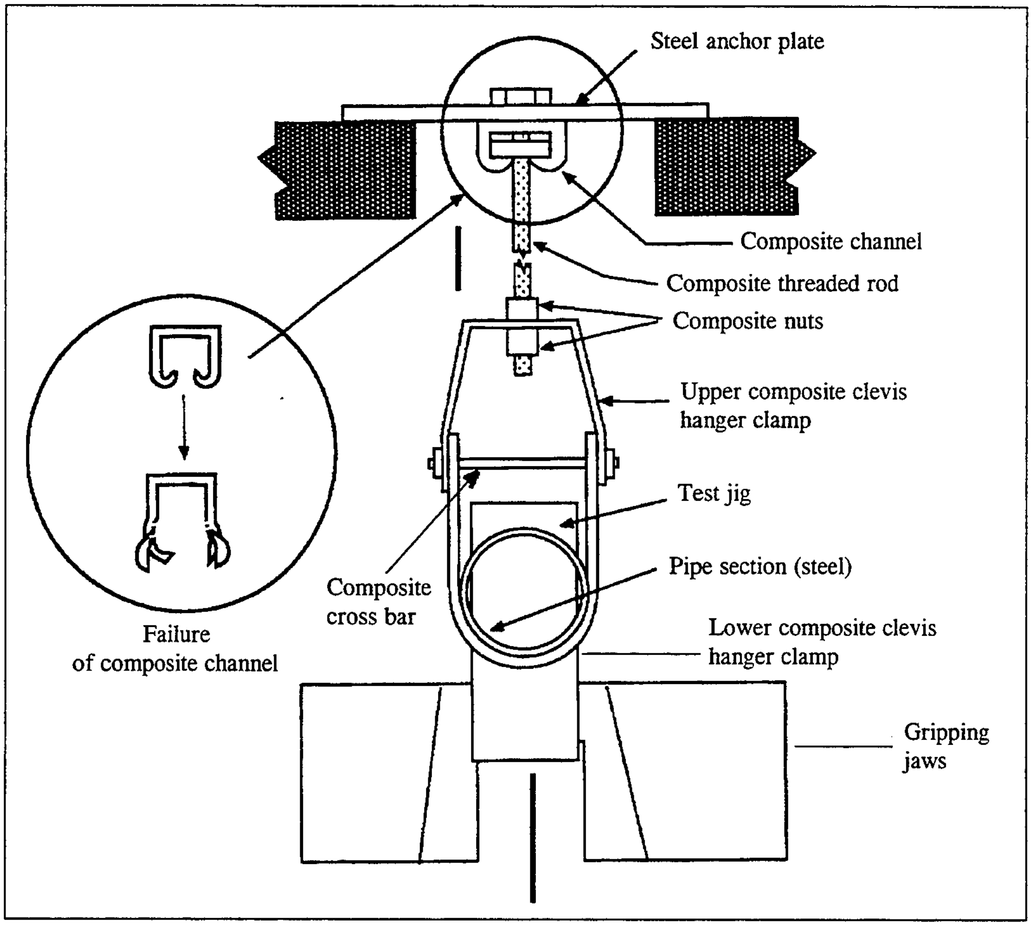

Figure 9. Test assembly for polyester and vinylester clevis hangers (using a channel).

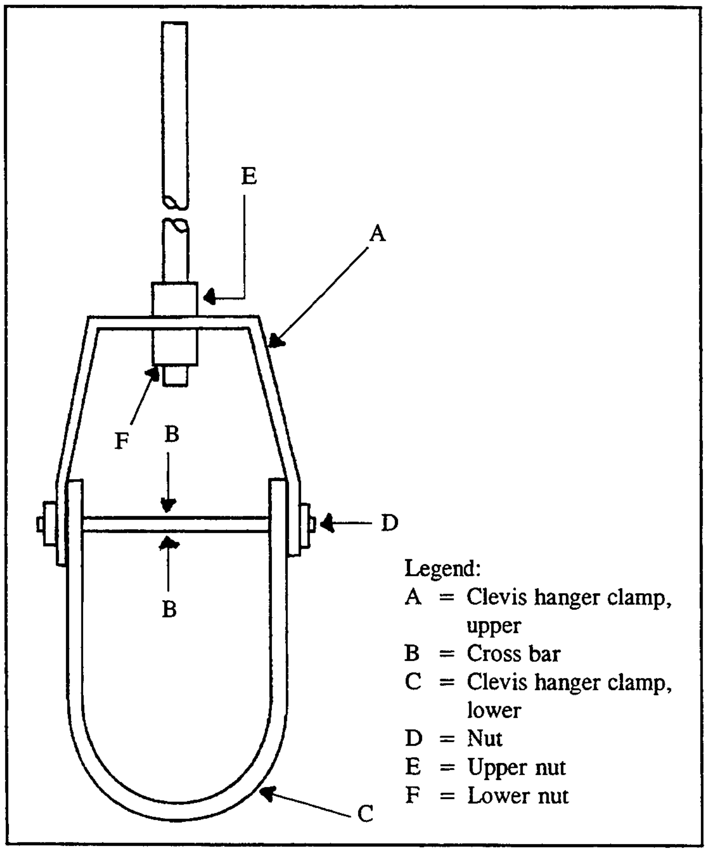

Figure 10. Failure points when composite hanger is subjected to high tensile testing.

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REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-018*

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE March 1996	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE **Polymer Composite Utility Pipe Hangers**	5. FUNDING NUMBERS
6. AUTHOR(S) Tom Novinson	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESSE(S)	8. PERFORMING ORGANIZATION REPORT NUMBER **TDS-2025-SHR**
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESSES Naval Facilities Engineering Service Center 1100 23rd Avenue Port Hueneme CA 93043-4370	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This TechData Sheet summarizes the highlights of work carried out under the Engineering Investigation (EI) project. Further details will be available in a report and in future TechData Sheets. The information provided in this TechData Sheet should be valuable for planners and designers concerned with reducing corrosion or pipe hanger systems in pier construction.

14. SUBJECT TERMS Utility pipe hangers, stainless steel pipe hanger, galvanized zinc, fiberglass, carbon steel hanger, and polymer composite.	15. NUMBER OF PAGES 5
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
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