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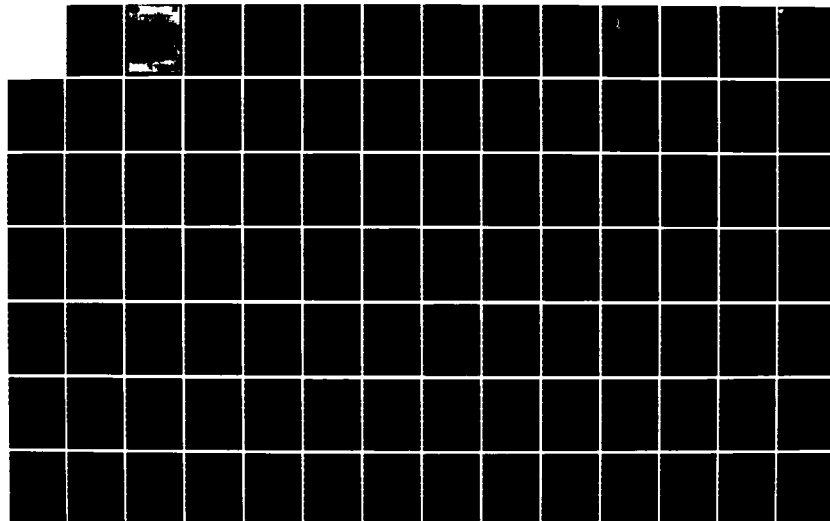
MISCELLANEOUS STRUCTURES EAST COAST AIR COMBAT
MANEUVERING RANGE OFFSHORE. (U) CREST ENGINEERING INC
TULSA OK SEP 76 27-771-98 CHES/NAVFAC-FPO-7626
N62477-76-C-0179

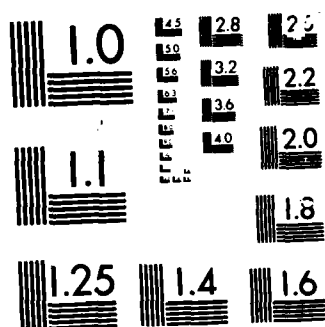
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MISCELLANEOUS STRUCTURES

EAST COAST AIR COMBAT MANEUVERING RANGE

OFFSHORE KITTY HAWK, NORTH CAROLINA

CONTRACT NO. N62477-76-C-0179

MODIFICATION NO. P0001

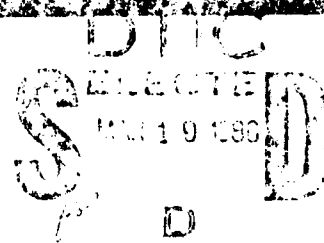
REPORT NO. 27-7-1001

PREPARED FOR

NAVAL FACILITIES ENGINEERING COMMAND

DEPARTMENT OF THE NAVY

CHESAPEAKE DIVISION



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CREST ENGINEERING, INC.
TULSA, OKLAHOMA

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Crest Engineering

7a. NAME OF MONITORING ORGANIZATION
Ocean Engineering
& Construction
Project Office
CHESNAVFACENGCOM

6c. ADDRESS (City, State, and Zip Code)
Tulsa, OK

7b. ADDRESS (City, State, and Zip)
BLDG. 212, Washington Navy Yard
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19. ABSTRACT (Continue on reverse if necessary & identify by block number)
This report contains design calculations relative to the superstructures and structural appurtenances for the four tripod-type ocean structures for the East Coast Air Combat Maneuvering Range offshore Kitty Hawk, North Carolina.

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MISCELLANEOUS STRUCTURES
EAST COAST AIR COMBAT MANEUVERING RANGE
OFFSHORE KITTY HAWK, NORTH CAROLINA
CONTRACT NO. N62477-76-C-0179
MODIFICATION NO. P0001

Report No. 27-771-98

Prepared for
NAVY FACILITIES ENGINEERING COMMAND
DEPARTMENT OF THE NAVY
CHESAPEAKE DIVISION

By
CREST ENGINEERING, INC.
TULSA, OKLAHOMA

September 1976

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SECTION 1

INTRODUCTION

1.1 INTRODUCTION

This report contains design calculations relative to the superstructures and structural appurtenances for the four tripod-type ocean structures for the East Coast Air Combat Maneuvering Range offshore Kitty Hawk, North Carolina.

1.2 DESIGN CRITERIA

The criteria employed to design each component of the structure are listed as follows:

(a) Superstructure:

Live Loads:	Upper Deck	100 psf
	Equipment Deck	150 psf
	Stairway	100 psf
Material:	A36 Structural Steel	

(b) Boat Landing:

Design Loads: 4,000 lbs. concentrated load or
equivalent uniform load.

Minimum Plan Dimensions: 4 ft. x 6 ft.

(c) Equipment Supports:

Wind Load: 150 knots at EL(+) 30'-0"

1.3 DESIGN SUMMARY

Pertinent information relative to the superstructure and boat landing are listed as follows:

Superstructure:

Equipment Deck Area	591.5 sq. ft.
Upper Deck Area	362.5 sq. ft.
Structural Steel Weight (including stairways, handrails, and kick plate)	113.5 kips
Paint Area	8,500.0 sq. ft.

Boat Landing:

Overall Dimensions	22 ft. x 12 ft. x 4 ft.
Structural Steel Weight	22.0 kips
Paint Area	1,115.7 sq. ft.

1.4 PERSONNEL RESUMES

The personnel whose resumes follow were actively engaged in this project.

CREST OFFSHORE, INC.



Chingmiin (Charlie) Chern

Senior Engineer

<u>University</u>	<u>Degree</u>	<u>Year</u>
National Taiwan University	Bachelor of Science Civil Engineering	1961
North Dakota State University	Master of Science Civil Engineering	1966
Lehigh University	Ph. D. Civil Engineering	1969
Tulsa University	Graduate Study in Business Administration- Management	1974

Societies, Licenses,
and
Other Activities:

Member American Society of Civil Engineers
Member International Association of Structural and
Bridge Engineers
Member American Society of Engineering Education
Registered Professional Engineer in Oklahoma

Experience:

1973 to Present

Senior
Civil
Engineer

Crest Offshore, Inc.

Engaged in the feasibility studies, structural analysis and design of offshore structures, equipment supports and other various types of petroleum related civil engineering works. Assignments include:

- ... Evaluation of engineering designs from other agencies.
- ... Analysis and design of offshore structures for oil industry.
- ... Analysis and design of supports and foundations for onshore refinery facilities.
- ... Development of a sequence of computer programs for the analysis of offshore structures.

CREST OFFSHORE, INC.

Chingmiin (Charlie) Chern

Senior Civil Engineer

Experience Continued:

1969 to 1973

North Dakota State University

Associate
Professor of
Civil Engineering

Engaged in full-time lecture instruction for civil engineering (graduate school division) and construction management. Also served as consultant to local industry (undergraduate school division) in the area of computer applications in engineering.

1966 to 1969

Fritz Engineering Laboratory

Research
Assistant

Assisted in the design and testing of various types of steel structures.

1966

North Dakota State Highway Department

Highway
Engineer

Responsible for construction surveying.

1965

U.S. Forest Service

Assistant
Crew Chief

Assisted in surveying responsibilities.

SECTION 2 SUPERSTRUCTURES

2.1 INTRODUCTION

Set forth hereinafter are the design calculations for the superstructure which is common to each platform. Structural steel weights and the surface area to be painted are also tabulated.

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Sheet 2.02 of

By C. Chern Client U.S. NAVY

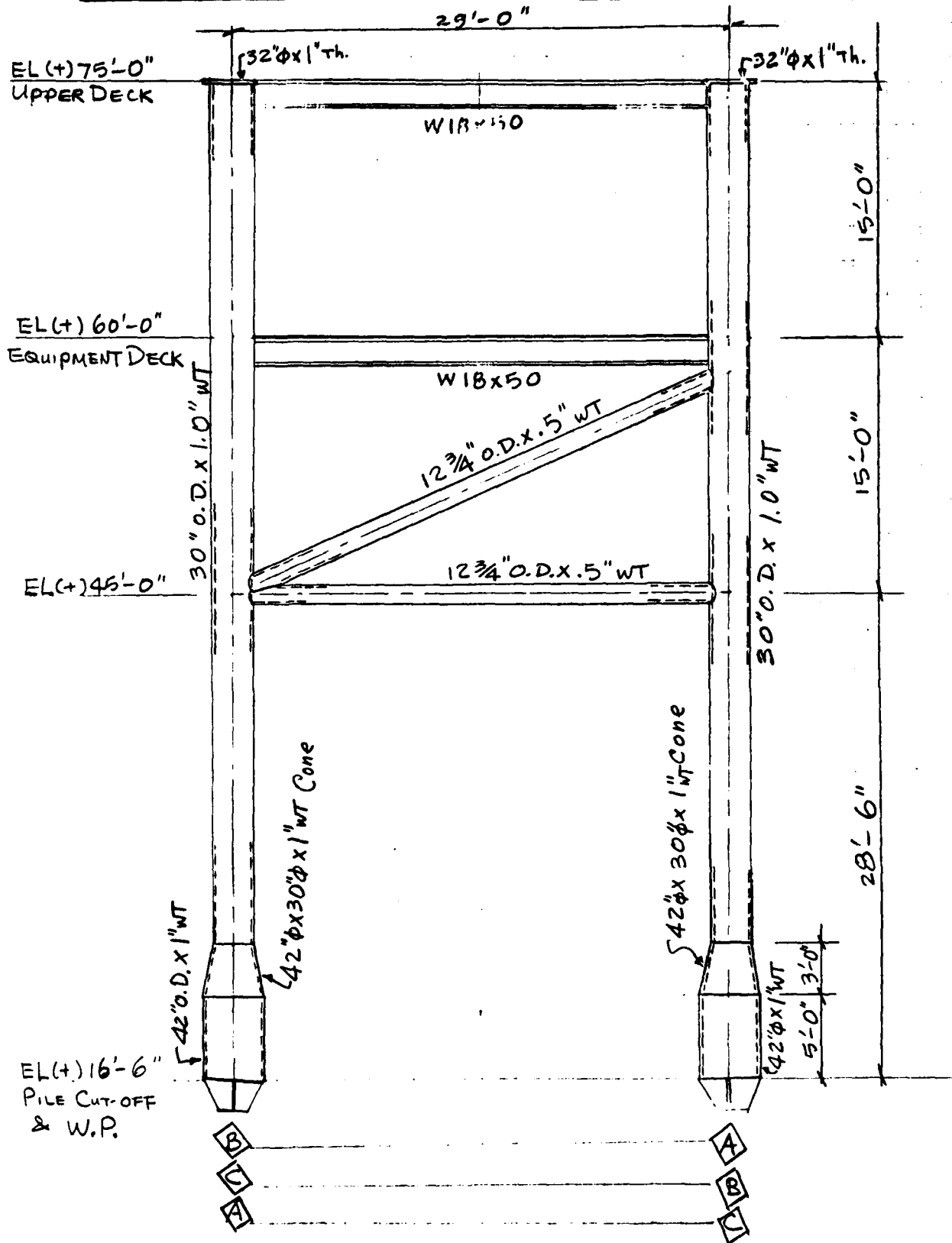
Subject Miscellaneous Structures

Date 6-10-76 Job No. 27-721-98

Calculation Superstructures (Elevation)

2.2 ELEVATION

Scale $\frac{1}{8}" = 1'-0"$



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Sheet 2-03 of

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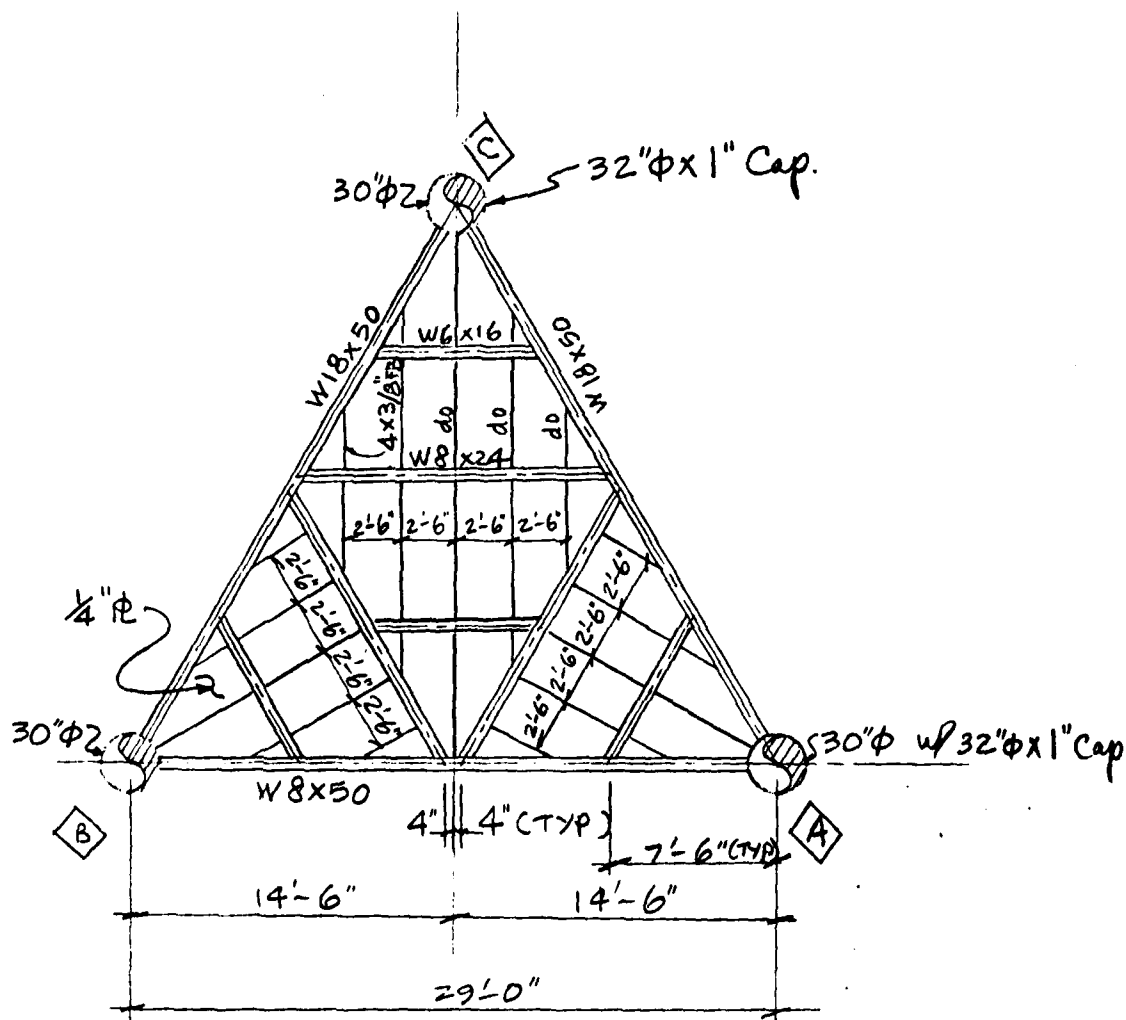
Date 6-10-76 Job No. 27-771-98

Calculation Superstructures (Upper Deck)

2-3 UPPER DECK

Design Live Loads = 100 psf

Scale $\frac{1}{8}" = 1'-0"$



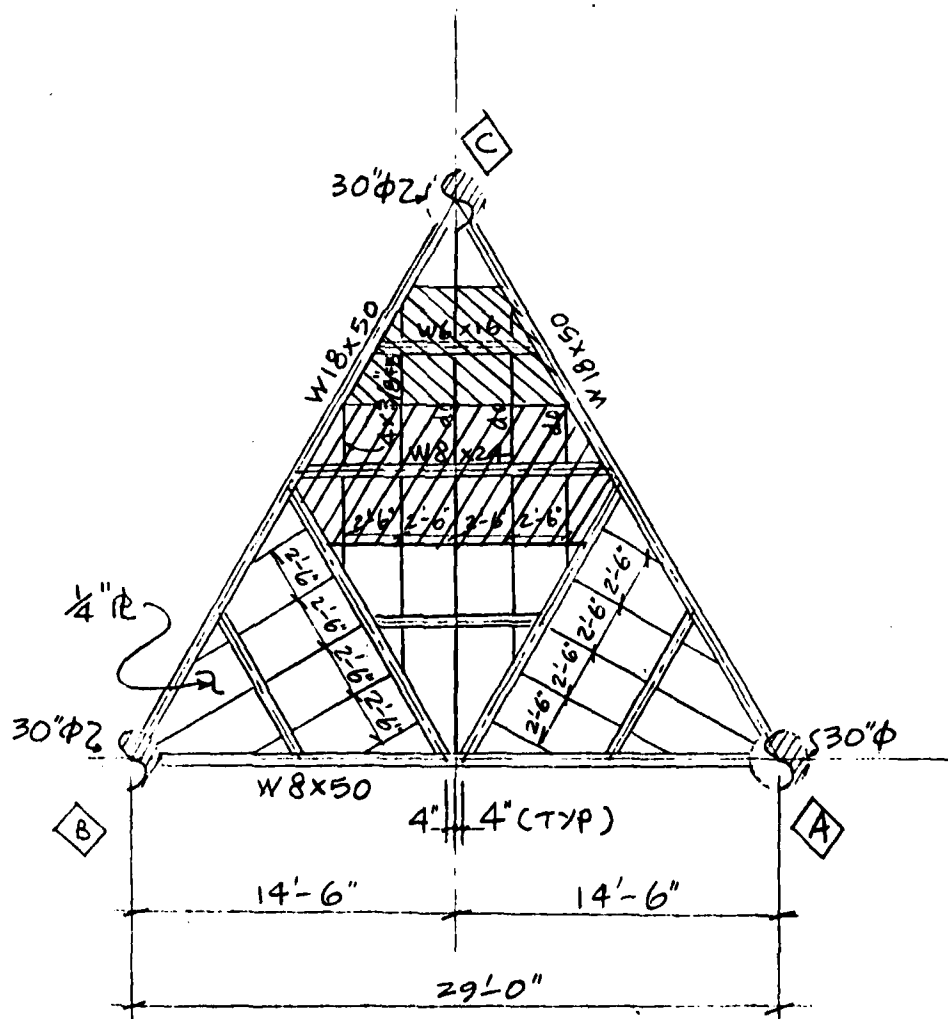
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Sheet 2-04 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-771-98 Calculation Superstructures (Upper Deck)

Design Live Loads = 100 psf

Scale $\frac{1}{8}" = 1'-0"$



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Sheet 2-05 of

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Subject Miscellaneous Structures

Date 6-10-76 Job No 27-771-98

Calculation Superstructures (Upper Deck)

4 x 3/8 Flat Bars

See Page 3.22

Report on Structural Concept Analysis
Appendix C - 3-pile Structure

W6x15.5

$$\text{Tributary Area} = 7.5' \times 5.5' = 41.25'$$

Uniform Loads:

$$\frac{1}{4}" \text{ R } 10.2 \times 41.25 = 420.75 \#$$

$$\text{L.L. } 100 \times 41.25 = 4,125.00 \#$$

$$\hline 4,545.75 \#$$

Bm. Wt.:

$$\text{W6x15.5 } 15.5 \times 7.5 = 116.25 \#$$

$$4 \times \frac{3}{8}" \text{ F.B. } \frac{6 \times 5.10 \times 5.5}{2} = 84.15 \#$$

$$\hline 200.40 \#$$

$$\text{Total Weight} = 4,746.15 \#$$

$$\text{Equivalent uniform load} = 632.82 \#/\text{ft}$$

$$\text{Say } 640 \#/\text{ft}$$

$$M_{\max} = \frac{1}{8} w l^2 = \frac{1}{8} \times 640 \times (7.5)^2 \times \frac{12}{1000} = 54 \text{ "K}$$

$$\text{Use W6x15.5 } S = 10.0 \text{ in}^3$$

$$\sigma_t = \frac{54}{10.0} = 5.4 \text{ Ksi}$$

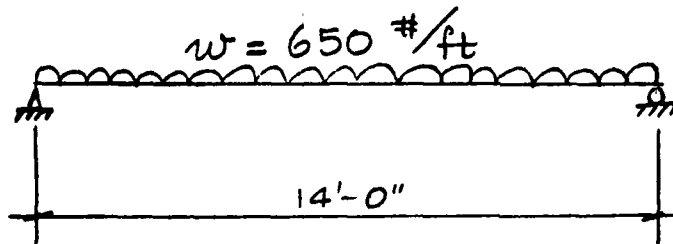
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Sheet 2.06 of

By C. Chern Client U.S. Navy Subject Miscellaneous Structures
 Date 6-12-76 Job No. 27-77L-98 Calculation Superstructures (Upper Deck)

W 8x24



$$\text{Tributary Area} = 12 \times 6.5 = 78 \text{ sq'}$$

Uniform Loads:

$\frac{1}{4}'' \text{ plate}$	10.2×78	$= 795.6 \text{ \#}$
L.L.	100×78	$= 7,800.0 \text{ \#}$
		$8,595.6 \text{ \#}$

Beam Wt.:

W8x24	24×14	$= 336 \text{ \#}$
$4 \times \frac{3}{8}'' \text{ F.B.}$	$10 \times 5.1 \times \frac{5.5}{2}$	$= 140.3 \text{ \#}$
		$476.3 \text{ \#}$

$$\text{Total Weight} = 8,595.6 + 476.3 = 9,071.9 \text{ \#}$$

$$\text{Equivalent uniform load} = 648 \text{ \#/ft}$$

Say $650 \text{ \#/ft}$

$$M_{\max} = \frac{1}{8} \times 650 \times (14)^2 \times \frac{12}{1000} = 191.1 \text{ in-k}$$

Use W8x24 $S = 20.8 \text{ in}^3$ $T_t = 9.2 \text{ ksi}$ O.K.

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Sheet 2.07 of ----

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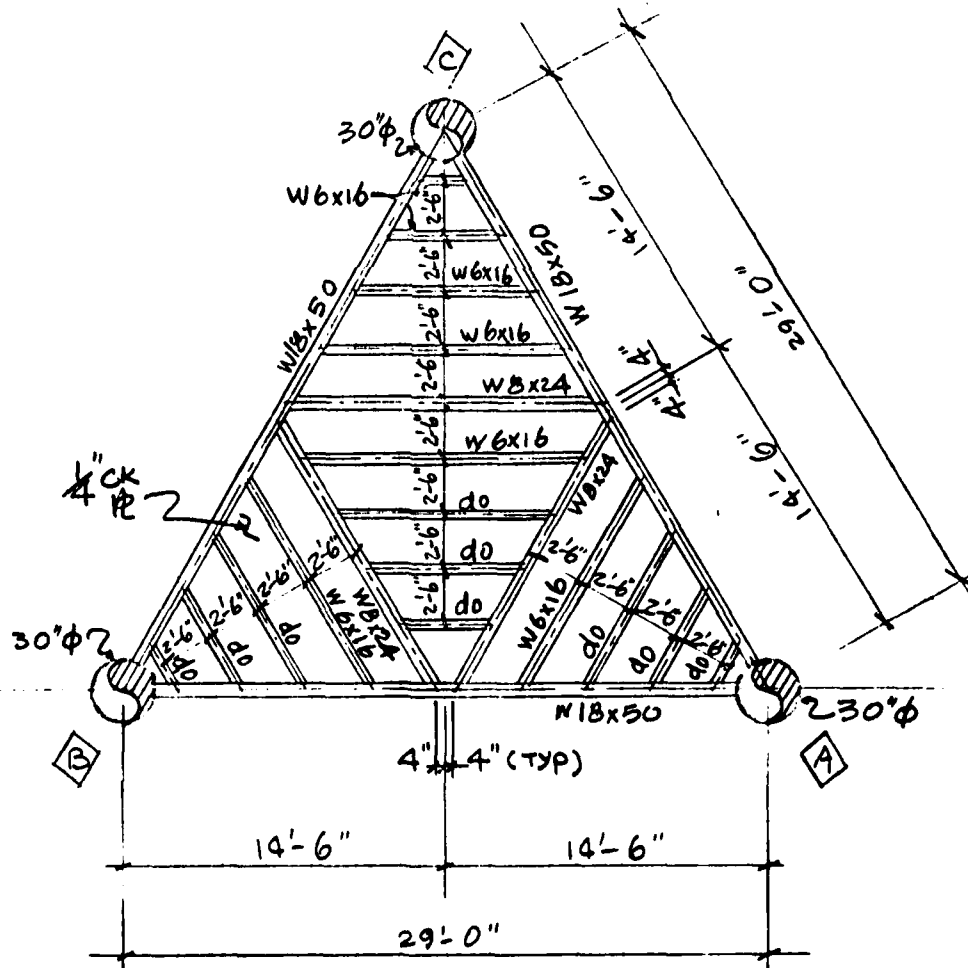
Date 6-10-76 Job No. 27-771-98

Calculation Superstructures (Equipment Deck)

2.4 EQUIPMENT DECK

Design Live Loads = 150 psf

Scale $\frac{1}{8}" = 1'-0"$



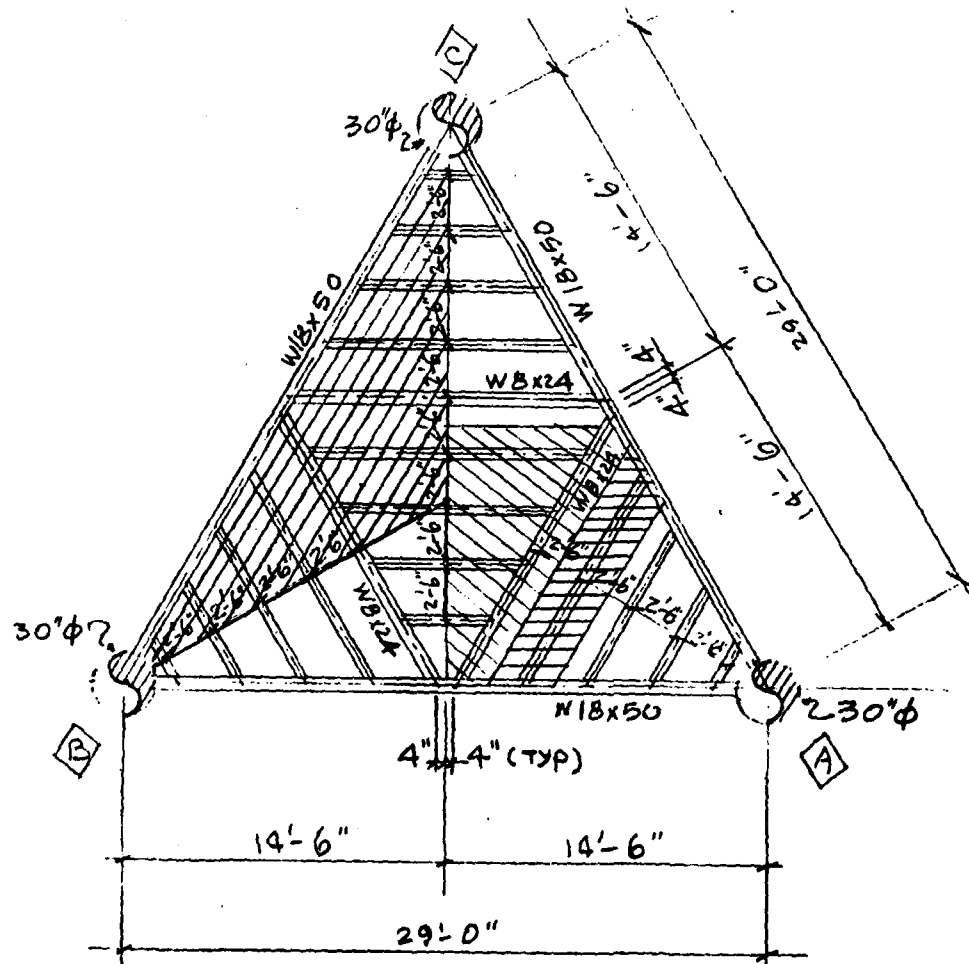
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Sheet 2-0B of

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Date 6-10-76 Job No. 27-771-98 Calculation Superstructures (Equipment Deck)

Design Live Loads = 150 psf

Scale $\frac{1}{8}" = 1'-0"$

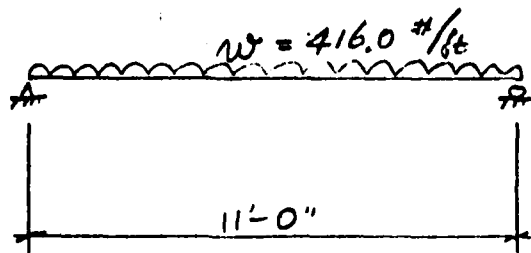


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Sheet 2.00 of ---

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 6-12-76 Job No. 22-77L-98 Calculation Superstructures (Equipment Deck)

W 6x15.5



Tributary Area 2'-6" x 11'-0"

D.L.

$$\frac{1}{4}'' \phi \quad 10.2 \times 2.5 = 25.5 \text{ \#/ft}$$

$$\text{Bm } W6x15.5 \quad \frac{15.5}{41.0 \text{ \#/ft}}$$

L.L.

$$150 \times 2.5 = 375 \text{ \#/ft}$$

$$\text{Total} \quad w = 416.0 \text{ \#/ft}$$

$$M_{\max} = \frac{1}{8} w l^2 = \frac{416.0 \times 11^2 \times 12}{8 \times 1000} = 75.5 \text{ \"-k}$$

$$\text{A36 Steel} \quad \sigma_t = 22 \text{ ksi}$$

$$S = \frac{75.5}{22} = 3.43 \text{ in}^3$$

$$\text{Use } W6x15.5 \quad S_x = 10.0 \text{ in}^3$$

$$\sigma_t = \frac{75.5}{10.0} = 7.5 \text{ ksi}$$

$$\text{AISC 2-48 Allowable load} = 14.8 \text{ kips}$$

$$> .416 \times 11 = 4.58 \text{ kips}$$

$$\text{AISC 2-95 Allowable moment} = 19 \text{ FT-kips}$$

$$= 228 \text{ \"-k} > 75.6 \text{ \"-k}$$

Use W6x16 for Min. Thickness $\geq \frac{1}{4}''$ (wet)

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Sheet 2-10 of

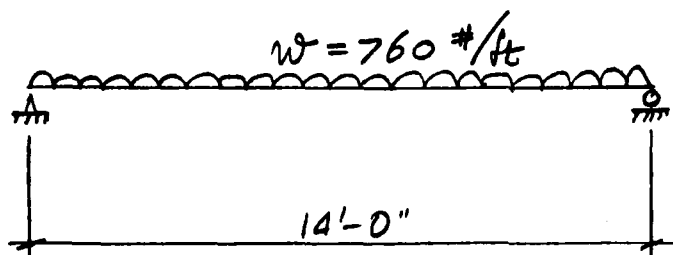
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Subject Miscellaneous Structures

Date 6-10-76 Job No. 27-271-98

Calculation Superstructures (Equipment Deck)

W 8x24



$$\begin{aligned} \text{Tributary Area} &= 14' \times 1.25' + \frac{1}{2} \times 7.5' \times 12' \\ &= 17.5 + 45 \\ &= 62.5 \text{ SQ. FT} \end{aligned}$$

$$\begin{aligned} \text{Uniform Loads: } & \frac{1}{4}'' \text{ @ } 10.2 \times 62.5 = 637.5 \text{ \#} \\ \text{L.L.} & 150 \times 62.5 = 9,375.0 \text{ \#} \\ & \hline & 10,012.5 \text{ \#} \end{aligned}$$

Beam Wt. :

$$\begin{aligned} \text{W8x24} & 24 \times 14 = 336 \text{ \#} \\ \text{W6x15.5} & 15.5 \times (6.5 + 5 + 3.5 + 2) = 264 \text{ \#} \\ & \hline & 600 \text{ \#} \end{aligned}$$

$$\text{Total Weight} = 10,612.5 \text{ \#}$$

$$\text{Equivalent uniform load} = 758.0 \text{ \#/ft}$$

$$\text{Say } 760 \text{ \#/ft}$$

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By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-721-98 Calculation Superstructures (Equipment Deck)

$$M_{max} = \frac{1}{8} w l^2 = \frac{1}{8} \times 760 \times 14^2 \times \frac{12}{1000} = 223.44 \text{ "K}$$

A36 Steel $\sigma_y = 22 \text{ ksi}$

$$S' = \frac{223.44}{22} = 10.2 \text{ in}^3$$

Use $W8 \times 24$ $S = 20.8 \text{ in}^3$

$$\tau_t = \frac{223.44}{20.8} = 10.74 \text{ ksi}$$

AISC 2-47 Allowable Load = 23.8 kips
 > 10.6 kips

AISC 2-95 Allowable moment = 38 FT-KIPS
= 456 in-KIPS > 223.44 in-K

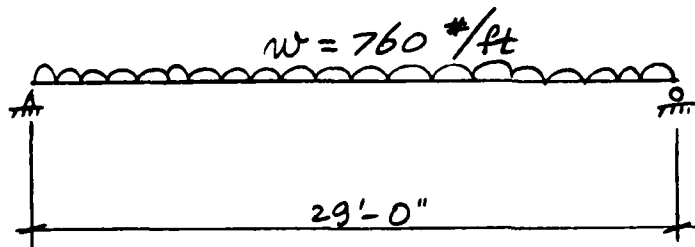
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 Date 6-10-76 Job No. 27-271-98 Calculation Superstructures (Equipment Deck)

W 18x50



$$\text{Tributary Area} = \frac{1}{2} \times 29' \times \left(\frac{1}{3} \times 25'\right) = 120.83 \text{ SQ. FT}$$

Uniform Loads:

$\frac{1}{4}'' \text{ P}$

$$10.2 \times 120.83 = 1,232.5 \text{ \#}$$

L.L.

$$150 \times 120.83 = 18,124.5 \text{ \#}$$

$$19,357.0 \text{ \#}$$

Beam Wt.

$$W 18 \times 50 \quad 29 \times 50 = 1,450 \text{ \#}$$

$$W 8 \times 24 \quad 24 \times (7 + 7) = 336 \text{ \#}$$

$$W 6 \times 15.5 \quad 15.5 \times (6.5 + 5 + 3.5 + 2) \times 3 = 791 \text{ \#}$$

$$2,577 \text{ \#}$$

$$\text{Total Wt.} = 19,357 + 2,577 = 21,934 \text{ \#}$$

$$\text{Equivalent uniform load} = 756.3 \text{ \#/ft}$$

Say $760 \text{ \#/ft}$

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By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-10-76 Job No. 27-771-98 Calculation Superstructures (Equipment Deck)

$$M_{max} = \frac{1}{8} w l^2 = \frac{1}{8} \times 760 \times (29)^2 \times \frac{12}{1000} = 958.74 \text{ "k}$$

A36 Steel $\sigma_t = 22 \text{ ksi}$

$$J = \frac{958.74}{22} = 43.6 \text{ in}^3$$

Use W18x50 $S = 89.1 \text{ in}^3$

$$\sigma_t = \frac{958.74}{89.1} = 10.8 \text{ ksi}$$

AISC 2-38 Allowable Loads = 49 kips
 $> 22 \text{ kips}$

AISC 2-93 Unbracing length = 3'-0"

Allowable moment = 178 ft-kip

$$= 2,136 \text{ " - kips}$$

$$> 958.74^{\circ}\text{K}$$

O.K.

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Sheet 2-16 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-2-76 Job No. 22-771-98 Calculation Superstructures (Equipment Deck)
8-9-76 (updated)

Check W21x73 Beam

$$\begin{aligned}\text{Tributary Area } \frac{1}{2} \times 29' \times \left(\frac{1}{3} \times 25'\right) &= 120.83 \text{ SQ. FT} \\ \frac{1}{2} (24' + 29') \times 5' &= 132.50 \text{ SQ. FT} \\ \hline &253.33 \text{ SQ. FT}\end{aligned}$$

Uniform Loads:

$$\begin{aligned}\frac{1}{4}'' \phi & 10.2 \times 253.33 = 2,584.0 \# \\ \text{L.L.} & 150 \times 253.33 = 38,000.0 \# \\ \hline & 40,584.0 \#\end{aligned}$$

Beam Wt:

$$\begin{aligned}\text{W21x73 } 29 \times 73 &= 2,117 \# \\ \text{W8x24 } 24 \times (7+7) &= 336 \# \\ \text{W6x15.5 } 15.5 \times (6.5+5+3.5+2) \times 3 &= 791 \# \\ \text{W6x15.5 } 15.5 \times 4 \times 10 &= 620 \# \\ \hline &3,864 \#\end{aligned}$$

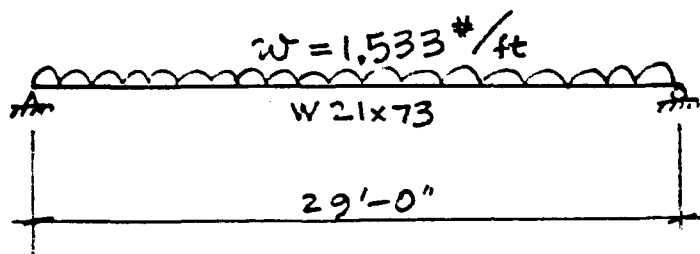
$$\begin{aligned}\text{Total Weight } W &= 40,584.0 + 3,864.0 \\ &= 44,448 \#\end{aligned}$$

$$\text{Equivalent uniform load } w = 1,533 \#/\text{ft}$$

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Sheet 2.17 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-2-76 Job No. 27-77L-98 Calculation Superstructures (Equipment Deck)



$$M_{max} = \frac{1}{8} \times \left(\frac{1.533}{1000} \right) \times 29^2 \times 12 = 1,933.9 \text{ \"K}$$

Try W 21 x 73 $S_x = 151 \text{ in}^3$; $I_x = 1600$

$$\sigma_t = \frac{1,933.9}{151} = 12.8 \text{ ksi} < 22 \text{ ksi}$$

O.K.

Max. deflection at center $\delta_c = \frac{5wl^4}{384EI}$

$$\delta_c = \frac{5 \times 1.533 \times 29^4 \times 12^3}{384 \times 30,000 \times 1600} = 0.51 \text{ \"} < 0.967 \text{ \"}$$

O.K.

AISC $\delta_{max} = \frac{l}{360} = \frac{29 \times 12}{360} = 0.967 \text{ \"}$

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Sheet 2.18 of ---

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-2-76 Job No. 27-271-98 Calculation Superstructures (Equipment Deck)

W10x29
Check ~~W8x24~~ @ 18'-0" Span

$$\text{Tributary Area} = 5 \times 21 = 105 \text{ SQ. FT}$$

$$\frac{1}{4}'' \text{ P} \quad 10.2 \times 84 = 857 \text{ \#}$$

$$\text{L.L.} \quad 150 \times 84 = 12,600 \text{ \#}$$

$$\underline{13,562 \text{ \#}}$$

Beam Wt.:

$$\text{W } 8 \times 24 \quad 24 \times 18 = 432 \text{ \#}$$

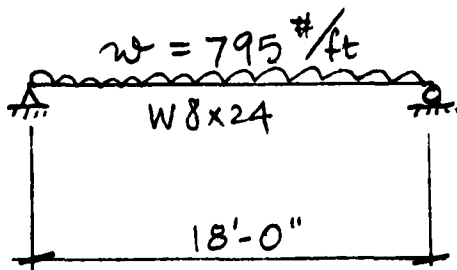
$$\text{W } 6 \times 15.5 \quad 15.5 \times 4 \times 5 = 310 \text{ \#}$$

$$\underline{742 \text{ \#}}$$

$$\text{Total Weight } W = 13,562 + 742$$

$$= 14,304 \text{ \#}$$

$$\text{Equivalent Uniform Load } w = 795 \text{ \#/ft}$$



$$M_{\max} = \frac{1}{8} \times \frac{795}{1000} \times 18^2 \times 12 = 386 \text{ \"K}$$

$$\text{W } 8 \times 24 \quad S_x = 20.8 \text{ in}^3; \quad I_x = 82.5 \text{ in}^4$$

$$(\sigma_t)_{\max} = \frac{386}{20.8} = 18.6 \text{ ksi} < 22 \text{ ksi} \text{ O.K.}$$

$$\delta_c = \frac{5 \times 795 \times 18^3 \times 12^3}{384 \times 30,000 \times 82.5} = 0.759 \text{ \"}$$

$$\text{AISC } \frac{l}{360} = \frac{18 \times 12}{360} = 0.6 \text{ \"} < 0.759 \text{ \" N.G.}$$

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Sheet 2.12 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-2-76 Job No. 27-771-98 Calculation Superstructures (Equipment Deck)

Try W10X29

$$S_x = 30.8 \text{ in}^3$$

$$I_x = 158 \text{ in}^4$$

$$(\sigma_t)_{\max} = \frac{386}{30.8} = 12.5 \text{ ksi}$$

$$\delta_c = \frac{5 \times 795 \times 18^4 \times 12^3}{384 \times 30,000 \times 158} = 0.396" < 0.5"$$

O.K.

CREST OFFSHORE, INC.

Sheet 2.20 of

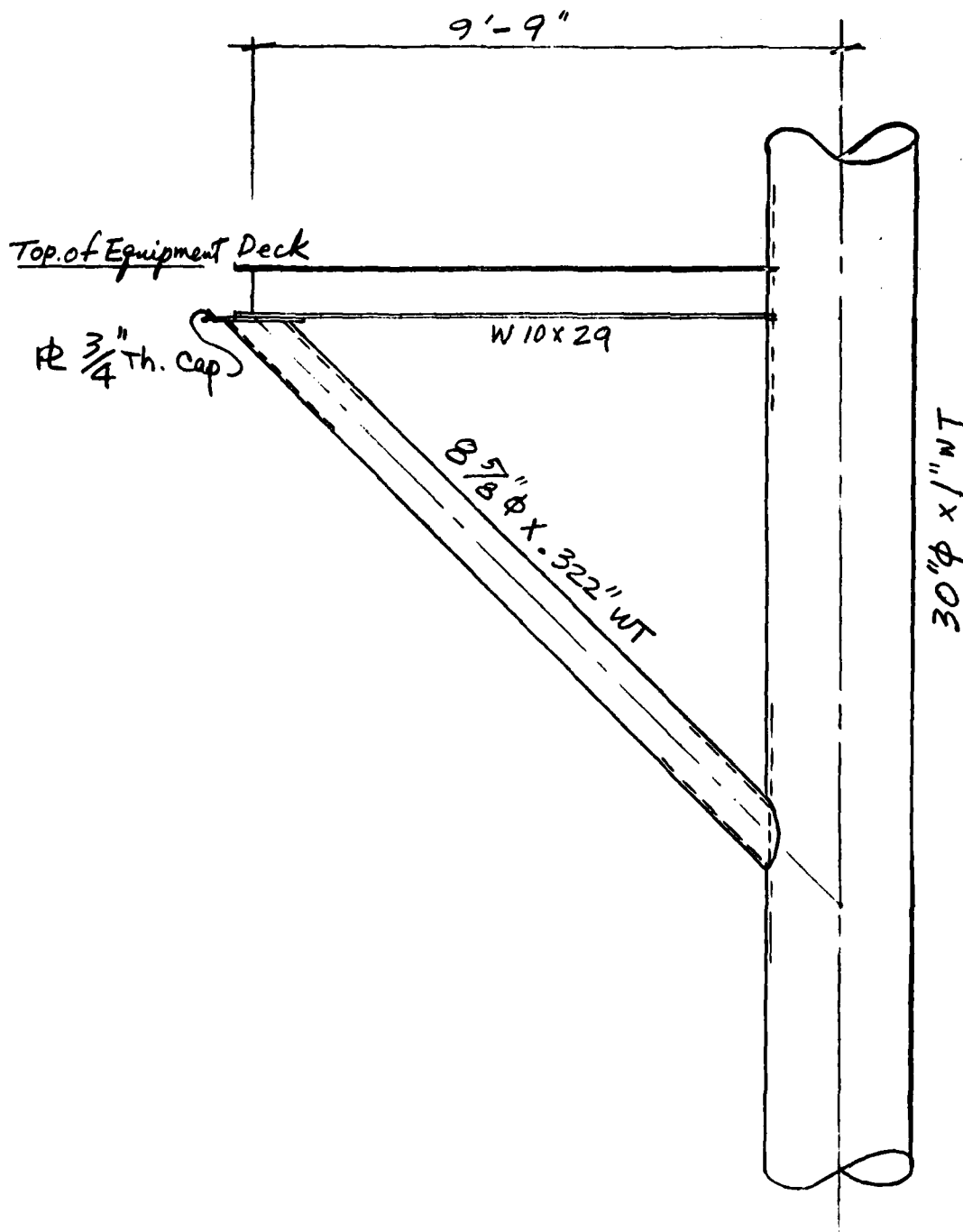
By C. Chern Client U.S. NAVY

Subject Miscellaneous Structures

Date 7-2-76 Job No. 27-771-98

Calculation Superstructures (Equipment Deck)

Section ①-①



CREST OFFSHORE, INC.

Sheet 2.21 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-2-76 Job No. 27-771-9B Calculation Superstructures (Equipment Deck)

Check $8\frac{5}{8}" \phi \times 322" WT$

$$A = 8.4 \text{ sq. in}$$

$$r = 2.94"$$

$$L = 13'-9"$$

$$K = \frac{KL}{r} = \frac{1 \times 13.75 \times 12}{2.94} = 56$$

$$F_a = 17.8 \text{ ksi}$$

$$\text{Axial Load} = \left(\frac{1}{2} \times 14,304\right) \times \sqrt{2} = 10,114 \text{ \#}$$

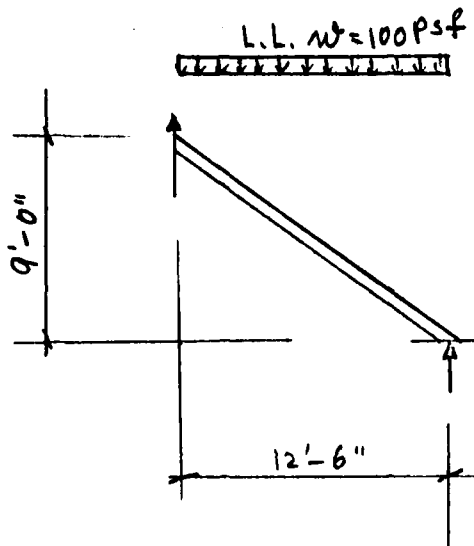
$$f_a = \frac{10.1}{8.4} = 1.2 \text{ ksi} \ll F_a$$

O.K.

CREST OFFSHORE, INC.

Sheet 2.23 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-1-76 Job No. 27-271-9B Calculation Superstructure (Stairways)



2- $\text{E}12$ @ 2'-6" Back-to-Back

Say 2- $\text{E}12 \times 20.7$

$$S_x = 21.5 \text{ in}^3$$

$$\text{L.L.} = 100 \times 2.5 \times \frac{12.5}{\sqrt{9^2 + 12.5^2}}$$

$$\text{L.L.} = 203 \text{ Plf}$$

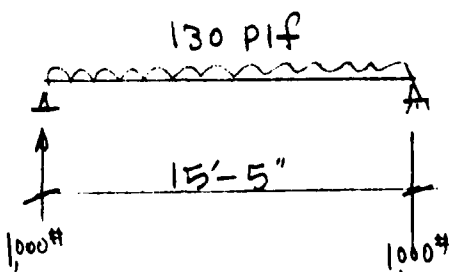
$$\text{Each Channel} \quad \text{L.L.} = 102 \text{ Plf}$$

$$\text{D.L.} = 21 (\text{E}12 \times 20.7)$$

$$\text{Misc} = 5$$

$$\text{Total} = 127$$

$$\text{Say } W = 130 \text{ Plf}$$



Moment due to 1K conc. Load.

$$M = \frac{PL}{4} = \frac{1 \times 15.4 \times 12}{4}$$

$$= 46.2 \text{ "K}$$

$$M_{\max} = \left(\frac{130}{1000} \right) \times \frac{15.4^2 \times 12}{8}$$

$$= 46.25 \text{ "K}$$

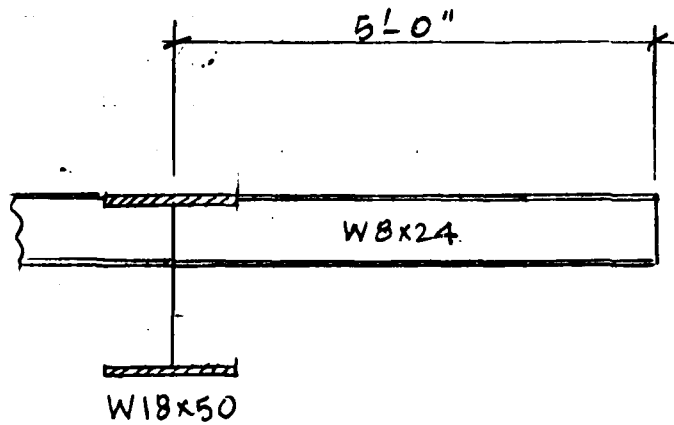
$$(\sigma_b)_{\max} = \frac{M}{S} = \frac{46.25}{21.5} = 2.15 \text{ ksi}$$

O.K.

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Sheet 2.24 of ---

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-1-76 Job No. 27-771-98 Calculation Superstructure (Stairways)



Loads from stairs

$$\begin{aligned} & (100 \times 2.5) \times 6.25 + (22 + 10) \times 7.7 \\ & = 1563^{\#} + 246^{\#} \\ & = 1809^{\#} \end{aligned}$$

Equivalent uniform load on W8x24

$$w_1 = \frac{1809}{5} = 362 \text{ Plf}$$

Uniform load from 100 psf

$$w_2 = 100 \times 2 = 200 \text{ Plf}$$

Total uniform loads

$$w = w_1 + w_2 = 562 \text{ Plf}$$

$$M_{\max} = \frac{wL^2}{2} = \frac{562 \times 5^2 \times 12}{2} = 84.3 \text{ ''-K}$$

$$W8 \times 24 \quad S_x = 20.8 \text{ in}^3$$

$$(\sigma_b)_{\max} = \frac{84.3}{20.8} = 4.05 \text{ ksi}$$

O. K.

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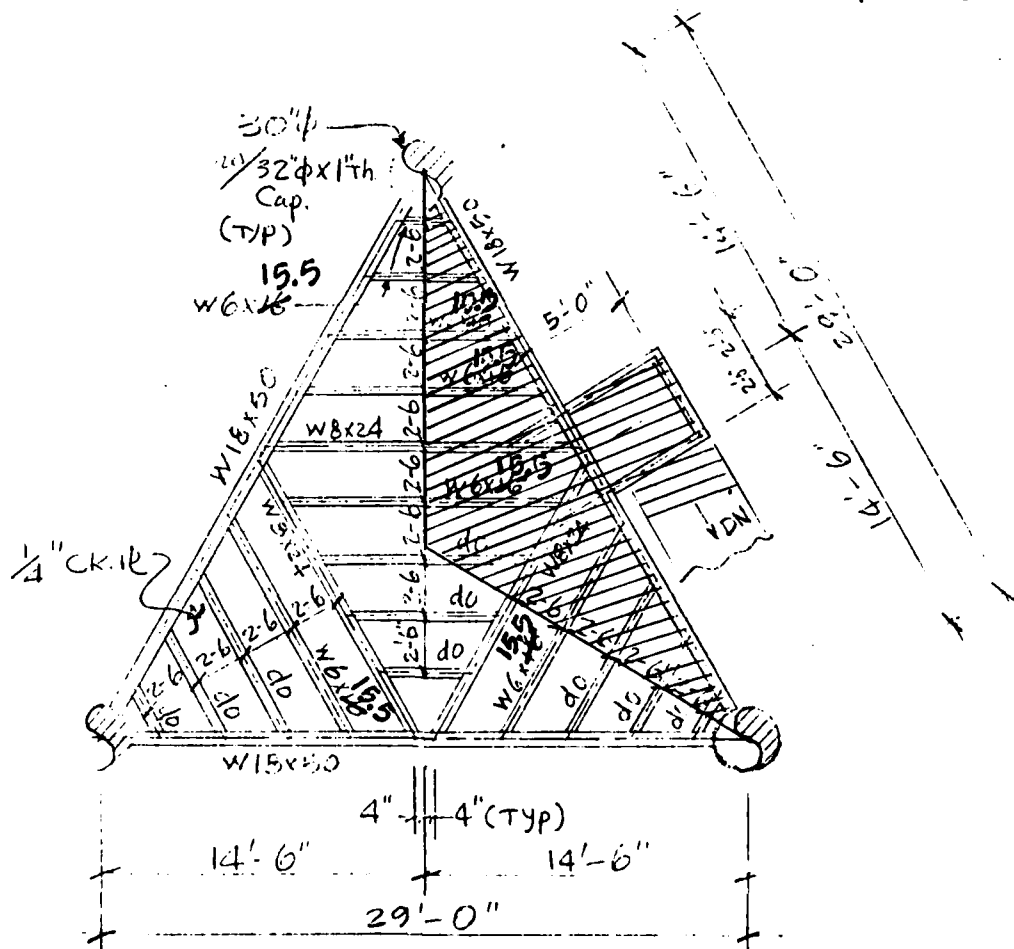
Sheet 225 of

By C. Chern Client U. S. NAVY Subject Miscellaneous Structures
Date 7-1-76 Job No. 27-771-98 Calculation Superstructures (Stairways)

Design Live Loads on Deck = 150 psf

Design Live Loads on Stairs = 100 psf (AISC)

or 1000 LBS Min.
(USAS AG4.1-1968)



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Sheet 2.26 of ---

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-1-76 Job No. 27-771-98 Calculation Superstructures (stairways)

W18x50

Additional loads due to stairway reactions

$$W_a = 562 \times 5 + 100 \times 2 \times 5 = 3,810 \#$$

Moment due to W_a

$$M_a = \frac{W_a L}{4} = \frac{3.81 \times 29 \times 12}{4} = 331.5 \text{ "K}$$

Total moment

$$M = 958.7 + 331.5 = 1,290.2 \text{ "K} < 2,136 \text{ "K}$$

$$W18x50 \quad S_x = 89.1 \text{ in}^3$$

(AISC
Allowable)

$$(\sigma_b)_{\max} = \frac{1,290.2}{89.1} = 14.48 \text{ ksi} \quad \text{o.k.}$$

$$\text{Total Loads} = 22 + 3.81 = 25.81 \text{ "K} < 49 \text{ "K} \quad \text{o.k.} \\ \text{(AISC Allowable)}$$

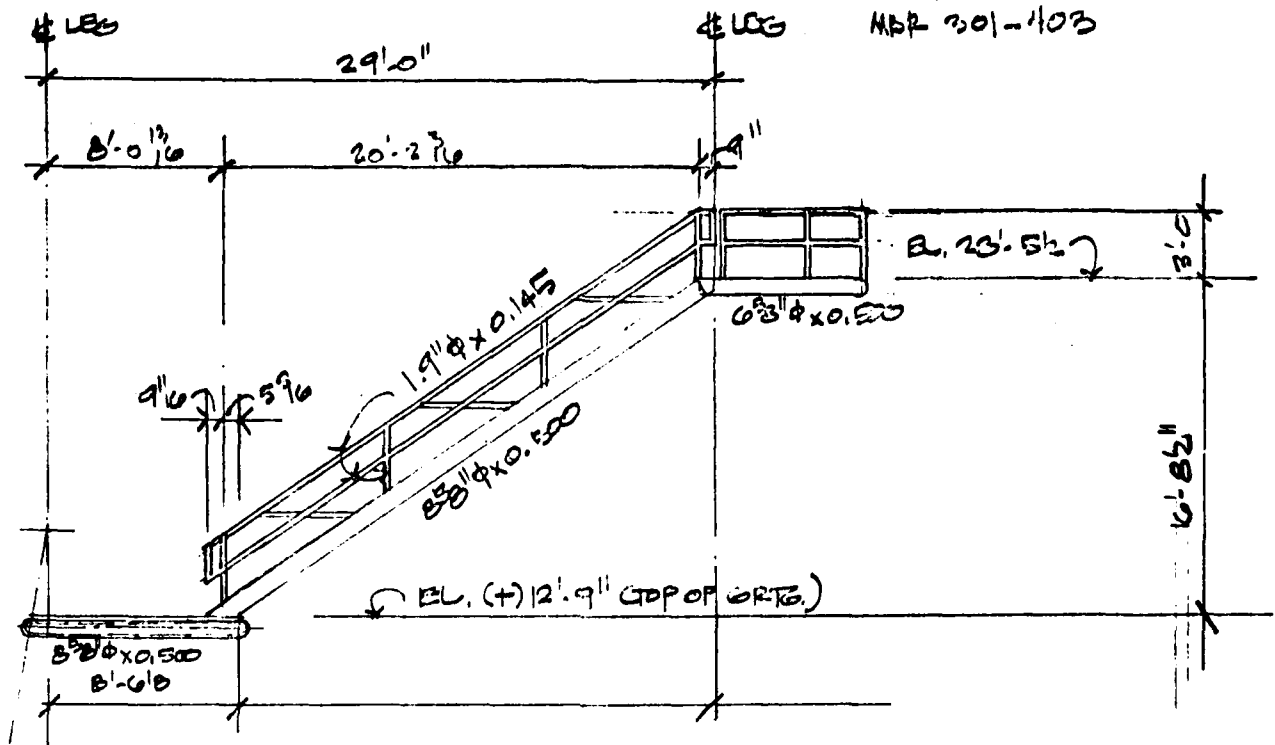
CREST OFFSHORE, INC.

Sheet 2.27 of ---

By JWS Client US NAVY Subject Miscellaneous Structures
Date 2-12-76 Job No. 27-17L-98 Calculation Superstructure

STAIRWAY 3

STAIRWAY #1
MBR 301-403



ELEVATION	WAVE FORCE	AVERAGE
81' + 23.5' = 104.5' ~ 110'	943 PSF	736.2 PSF
100	605 "	
81' + 12.75' = 93.75'	524 "	
90	476 "	

PROPERTIES of B'5" x 0.500 $A_x = 12.163$ $I_x = 105.743$ $S_x = 24.520$ $W_t = 43.4 \#$
" " " 1.9" x 0.145 $= 0.799$ $= 0.310$ $= 0.326$ $2.72 \#$

DEAD LOAD AT STRINGER

HAIRY L = $2.72 \# \times (1 \times 2 + 3) = 6.6$ ACTING AS POINT LOAD AT 1/3 SPAN
STAIR TREADS = $7.36 \# \times 1.25' = 9.2 \#$
STRINGER = 43.4
D.L. = 59.2 SAY 60 PLF
L.L. = $150 \text{ PLF} \times 1.25' = 187.5 \text{ PLF}$
 247.5 PLF SAY 250 PLF

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Sheet 2.28 of

By WV Client USE NAVY Subject Miscellaneous Structures
Date 8.11.76 Job No. 21-JA-98 Calculation Superstructure

STRINGER

NAVY #1

THERE IS NO AXIAL FORCE ON STRINGER

$$\text{OR } P=0 \text{ \& } P_x = F_x = 0$$

$$\therefore \text{USE: } \frac{\sqrt{M_y^2 + M_x^2}}{F_b} \leq 1.0$$

$$M_y = 0.25(1.5)^2/8 = 12.5 \text{ k} \quad f_{by} = \frac{12.5 \times 12}{24.5} = 6.12$$

$$M_x = 0.726(1/2)(20)^2/8 = 27.6 \text{ k} \quad f_{bx} = \frac{27.6 \times 12}{24.5} = 13.52$$

$$f_b \cdot \sqrt{f_{by}^2 + f_{bx}^2} = \sqrt{(6.12)^2 + (13.52)^2} = 14.84$$

$$f_b / F_b = \frac{14.84}{0.6 \times 30 \times 1.33} = 0.52 < 1.0 \quad \therefore \text{O.K.}$$

$$\boxed{8.8" \phi \times 0.500 \text{ O.K.}}$$

HANDRAIL

$$w = 130 \text{ #/ft} \left(\frac{2}{12} \right) = 123 \text{ #/ft}$$

$$M = 0.123(5)^2/8 = 0.38 \text{ k}$$

$$f_p = \frac{0.38 \text{ k} \times 12}{0.6 \times 30 \times 1.33} = 0.158 \text{ in}^3 < 0.326 \text{ in}^3$$

$$\boxed{1.9" \phi \times 0.145 \text{ O.K.}}$$

BALASTER

$$\text{LOAD FROM HANDRAIL} = 123 \times 7' = 861 \text{ #}$$

$$M = 0.871 \times 3' + 0.301 \times 15' = 3.87 \text{ k}$$

$$f_{bx} = \frac{3.87 \times 12}{21.6 \times 1.33} = 1.62 \text{ in}^3$$

$$\boxed{\text{USE: } 2.875" \phi \times 0.375 \text{ BALASTER'S!}}$$

$$w/sx = 1.137$$

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By KVS Client U.S. NAVY Subject Miscellaneous Structures
Date 8.10.76 Job No. 27-11-98 Calculation Superstructure

LOADING

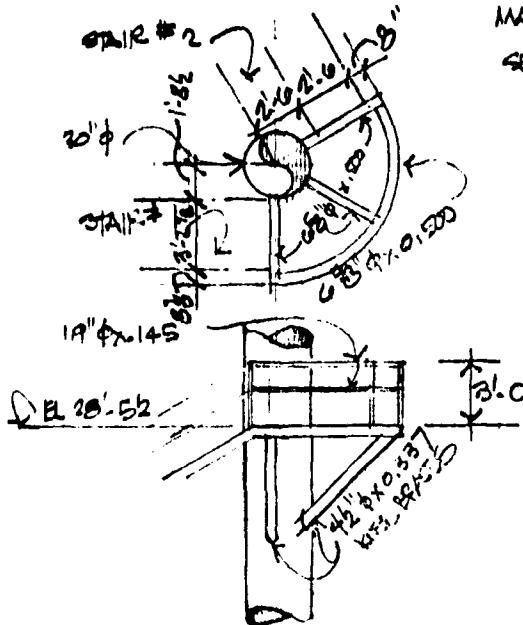
$$81' + 28.5' = 109.5' \approx 110'$$

MAX. WAVE FORCE AT ELEV 110' ABOVE MUD LINE = 948 PSF

SECTIONAL PROPERTIES

SECTION	A _x	I _x	S _x	wt.
6" ϕ x 0.500	9.621	15.43	13.72	32.71 #/ft
42" ϕ x 0.337	4.407	9.613	4.272	14.98 #/ft
1.9" ϕ x 0.145	0.799	0.310	0.326	2.72 #/ft

LANDING #1



LANDING BEAM - interior beam

$$W = W_u + W_{DL} = 5' \times 50 \text{ PSF} + (1.36 \text{ #/ft} \times 5' + 32.71 \text{ #/ft}) = 820 \text{ #/ft}$$

$$M = 0.02 (425)^2 / 8 = 1.85$$

$$S_p = 1.85 \times 12 / (21.6) = 1.03 \text{ in}^3 < 13.72$$

WAVE LOADING ON 9/8 beam.

$$M = 0.943 (1/2) (5)^2 / 8 + (0.820 (5)^2 / 8) = 3.01 \text{ k}$$

$$S_p = 3.01 \times 12 / (21.6 \times 1.33) = 1.26$$

6" ϕ x 0.500 beam o.k.

KNEE BRACES

$$P = [2' \times 5' (50 \text{ PSF} + 136) + 7' (32.71 + 2.72 \times 2)] = 1841 \text{ #}$$

$$f_a = \frac{P}{A} = \frac{1841 \text{ #}}{4.407 \text{ in}^2} = 418 \text{ psi} \quad \frac{F_y}{F} = \frac{1.0 \times 418}{\sqrt{9.613/4.407}} = 48.7$$

$$\frac{f_a}{F_y} = \frac{418}{1841} = 0.02 < 0.15 \quad \therefore F_y = 18.44$$

$$\frac{f_b}{F_b} = \frac{[0.943 (1/2) (5)^2 / 8] [12 / 4.272]}{21.60} = \frac{4.49}{21.60} = 0.208$$

$$f_a/F_y + f_b/F_b = 0.02 + 0.208 = 0.228 < 1.0 \text{ o.k.}$$

$\therefore$ 42" ϕ x 0.337 knee brace o.k.

HANDRAIL

$$W = 948 \text{ #/ft} \times (3/12) = 158$$

$$M = 0.158 (5)^2 / 8 = 0.494 \text{ k}$$

$$S_p = 0.494 \times 12 / (21.6) = 0.274 < 0.316$$

$\therefore$ 1.9" ϕ x 0.145 HANDRAIL o.k.

BALUSTER

$$M = 0.158 \times 5' (3' + 1.5') = 3.55 \text{ k}$$

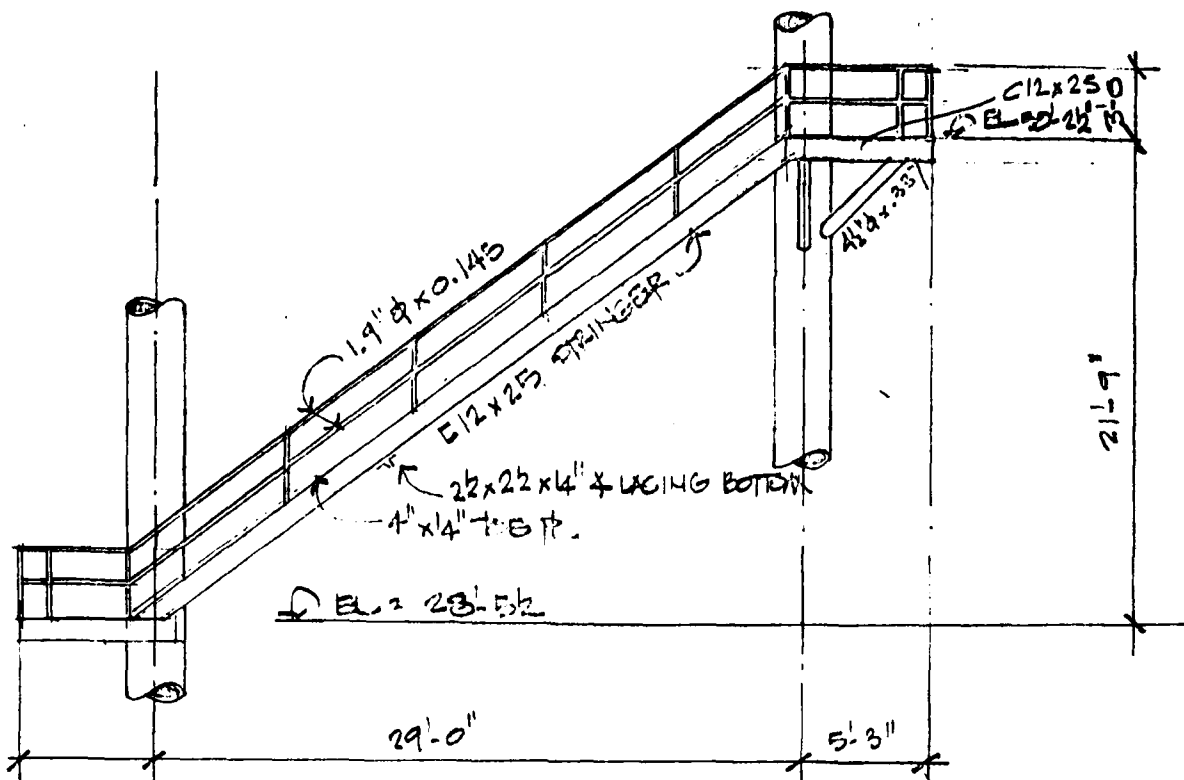
$$S_p = 3.55 \times 12 / (21.6 \times 1.33) = 1.48 \text{ in}^3$$

USE 2" ϕ x .375 MINIMUM w/ $S_x = 1.637$

CREST OFFSHORE, INC.

Sheet 230 of

By MS Client DS NAME Subject Miscellaneous Structures
Date 8.11.74 Job No. 27-221-98 Calculation Superstructure



ELEVATION STAIRWAY #2

SECTION PROPERTIES

Section	A_x	wt.	I_x	S_x	r_x	I_y	S_y	r_y
C 12 x 25	7.35		144	24.1	4.43	4.47	1.88	0.780
1.9" x 14.5	0.799	2.72 ^{lb}	0.310	0.926				
2.4 x 2.4 x 1/4	1.19	4.1 ^{lb}	0.702	0.394	0.491	r_3		

LAO 17-465

DEAD LOADS: STRINGER = 23 PLF

HANDRAIL = 2 "

THANKS = 10 // 137

LIVE LOAD: $150 \text{ RSP} \times 1.25' = 188''$

TOTAL LOAD = 225 PLF

WAVE LOADING

$$81 + 50 = 131 \quad 130 \quad 184 - 910$$

81 + 125 = 109.5 120 1048 - 998

110 948

ASSUME 1000 $\frac{1}{2}$ S.F.

CREST OFFSHORE, INC.

Sheet 2.31 of

By WV Client U.S. Navy Subject Miscellaneous Structures
 Date 8-11-76 Job No. 27-77-98 Calculation Superstructure

STAIRWAY #2

HANDRAIL

$$W_{hand} = 1000 \frac{\text{lb}}{\text{ft}} \times \left(\frac{3}{12}\right) = 167 \text{ PLF}$$

$$M = 0.167 (6)^2 / 8 = 0.752 \text{ k}$$

$$S_x = 0.752 \text{ k} \times 12 / (21.6 \times 1.33) = 0.34 \text{ in}^3 < 0.294 \text{ in}^3$$

$$\therefore 1.9" \phi \times 0.145 \text{ o.k.}$$

BALUSTERS

$$P = 167 \text{ k} \times 6' = 1.0 \text{ k}$$

$$M = 1.0 \text{ k} \times 3' + 1.0 \text{ k} \times 1.5' = 4.5 \text{ k}$$

$$S_x = 4.5 \times 12 / (21.6 \times 1.33) = 1.83 \text{ in}^3$$

$$\text{USE } 2.31" \phi \times 0.375"$$

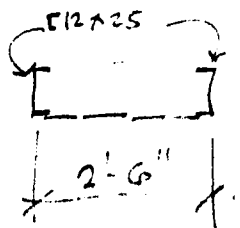
STRINGER

$$W_{string} = 1000 \frac{\text{lb}}{\text{ft}} \times 1' = 1000 \text{ PLF}$$

$$W_{ps} = 225 \text{ PLF}$$

$$f_{bx} = \frac{M_x}{S_x} = \frac{0.225 (29)^2 \times 12}{8} = 11.77 < 21.6 \therefore \text{o.k.}$$

Note: for wave force the whole stair width is used



$$I = 7.35 \text{ in}^2 \left(\frac{30}{2}\right)^2 = 1654 \text{ in}^4 \quad S_y = \frac{1654}{15} = 110$$

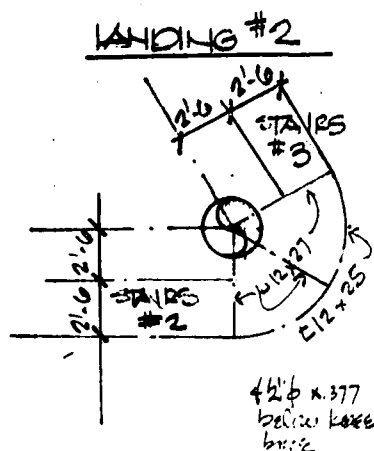
$$f_{by} = \frac{M_y}{S_y} = \frac{1.0 (29)^2 \times 12}{8} = 11.47 \text{ ksi} < 21.6 \times 1.33$$

deck deflection $\Delta_{all} = \frac{1}{360} = \frac{29 \times 12}{360} = 0.96 \approx 1.0"$

$$\Delta = \frac{5 (0.225) (29)^4 \times 12}{384 \times 29 \times 144} = 0.86" < 1.0" \therefore \text{o.k.}$$

$$\boxed{L 12 \times 25 \text{ o.k.}}$$

By KW Client U.S. NAVY Subject Miscellaneous Structures
 Date 8-11-76 Job No. 27-771-98 Calculation Superstructure



SECTION PROPERTIES

SECTION	A_x	I_x	S_x	wt.	S_y
E 12x25	7.35	144	24.1	25	
W 12x27	7.95	204	34.2		
4 1/2" x 3/7"	4.407	9.643	4.272	14.93 #1	

LOADING

WAVE = 784 PSF

INTERIOR LANDING BEAM

$$W = W_{LL} + W_{DL} = 5' \times 150 \text{ PSF} + (7.36 \times 5 \text{ FT}) = 814 \text{ #1}$$

$$M = 0.814(4)^2/8 = 1.628 \text{ k}$$

$$f_p = 1.628 \times 12 / 21.0 = 0.93 \text{ k/in}^2 < 34.2 \text{ k.s.i.}$$

BEAM SUPPORTING STAIRS STRINGER

$$W = 1/2 \text{ of } W_{LL} = 814/2 = 407 \text{ #1}$$

$$P_{EFT} = 0.225 \text{ #1} \times 29/2 = 3.26 \text{ k}$$

$$P_{HOP} = 1.05 \text{ #1} \times 29/2 = 14.5 \text{ k}$$

$$M = 0.407(4)^2/2 + 3.26 \times 4 + 3.26 \times 1.5 = 21.2 \text{ k}$$

$$f_a = \frac{P}{A} = \frac{14.5 \text{ k}}{7.95 \text{ in}^2} = 1.82 \text{ k/in}^2$$

$$f_b = \frac{M}{S} = \frac{21.2 \text{ k} \times 12}{21.0} = 11.8 \text{ k/in}^2$$

$$KL/r = 2 \times 4 \times 12 / \sqrt{204/7.95} = 19 \leq F_a = 20.00$$

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} = \frac{1.82}{20.00} + \frac{11.8}{21.4} = 0.63 < 1.0 \text{ o.k.}$$

OUTSIDE STRINGER

$$M_y = 0.784(5)^2/8 = 2.45 \text{ k}$$

$$M_x = (2 \times 1.60 + 2 \times 7.36 + 25)(5)^2/8 = 1.06$$

$$f_{by} = \frac{2.45 \text{ k} \times 12}{1.88 \text{ in}^2} = 15.64$$

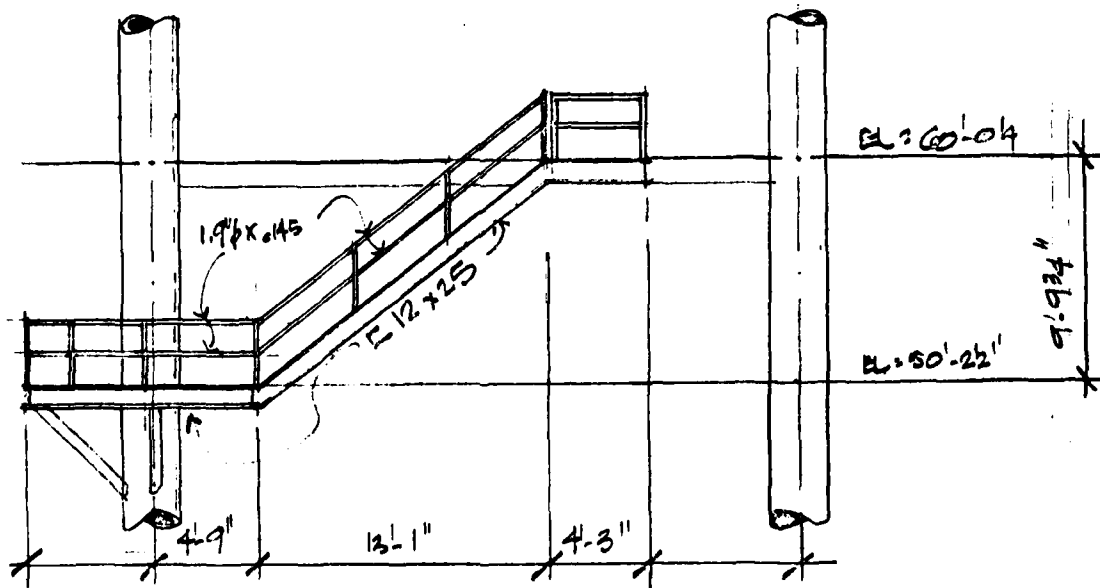
$$f_{bx} = \frac{1.06 \times 12}{24.1} = 0.53$$

$$\frac{f_{by}}{F_{by}} + \frac{f_{bx}}{F_{bx}} = \frac{15.64}{21.6 \times 1.33} + \frac{0.53}{21.4} = 0.57 < 1.0 \text{ o.k.}$$

CREST OFFSHORE, INC.

Sheet 2.33 of ---

By W.H. Client (S) S. 11-98 Subject Miscellaneous Structures
 Date 8-11-70 Job No. 27-11-98 Calculation Superstructure



STAIRWAY #3

SECTION PROPERTIES

SECTION	A_x	I_x	S_x	S_y	wt.
C 12 x 25	7.35	144	24.1	1.88	
1.9" x .145	0.779	0.810	0.326		2.72 #/ft

STAIR STRINGER

WERT = 225 PCF (see stair #2)

$$M = 0.225(18)^2/8 = 9.11 \text{ K}$$

$$S_r = 9.11 \times 12 / 21.6 = 5.06 < 24.1$$

OK DEFLECTION $\Delta_{all} = 18 \times 12 / 240 = 0.9$

$$\Delta = 5(.225)(18)^4 / (384 \times 29 \times 144) = 0.13''$$

o.k.

WAVE FORCE = 537 PSF

TWO STAIR STRINGERS & 4'S & TRENDS BAK TROSS w/ $S_x = 110 \text{ w}^3$ (see #2)

$$M = 0.537(18)^2/8 = 21.75 \text{ K}$$

$$f_b = 21.75 \times 12 / 110 = 2.37 \text{ ksi} < 21.6 \therefore \text{o.k.}$$

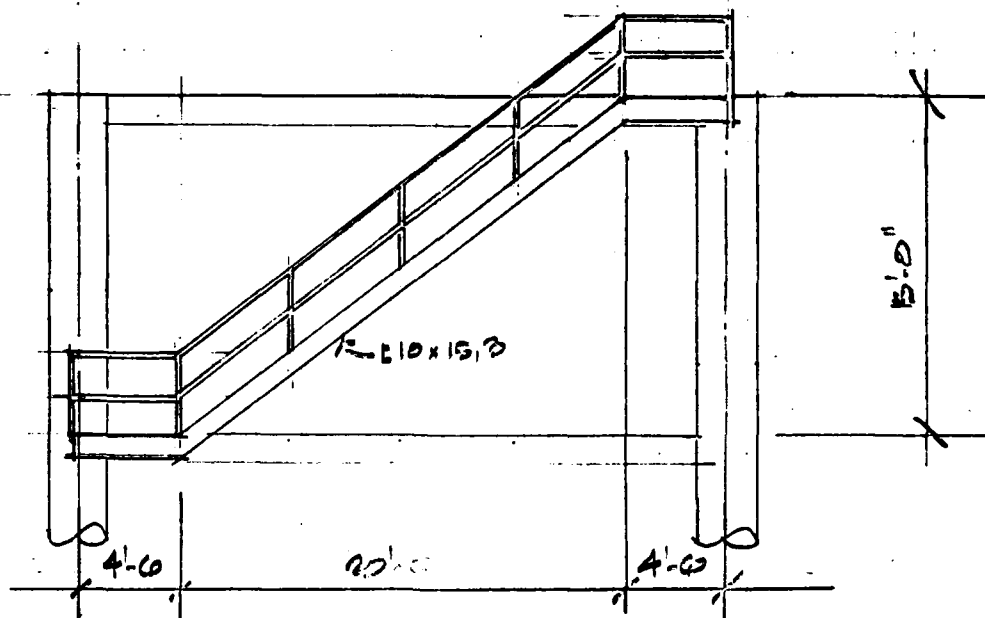
HANDRAILS & BALUSTERS

NEGLECT BY INSPECTION

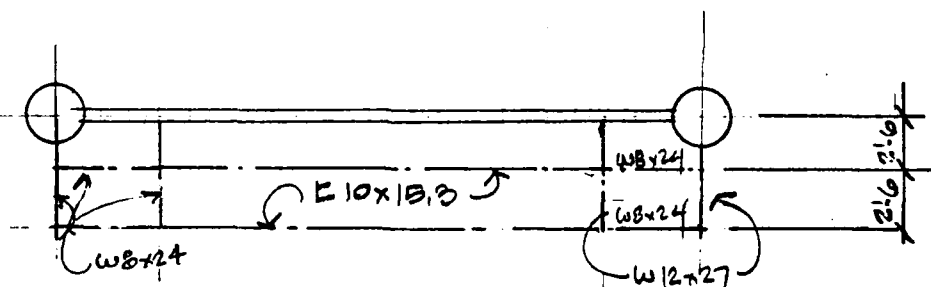
CREST OFFSHORE, INC.

Sheet 2.35 of ---

By WMA Client DCI Subject Miscellaneous Structures
 Date 5-12-76 Job No. 27-71-98 Calculation Superstructure



ELEV. STAIR #4



STAIR #4 PLAN

SECTION PROPERTIES

SECTION	A	I _x	S _x	r _x	S _y	I _y
E10x15.3	4.49	67.4	13.6	3.87	1.14	0.713
W8x24	7.06	82.4	20.8	3.42	5.61	1.61
W12x27	7.95	204	34.2	5.07	5.63	1.52

LOADING

NOTE NO WAVE LOAD WILL OCCUR ON THIS STAIR
 DEAD LOAD = ACTUAL
 LIVE LOAD = 150 PSF

By MVS Client 21-171-98 Subject Miscellaneous Structures
 Date 8-13-70 Job No. 21-171-98 Calculation Superstructure

STAIR # 4

HANDRAILS - NEGLECT BY INSPECTION

STRINGERS

$$W_L = W_{DL} + W_{LL} = 1.25 \times 10 + 15.3 + 1.25 \times 150 = 215 \#'$$

$$M = 0.215(20)^2/8 = 10.8 \text{ K}$$

$$f_b = 10.8 \times 12 / 13.5 = 9.6 < 21.6 \text{ o.k.}$$

WIND = 25 PSF

$$M = 0.025(20)^2/8 = 1.25$$

$$f_b = 1.25 \times 12 / 1.16 = 12.93$$

(STAIRS FORMS TRUSS & WIND WILL BE INSIGNIFICANT)

By Br truss $\approx 100 \text{ w}^3$

$$f_b = 1.25 \times 12 / 100 = 0.15 < 21.6$$

check deflection $\Delta_{all} = L/360 = 20 \times 12 / 360 = 0.67$

$$\Delta_{actual} = \frac{5(0.225)(20)^4}{384 \times 29 \times 0.74} \times 1.728 = 0.414 < 0.67$$

LOWER LANDING

$$P_{LOAD FROM STRINGERS} = 10' \times 215 \# = 2150 \#$$

$$M = (5.0 + 2.5)(2.15 \text{ K}) + (2' \times 170 \#')(5)^2/2 = 20.375 \text{ K}$$

$$f_b = \frac{20.375 \text{ K} \times 12}{20.8 \text{ w}^3} = 11.75 \text{ K} < 21.6 \text{ o.k.}$$

check deflection $\Delta_{all} = L/360 = 5 \times 12 / 360 = 0.17$

$$\Delta_{actual} = \frac{(2 \times 1.7)(5)^4 \times 1.728}{8 \times 29 \times 82.4} + \frac{2.15(5)^3 \times 1.728}{3 \times 29 \times 82.4} + \frac{2.15(2.5)^2(3 \times 5 - 2.5) \times 1.728}{6 \times 29 \times 82.4}$$

$$= 0.019 + 0.065 + 0.020 = 0.104 < 0.17$$

UPPER LANDING

BY INSPECTION IF W8x24 WORKS FOR LOWER LANDING W12x27 WILL BE O.K FOR UPPER LANDING

CREST OFFSHORE, INC.Sheet 2-37 of By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-14-76 Job No. 27-771-9B Calculation Superstructures**2.6 DEAD WEIGHT OF SUPERSTRUCTURE**

MEMBER SIZE	MEMBER LENGTH	NO. REQUIRED	TOTAL LENGTH	UNIT WEIGHT	TOTAL WEIGHT
IN. x IN.	FT		FT	LBS/FT	LBS
42"φ x 1.0" WT	5.0	3	15.0	473.39	7,100.9
30"φ x 1.0" WT	50.5	3	151.5	309.73	46,924.1
42"φ x 30"φ x 1" WT Cone	3.0	3	9.0	391.56	3,524.0
14"φ x .5" WT	32.65	3	97.95	72.09	7,061.2
12 ³ / ₄ "φ x .5" WT	29.0	3	87.0	65.42	5,691.5
					70,301.7
<u>EQUIPMENT DECK</u>					
W18x50	29.0	2	58.0	50.0	2,900.0
W21x73	29.0	1	29.0	73.0	2,117.0
W10x29	38.0	1	38.0	29.0	1,102.0
W8x24	14.5	3	43.5	24.0	1,044.0
W8x24	5.0	2	10.0	24.0	240.0
W8x24	4.0	1	4.0	24	96.0
W6x16*	8.0	7	56.0	16	896.0

CREST OFFSHORE, INC.

Sheet 2.38 of ----

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-14-76 Job No. 27-771-98 Calculation Superstructures

MEMBER SIZE	MEMBER LENGTH	NO. REQUIRED	TOTAL LENGTH	UNIT WEIGHT	TOTAL WEIGHT
IN. X IN.	FT		FT	LBS/FT	LBS
W 6x16*	4.0	2	8.0	16.0	128.0
W 6x16* (2.9+5.8+8.7+11.6)	29.0	4	116.0	16.0	1,856.0
1/4" ϕ	362.5 $\square'$	1	362.5	10.2	3,697.5
1/4" ϕ	188.0 $\square'$	1	188.0	10.2	1,917.6
8 5/8" ϕ X .322" WT	13.8	2	27.6	28.55	787.2
					16,781.3
<u>UPPER DECK</u>					
W 18x50	29.0	3	87.0	50.0	4,350.0
W 8x24	14.5	3	43.5	24.0	1,044.0
W 6x16*	7.25	4	29.0	16.0	464.0
4x3/8" FB	37.5	4	150.0	5.1	765.0
1/4" ϕ	362.5 $\square'$	1	362.5	10.2	3,697.5
32" ϕ X 1" Th. Cap.	5.6 $\square'$	3	16.8	40.8	685.4
					11,005.9
					98,088.9

CREST OFFSHORE, INC.

Sheet 2.39 of

By C. C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-14-76 Job No. 27-771-98 Calculation Superstructures

MEMBER SIZE	MEMBER LENGTH	NO. REQUIRED	TOTAL LENGTH	UNIT WEIGHT	TOTAL WEIGHT
IN. x IN.	FT		FT	LBS/FT	LBS
<u>STAIRS #1</u>					
C 12x25	25.22	2	50.44	25.0	1,261.0
Treads		25		25.0 ea.	625.0
1/4" x 4" PL	25.22	2	50.44	3.40	171.5
1.9" ϕ x .145" WT	25.22	4	100.88	2.72	274.4
"	11.0	6	66.0	2.72	179.5
"	8.25	8	66.0	2.72	179.5
"	3.0	4	12.0	2.72	32.6
$\angle 2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	30.0	1	30.0	4.10	123.0
C 10x20	10.5	1	10.5	20.0	210.0
"	4.25	3	12.75	"	255.0
"	6.0	3	18.0	"	360.0
Grating	26.2 ^{SO. FT}	1		9.04	236.8
1.9" ϕ x .145" WT	10.5	2	21.0	2.72	57.2
"	3.5	4	14.0	"	38.1
EL. (+) 12'-9 1/4" TO EL. (+) 29'-1"					4,003.6

CREST OFFSHORE, INC.

Sheet 2.40 of ---

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-16-76 Job No. 27-771-98 Calculation Superstructures

MEMBER SIZE	MEMBER LENGTH	NO. REQUIRED	TOTAL LENGTH	UNIT WEIGHT	TOTAL WEIGHT
	FT		FT	LBS/FT	LBS
<u>STAIRS #2</u>					
C 12x25	36.25	2	72.5	25.0	1,812.5
Treads		34		25.0 ea	850.0
1/4" x 4" ϕ	36.25	2	72.5	3.4	246.5
1.9" ϕ x .145" WT	36.25	4	145.0	2.72	394.4
"	3.5	12	42.0	"	114.2
< 2 1/2 x 2 1/2 x 1/4	40.0	1	40.0	4.10	164.0
C 10x20	10.5	1	10.5	20.0	210.0
"	4.25	3	12.75	20.0	255.0
"	6.0	3	18.0	20	360.0
Grating	26.2 ^{SQ. FT}	1		9.04	236.8
1.9" ϕ x .145" WT	10.5	2	21.0	2.72	57.2
"	3.5	4	14.0	"	38.1
					<u>4,738.7</u>
EL. (+) 29'-1" to EL. (+) 50'-10"					

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Sheet 2.41 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-16-76 Job No. 27-171-98 Calculation Superstructures

MEMBER SIZE	MEMBER LENGTH	NO. REQUIRED	TOTAL LENGTH	UNIT WEIGHT	TOTAL WEIGHT
	FT		FT	LBS/FT	LBS
STAIRS #3					
C12x25	5.0	2	10.0	25.0	250.0
C12x25	15.3	2	30.6	"	765.0
Treads		15		25.0	375.0
1/4"x4" PL	20.3	2	40.6	3.4	138.0
Grating	12.5 ^{SQ.FT}	1		9.04	113.0
1/4"x4" PL	14.2	1	14.2	3.4	48.3
Grating	20.0	1		9.04	180.8
1.9"φx.145"WT	20.3	4	81.2	2.72	220.9
"	3.5	10	35.0	"	95.2
"	29.0	1	29.0	"	78.9
EL.(+)50'-10" +0 EL.(+)60'-0"					2,265.1
STAIRS #4 SAME AS STAIRS #3					2,265.1
TOTAL STAIRS					13,272.5 ^{LBS}

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Sheet 2.42 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-16-76 Job No. 27-771-98 Calculation Superstructures

MEMBER SIZE	MEMBER LENGTH	No. REQUIRED	TOTAL LENGTH	UNIT WEIGHT	TOTAL WEIGHT
	FT		FT	LBS/FT	LBS
HAND RAILS ON DECKS					
<u>UPPER DECK</u>					
1.9"φX.145"WT	29.0	6	174.0	2.72	473.3
"	3.5	27	94.5	"	257.0
<u>EQUIPMENT DECK</u>					
1.9"φX.145"WT	29.0	4	116.0	2.72	315.5
"	38.0	2	96.0	"	216.1
"	3.5	29	101.5	"	276.1
					1,538.0
<u>Kick Plates</u>					
1/4" x 4" PL	29.0	3	87.0	3.4	295.8
1/4" x 4" PL	29.0	2	58.0	3.4	197.2
"	38.0	1	38.0	"	129.2
					622.2
					2,160.2

CREST OFFSHORE, INC.

Sheet 2.43 of

By C. Chern Client U. S. NAVY Subject Miscellaneous Structures
Date 7-16-76 Job No. 27-771-98 Calculation Superstructures

SUMMARY

SUPERSTURE LEG & TUBULAR BRACES 70,302 LBS

EQUIPMENT DECK 16,781 LBS

UPPER DECK 11,006 LBS

STAIRS 13,273 LBS

HAND RAILS (DECKS) 2,160 LBS

113,522 LBS

113.5 kips

($56\frac{3}{4}$ TONS)

* W6x16 changed to W6x15.5

CREST OFFSHORE, INC.

Sheet 2.44 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-15-76 Job No. 27-771-98 Calculation Superstructures

2.7 PAINT AREA

MEMBER SIZE	MEMBER LENGTH (C. to C.)	SURFACE AREA	NO. REQUIRED	TOTAL AREA	NOTES
	FT	SQ. FT		SQ. FT	
42" ϕ x 1" WT	5.0	55.0	3	165.0	Jkt LEG
30" ϕ x 1" WT	50.5	396.6	3	1,189.8	"
42" ϕ x 30" ϕ x 1" WT (Cone)	3.0	28.3	3	84.8	"
14" ϕ x .5" WT	32.65	119.7	3	359.0	Verti. Braces
12 3/4" ϕ x .5" WT	29.0	96.8	3	290.4	Horiz. Braces
				2,089.0	
W 18 x 50	29.0	246.5	2	493.0	Equipment Deck
W 21 x 73	29.0	287.6	1	287.6	"
W 10 x 29	38.0	101.3	1	101.3	"
W 8 x 24	14.5	35.0	3	105.0	"
W 8 x 24	5.0	12.1	2	24.2	"
W 8 x 24	4.0	9.7	1	9.7	"
W 6 x 16*	8.0	13.7	7	95.7	"

CREST OFFSHORE, INC.

Sheet 2.45 of ---

By C. Chern Client U. S. NAVY Subject Miscellaneous Structures
 Date 7-15-76 Job No. 27-771-98 Calculation Superstructures

MEMBER SIZE	MEMBER LENGTH (C. to C.)	SURFACE AREA	NO. REQUIRED	TOTAL AREA	NOTES
	FT	SQ. FT		SQ. FT	
W 6x16*	4.0	6.8	2	13.6	Equipment Deck
W 6x16* (2.9+5.8+8.7+11.6)	29.0	49.5	4	198.0	"
1/4" PL		362.5	2	725.0	"
1/4" PL		188.0	2	376.0	"
8 5/8" φ x .322 WT	13.8	31.2	2	62.4	"
				2,491.5	
W 18x50	29.0	123.3	3	369.9	Upper Deck
W 8x24	14.5	35.0	3	105.0	"
W 6x16	7.25	12.4	4	49.6	"
4"x 3/8" FB	37.5	25.0	4	100.0	"
1/4" PL		362.5	2	725.0	"
				1,349.5	

CREST OFFSHORE, INC.

Sheet 246 of ----

By C. Chon Client LS. V&P Subject Miscellaneous Structures
 Date 7-16-76 Job No. 22-221-98 Calculation Superstructure

MEMBER SIZE	MEMBER LENGTH (C. TO C.)	SURFACE AREA	NO. REQUIRED	TOTAL AREA	NOTES
	FT	SQ. FT		SQ. FT	
C12 x 25	25.22	151.3	2	302.6	STAIRS #1
Treads		4.1	25	102.5	
1/4" x 4" PL	25.22	16.8	2	33.6	
1.9" Ø x .145 WT	25.22	12.5	4	50.0	
"	11.0	5.5	6	33.0	
"	8.25	4.1	8	32.8	
"	3.0	1.5	4	6.0	
< 2 1/2 x 2 1/2 x 1/4	30.0	25.0	1	25.0	
[10 x 20	10.5	27.1	1	27.1	
"	4.25	11.0	3	33.0	
"	6.0	15.5	3	46.5	
Grating	26.25 FT	52.4	1	52.4	
1.95 x .145 WT	10.5	5.2	2	10.4	
"	3.5	1.7	4	6.8	
				761.7	

CREST OFFSHORE, INC.

Sheet 2.47 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-16-76 Job No. 27-77-98 Calculation Superstructures

MEMBER SIZE	MEMBER LENGTH (C. TO C.)	SURFACE AREA	NO. REQUIRED	TOTAL AREA	NOTES
	FT	SQ. FT		SQ. FT	
C12x25	36.25	108.8	2	217.6	STAIRS #2
Treads		4.1	34	139.4	
1/4"x4" PL	36.25	24.2	2	48.4	
1.9"φX.145"WT	36.25	18.0	4	72.0	
"	3.5	1.74	12	20.9	
2 1/2 x 2 1/2 x 1/4	40.0	16.7	1	16.7	
C10x20	10.5	27.1	1	27.1	
"	4.25	11.0	3	33.0	
"	6.0	15.5	3	46.5	
Grating	26.2 SQ. FT	52.4	1	52.4	
1.9"φX.145"WT	10.5	5.2	2	10.4	
"	3.5	1.7	4	6.8	
				691.2	

CREST OFFSHORE, INC.

Sheet 2.48 of ---

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-16-76 Job No. 27-77L-98 Calculation Superstructures

MEMBER SIZE	MEMBER LENGTH (C. TO C.)	SURFACE AREA	NO. REQUIRED	TOTAL AREA	NOTES
	FT	SQ. FT		SQ. FT	
E 12x25	5.0	15.0	2	30.0	STAIRS #3
E 12x25	15.3	45.9	2	91.8	
Treads		4.1	15	61.5	
1/4" x 4" P	20.3	13.1	2	27.0	
Grating	12.5 SQ. FT	25.0	1	25.0	
1/4" x 4" P	14.2	9.5	1	9.5	
Grating	20.0 SQ. FT	40.0	1	40.0	
1.9" φ x .145" WT	20.3	10.1	4	40.4	
"	3.5	1.74	10	17.4	STAIRS #4
"	29.0	14.4	1	14.4	
				357.0	
				357.0	
				2,166.9	TOTAL STAIRS

CREST OFFSHORE, INC.

Sheet 2.49 of

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-16-76 Job No. 27-771-9B Calculation Superstructures

MEMBER SIZE	MEMBER LENGTH (C. TO C.)	SURFACE AREA	NO. REQUIRED	TOTAL AREA	NOTES
	FT	SQ. FT		SQ. FT	
1.9" ϕ x .145" WT	29.0	14.4	6	86.4	Hand Rails on Decks Upper Deck
"	3.5	1.74	27	47.0	
1/4" x 4" ϕ	29.0	19.3	3	58.0	
1.9" ϕ x .145" WT	29.0	14.4	4	57.6	Equipment Deck
"	38.0	18.9	2	37.8	
"	3.5	1.74	29	50.5	
1/4" x 4" ϕ	29.0	19.3	2	38.6	
"	38.0	25.3	1	25.3	
				401.2	

CREST OFFSHORE, INC.

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By C. Charr Client U.S. Navy Subject Miscellaneous Structures
Date 7-16-76 Job No. 27-721-98 Calculation Superstructures

SUMMARY

SUPERSTRUCTURE LEG & TUBULAR BRACES	2,089 SQ. FT
EQUIPMENT DECK	2,492 SQ. FT
UPPER DECK	1,350 SQ. FT
STAIRS	2,167 SQ. FT
HANDRAILS & KICK PLATES (DECKS)	401 SQ. FT
	8,499 SQ. FT
	(8,500 SQ. FT)

*W 6x16 was changed to W 6x15.5

By J. Talbot Client U.S. Navy Subject Miscellaneous Structures
 Date 8-16-76 Job No. 27-771-9B Calculation Superstructure

Lifting Eyes - Superstructure

Weight of Superstructure = 120^k

Assume entire weight is at one lift eye.

Assume impact factor of 2.0.

Assume total applied load of 240^k can be acting completely vertical or completely horizontal.

Assume sling $\theta = 60^\circ$.

Check Shear in Pin:

Use 3.25" Diameter Pin -

$$\frac{P}{A} = \frac{280^k}{2 (\pi 1.625^2)} = 16.9 \text{ ksi}$$

$$F_s = 0.4 (36 \text{ ksi}) \times 1.33 = 19.2 \text{ ksi}$$

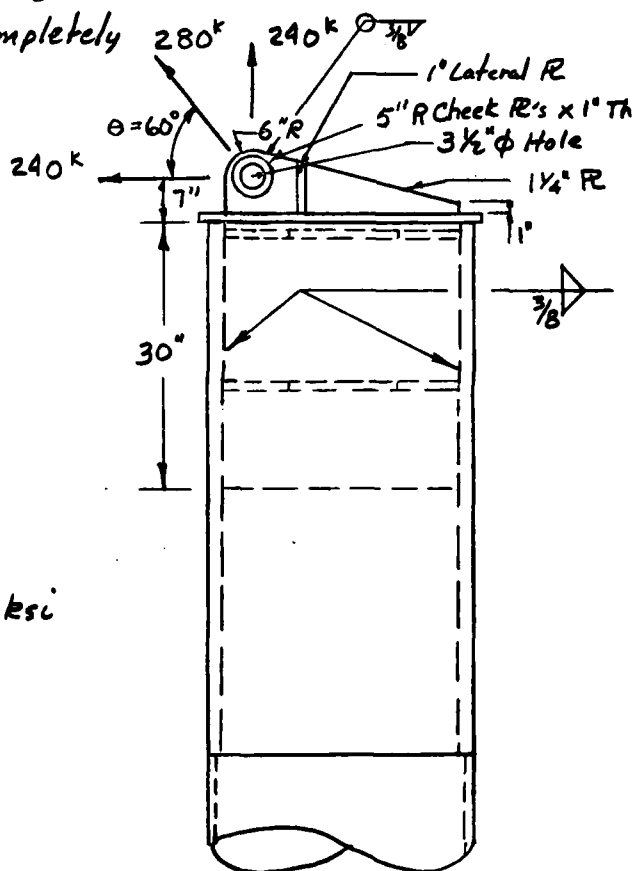
$$16.9 < 19.2$$

Check Bearing on Plate

$$\frac{P}{Dt} = \frac{280^k}{(3.25)(3.25)} = 26.5 \text{ ksi}$$

$$F_{br} = 0.9 (36 \text{ ksi}) = 32.4 \text{ ksi}$$

$$26.5 < 32.4$$



By J. Talbot Client U.S. Navy Subject Miscellaneous Structures
 Date 8-16-76 Job No. 27-771-98 Calculation Superstructure

Check Pin Shearing Through Plates

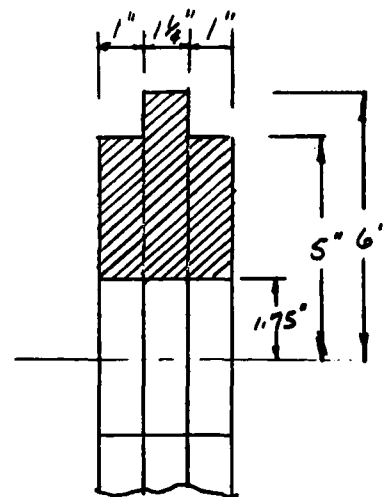
$$A = 4[(5 - 1.75) \times 1.0] + 2[(6 - 1.75) \times 1.25]$$

$$A = 13.0 + 10.6 = 23.6 \text{ in}^2$$

$$f_s = \frac{280^k}{23.6 \text{ in}^2} = 11.9 \text{ ksi}$$

$$F_s = 0.4 (36 \text{ ksi}) \times 1.33 = 19.2 \text{ ksi}$$

$$11.9 < 19.2$$



By J. Tolbat Client U.S. Navy Subject Miscellaneous Structures
Date 8-16-76 Job No. 27-771-98 Calculation Superstructure

* Tension Through Lift Eye

$$A = 4[3.25 \times 1.0] + 2[4.25 \times 1.25] = 23.6 \text{ in}^2$$

$$f_t = \frac{280 \text{ k}}{23.6 \text{ in}^2} = 11.9 \text{ ksi}$$

$$F_t = 0.6 (36 \text{ ksi}) \times 1.33 = 28.7 \text{ ksi}$$

$$11.9 < 28.7$$

Check Weld of Cheek Plates

$$\frac{A_R}{A_{\text{Total}}} = \frac{1.0}{3.25} = 0.31$$

$$P_{\text{shear}} = 0.31 \times 280 \text{ k} = 86.8 \text{ k}$$

$$\text{Circumference} = \pi (10) = 31.4 \text{ ''}$$

$$\frac{P}{C} = \frac{86.8}{31.4} = 2.8 \text{ k/in}$$

$$w = \frac{2.8}{11.2} = 0.25 \text{ in}$$

Use $\frac{3}{8}$ '' fillet weld on cheek plates.

By J. Talbot Client U.S. Navy Subject Miscellaneous Structures
Date 8-16-76 Job No. 27-771-98 Calculation Superstructure

Check Plate Weld to Column

Force due to Moment,

$$J_w = \frac{d^3}{3} = \frac{900}{3} = 300 \text{ in}^2$$

$$f_m = \frac{M}{2J_w} = \frac{2040 \text{ in-k}}{2(300)} = 3.4 \text{ k/in}$$

Force due to Shear,

$$A_w = 4 \times 30 \text{ in} = 120 \text{ in}$$

$$f_s = \frac{P}{A_w} = \frac{280 \text{ k}}{120 \text{ in}} = 2.3 \text{ k/in}$$

Total Force on Weld,

$$f = (f_m^2 + f_s^2)^{1/2} = (3.4^2 + 2.3^2)^{1/2} = 4.1 \text{ k/in}$$

$$w = \frac{4.1}{11.2} = 0.37 \text{ in.}$$

Use $\frac{1}{2}$ " fillet weld for lug plate to column

SECTION 3

BOAT LANDING

3.1 INTRODUCTION

The boat landing structural framing presented herein is designed to fit each of the four platform structures. Component details, boat bumpers, grating and stairs associated with the boat landing are not included in this section. Structural steel weights and the surface area to be painted are provided however.

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Sheet 3.02 of 12

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-15-76 Job No. 27-771-98 Calculation Boat Landing

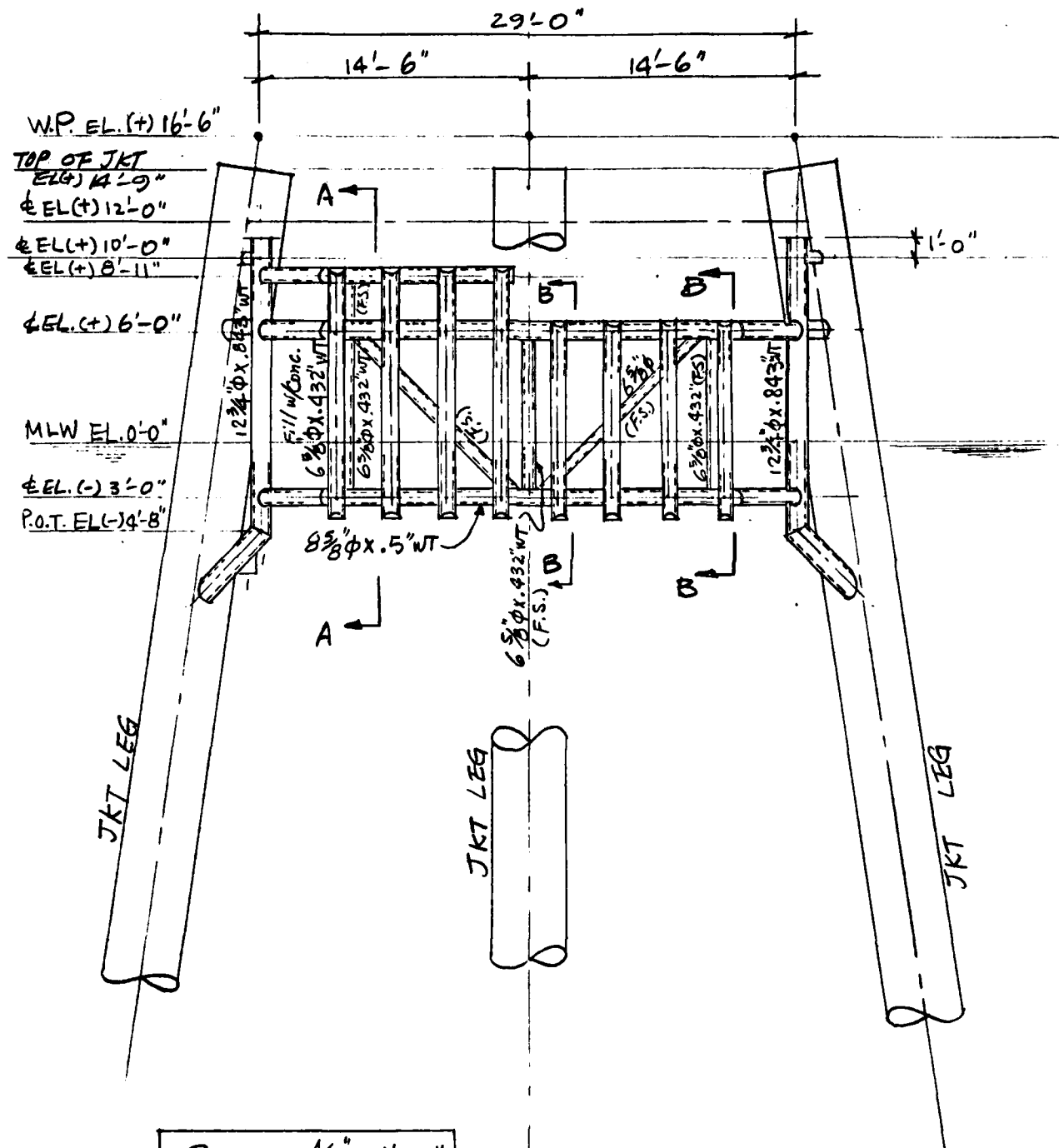
3.2 ELEVATIONS, PLANS AND SECTIONS

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Sheet 3.03 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 6-16-76 Job No. 27-721-98 Calculation Boat Landing

ELEVATION (Front View)

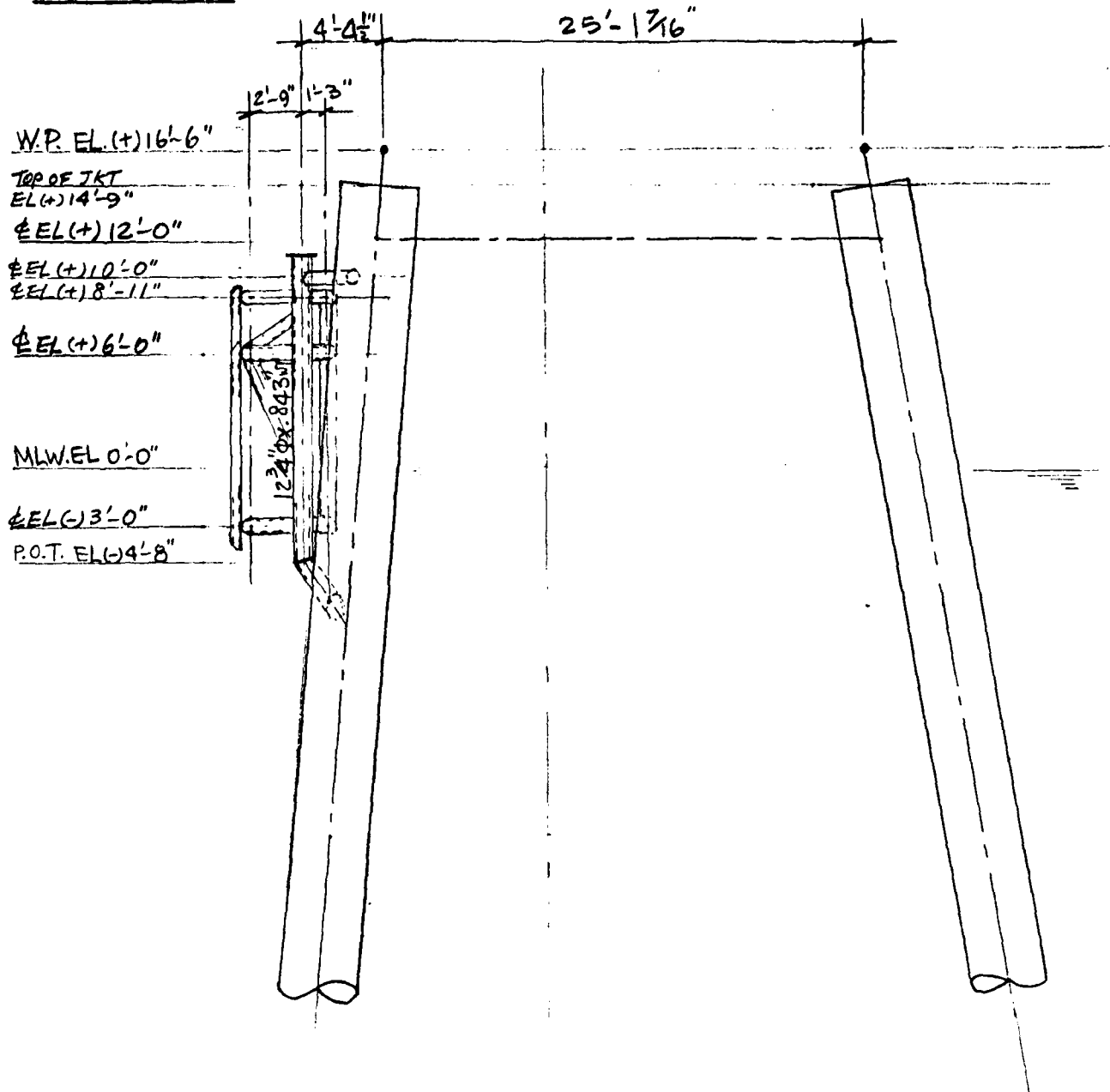


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Sheet 3.04 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-17-76 Job No. 22-771-98 Calculation Boat Landing

ELEVATION (Side View)



SCALE $\frac{1}{8}" = 1'-0"$

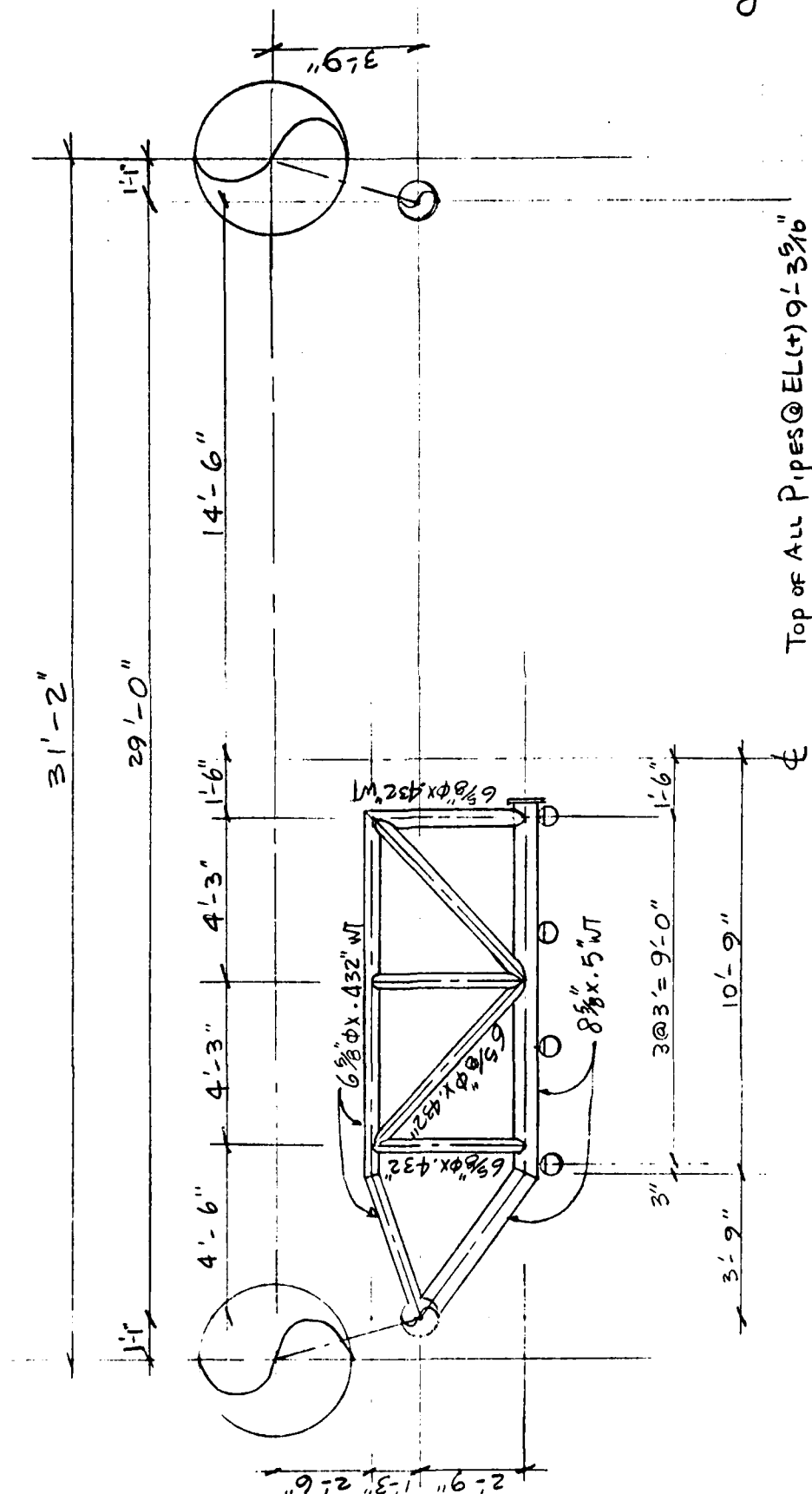
CREST OFFSHORE, INC.

Sheet 3.05 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-17-76 Job No. 27-776-98 Calculation Boat Landing

Date 6-17-76 Job No. 27-771-98

Calculation Boat Landing



29'-0"

14'-6"

6"

3

1

4'-6"

LM.254x432W

3/8" ϕ x .432" WT

19

5.700

5/8" x .5" WT

3 @ 3' = 9'-0"

14

 $\frac{1}{6}$

"

Top of All Pipes @ EL (+) 9'-3 5/16"

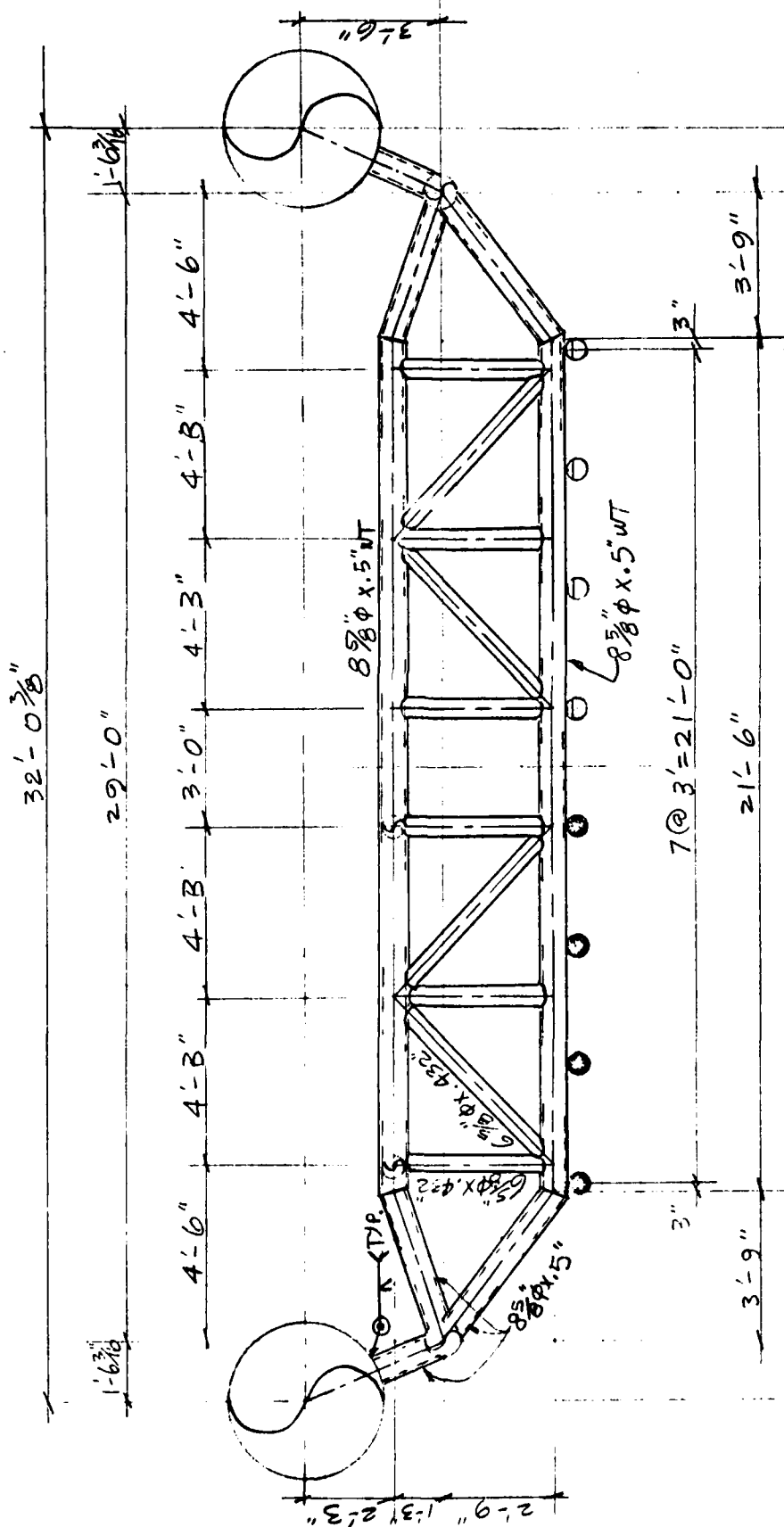
PLAN @ EL (+) 8'-11"

Scale $\frac{1}{4}'' = 1'-0''$

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Sheet 3.06 of 15

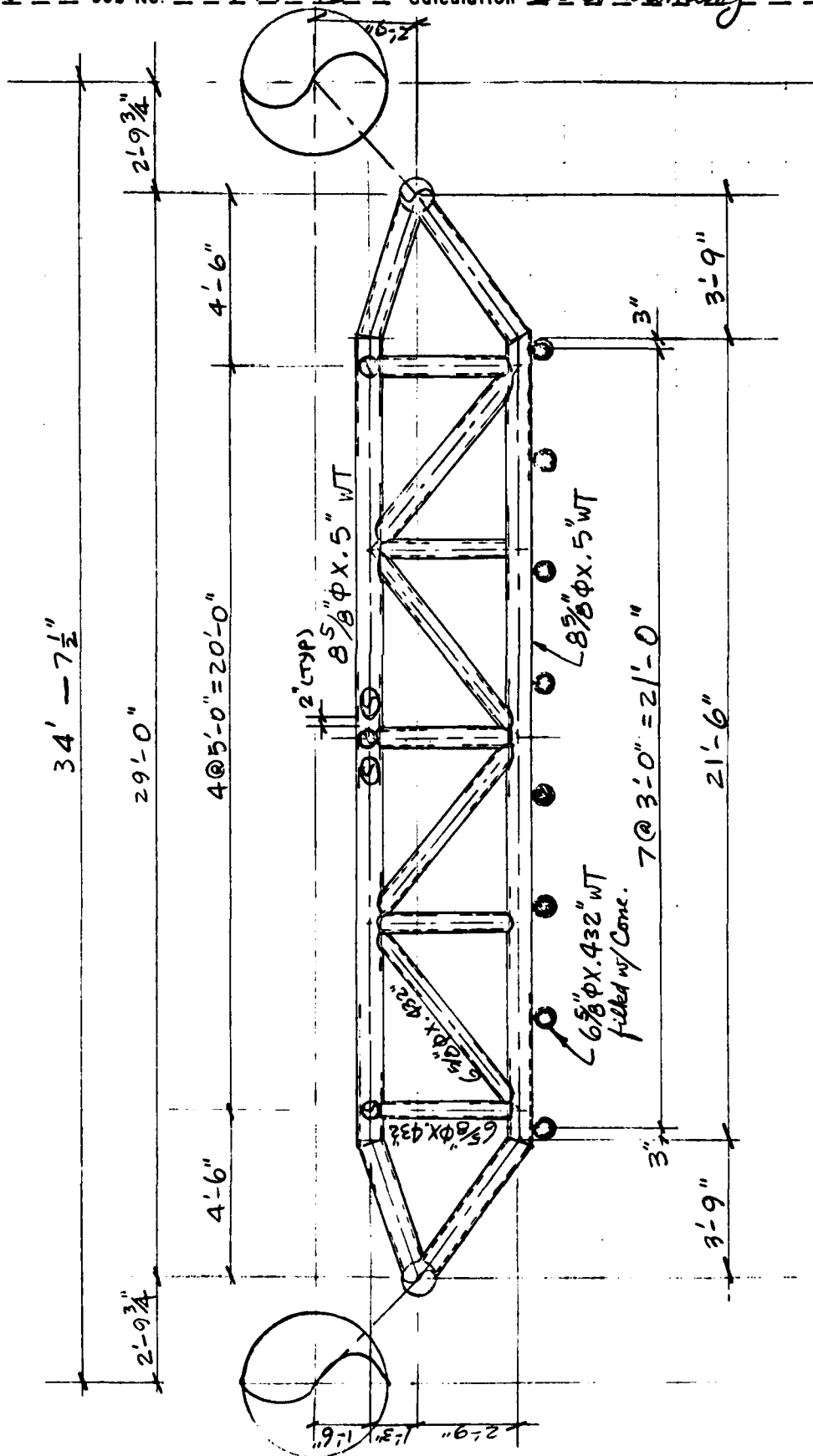
By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-16-76 Job No. 27-771-98 Calculation Boat Landing



CREST OFFSHORE, INC.

Sheet 3.07 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 6-16-76 Job No. 27-771-98 Calculation Boat Landing



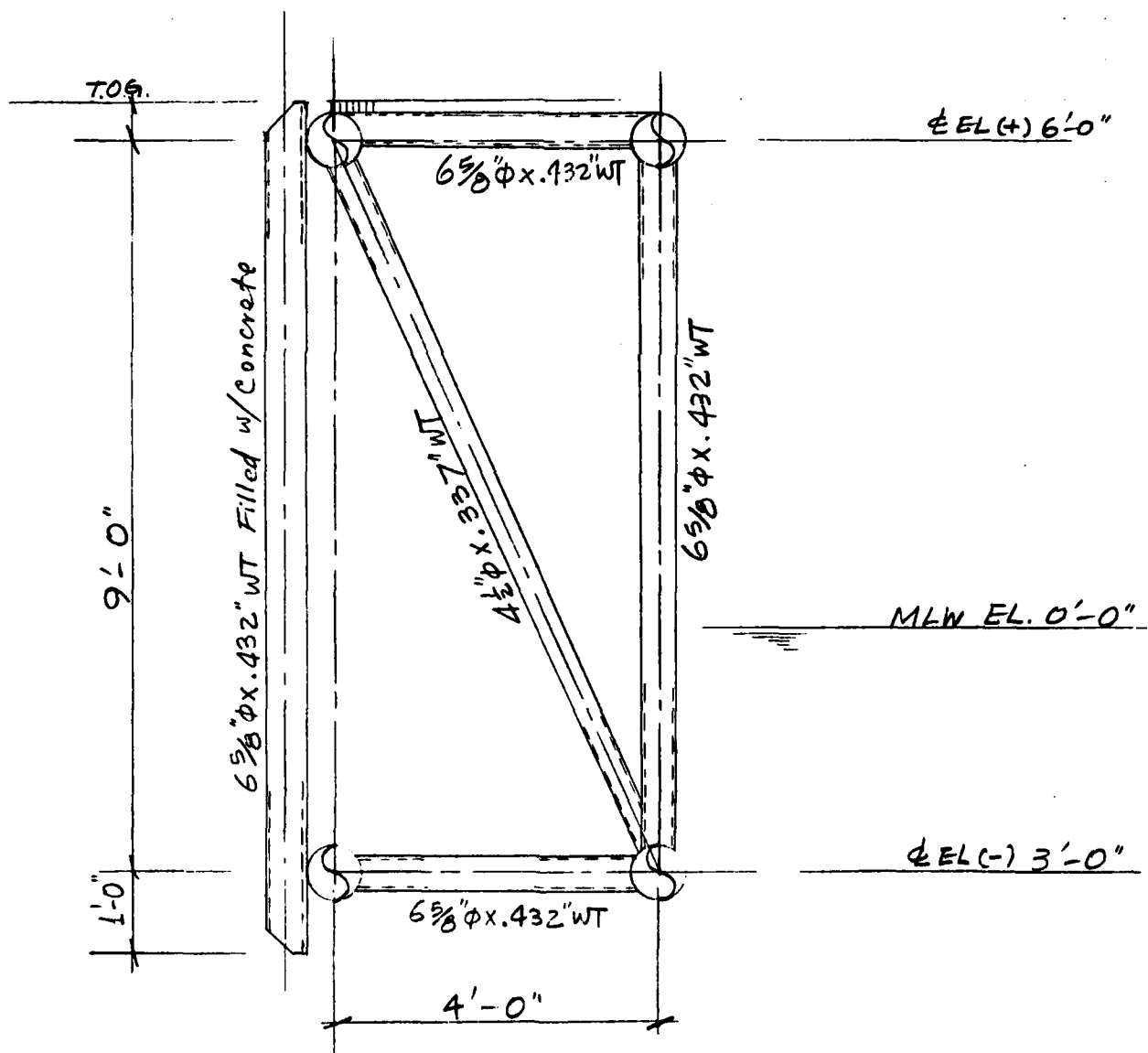
PLAN @ E.L.C. 3'-0"

SCALE $\frac{1}{4}" = 1' - 0"$

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Sheet 3.08 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-17-76 Job No. 27-771-98 Calculation Boat Landing



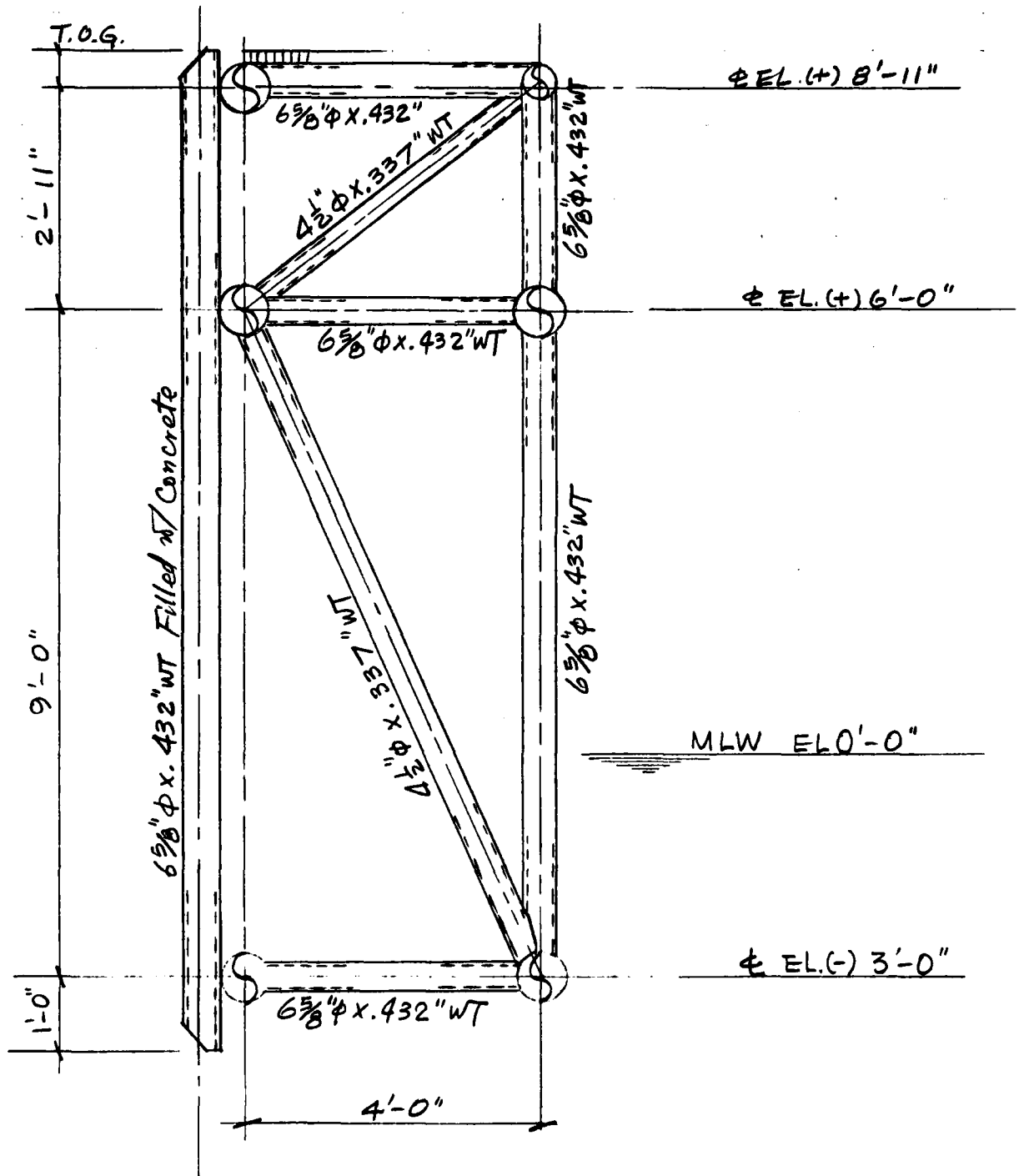
SECTION B

Scale $\frac{1}{2}'' = 1'-0''$

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Sheet 3.09 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 6-12-76 Job No. 27-771-98 Calculation Boat Landing



SECTION A

Scale $\frac{1}{2}" = 1'-0"$

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 6-17-76 Job No. 22-771-98 Calculation Boat Landing

Check Member Strength

(1) 6 5/8" ϕ x .432" filled with concrete

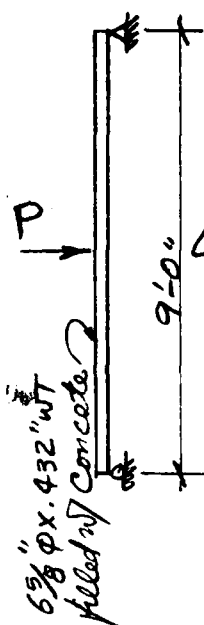
Assume no composite action between steel wall and concrete filling.

$$I_x = 40.501 \text{ in}^4 ; \quad S_x = 12.23 \text{ in}^3$$

$$\text{Span} = 9'-0"$$

$$M = \frac{PL}{4}$$

$$M = \sigma S_x$$



$$\text{L/se } \sigma = 22 \text{ ksi}$$

$$M = 22 \times 12.23 = 269.1 \text{ in}^k$$

$$= 22.42 \text{ ft-kips}$$

$$P = \frac{4M}{L} = \frac{4 \times 22.42}{9} = 10 \text{ kips}$$

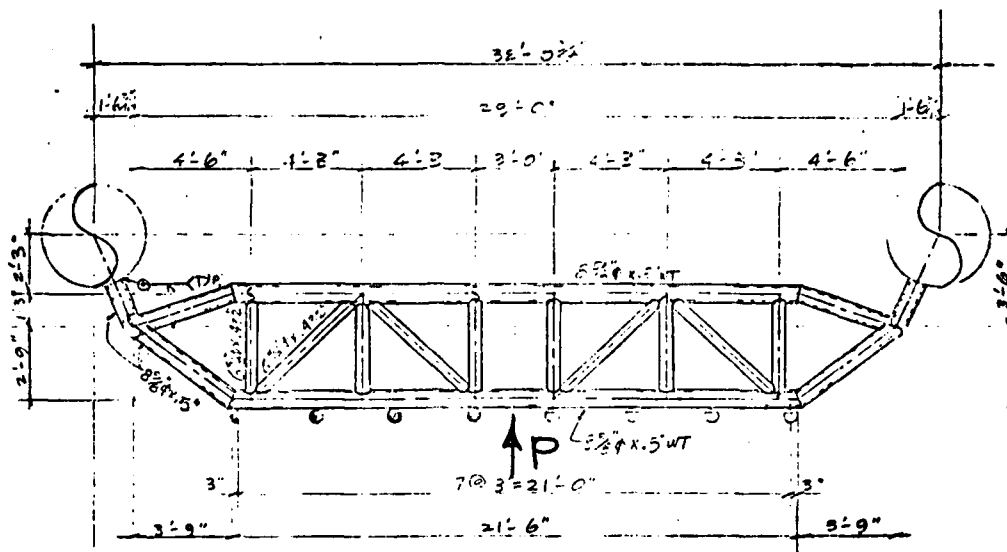
Consider impact factor of 2.0

$$P = \frac{10}{2} = 5 \text{ kips}$$

** 6 5/8" ϕ fenders are able to resist a minimum of 5 kips impact force.

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 6-17-76 Job No. 27-771-98 Calculation Boat Landing

(2) Frame at EL.(+) 6'-0"



$$\text{Moment of Inertia} = \sum A d^2 + \sum I_o^2$$

$$8 \frac{5}{8} \text{ } \phi \times 5 \text{ } \text{WT} \quad A = 12.76 \text{ in}^2 \quad ; \quad I_o = 105.74 \text{ in}^4$$

$$I = 2 \left[12.76 \times 24^2 + 105.74 \right]$$

$$= 14,911 \text{ in}^4$$

$$P = 10 \text{ kips} \quad (= 5 \text{ kips} \times 2 \text{ impact factor})$$

$$\sigma_b = \frac{M c}{I} = \left[\frac{10 \times 21.5}{4} \times 12 \right] \times \frac{28}{14,911}$$

$$= 1.21 \text{ ksi} \ll 22 \text{ ksi}$$

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 6-17-76 Job No. 22-771-98 Calculation Boat Landing

(3) Vertical Load Resistance at Jacket Leg Connections

Total Dead Weight = 22 kips

Live Load = 4 kips

26 kips

Shear at each connection = $\frac{26}{6} = 4.33$ kips

Full penetration field welds on $8\frac{3}{8}" \times .5"$ WT pipe
effective shear area $\doteq 12.76 \text{ in}^2$

$$\tau = \frac{4.33}{12.76} = 0.34 \text{ ksi}$$

CREST OFFSHORE, INC.

Sheet 3-13 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 6-12-76 Job No. 27-711-98 Calculation Boat Landing

3-3 DEAD WEIGHT OF BOAT LANDING

MEMBER SIZE	MEMBER LENGTH	NO. REQUIRED	TOTAL LENGTH	UNIT WEIGHT	TOTAL WEIGHT
IN. X IN.	FT		FT	LBS/FT	LBS
<u>EL. (+) 8'-11"</u> 8 5/8" ϕ x .5" WT	9.75	1	9.75	43.39	423.1
	4.00	1	4.00		173.6
			13.75		596.7
6 5/8" ϕ x .432" WT	9.50	1	9.50	28.57	271.4
	2.50	1	2.50		71.4
	4.00	3	12.00		342.8
	5.84	2	11.68		333.7
			35.68		1,019.3
<u>EL. (+) 6'-0"</u> 8 5/8" ϕ x .5" WT	21.5	2	43.0	43.39	1,865.8
	4.0	2	8.0		347.1
	3.5	2	7.0		303.7
	1.5	2	3.0		130.2
			61.0		2,646.8
6 5/8" ϕ x .432" WT	4.0	6	24.0	28.57	685.7
	5.84	4	23.36		667.4
			47.36		1,353.1
<u>EL. (-) 3'-0"</u> 8 5/8" ϕ x .5" WT	21.5	2	43.0	43.39	1,865.8
	4.0	2	8.0		347.1
	3.5	2	7.0		303.7
			58.0		2,516.6

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Sheet 3-14 of 15

By C. Chorn Client U.S. NAVY Subject Miscellaneous Structures
 Date 6-12-76 Job No. 27-771-98 Calculation Boat Landing

MEMBER SIZE	MEMBER LENGTH	NO. REQUIRED	TOTAL LENGTH	UNIT WEIGHT	TOTAL WEIGHT
IN. X IN.	FT		FT	LBS/FT	LBS
6 $\frac{5}{8}$ " ϕ X .432" WT	4.0	5	20.0	28.57	571.4
	6.4	4	25.6		731.4
			45.6		1,302.8
<u>Verticals</u> 12 $\frac{3}{4}$ " ϕ X .843" WT	15.67	2	31.34	107.32	3,363.4
	5.0	2	10.0		1,073.2
			41.34		4,436.6
6 $\frac{5}{8}$ " ϕ X .432" WT Filled w/ Conc.	13.0	4	52.0	28.57 <u>22.60</u> (51.17)	2,660.8
	10.0	4	40.0		2,046.8
			92.0		4,707.6
6 $\frac{5}{8}$ " ϕ X .432" WT	9.0	3	27.0	28.57	771.4
	3.0	2	6.0		171.4
	13.45	2	26.9		768.5
			59.9		1,711.3
4 $\frac{1}{2}$ " ϕ X .337" WT	7.21	3	21.63	14.98	324.0
	5.0	1	5.00		74.9
			26.63		398.9
<u>Grating</u>	80 SQ. FT			10.4 #/sq ft	832.0
					21,521.7 #
					Say 22,000 #

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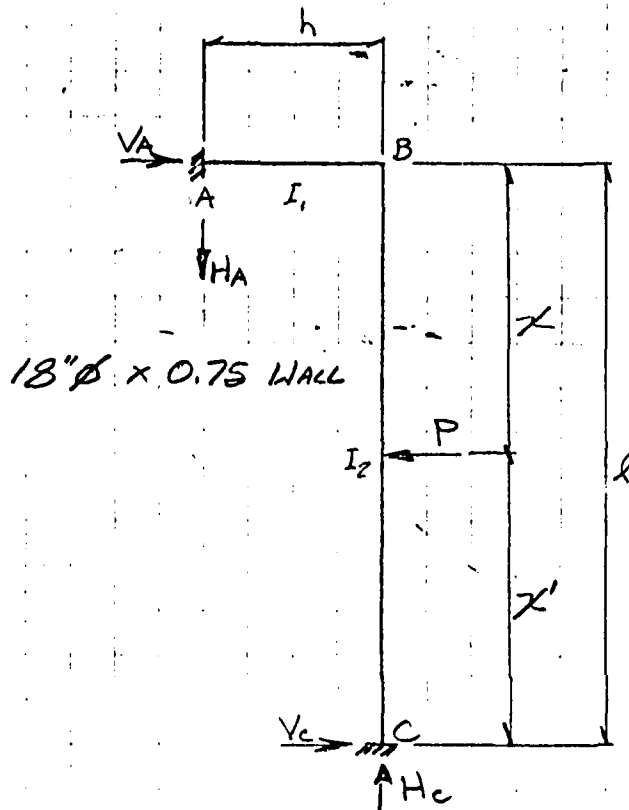
Sheet 2.15 of 15

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-16-76 Job No. 22-72L-9B Calculation Boat Landing

3.4 PAINT AREA

MEMBER SIZE	MEMBER LENGTH	SURFACE AREA	NO. REQUIRED	TOTAL AREA	NOTES
	FT	SQ. FT		SQ. FT	
8 $\frac{5}{8}$ " ϕ x .5" WT	13.75			31.0	EL.(+) 8'-11"
6 $\frac{5}{8}$ " ϕ x .432" WT	35.68			61.9	
8 $\frac{5}{8}$ " ϕ x .5" WT	61.0			137.7	EL.(+) 6'-0"
6 $\frac{5}{8}$ " ϕ x .432" WT	47.36			82.1	
8 $\frac{5}{8}$ " ϕ x .5" WT	58.0			131.0	EL.(+) 3'-0"
6 $\frac{5}{8}$ " ϕ x .432" WT	45.6			79.1	
12 $\frac{3}{4}$ " ϕ x .843" WT	41.34			138.0	Verticals
6 $\frac{5}{8}$ " ϕ x .432" WT	151.9			263.5	
4 $\frac{1}{2}$ " ϕ x .337" WT	26.63			31.4	
Grating		80.0		160.0	
				1,115.7	TOTAL

By ADD Client U.S. NAVY Subject MISCELLANEOUS STRUCTURE
 Date 2-2-76 Job No. 27-221-28 Calculation BOAT FENDER ANALYSIS

3.5 Boot FendersSTIFFNESS ANALYSIS

$$P = 100^k$$

$$l = 19.5 \times 12 = 234.0''$$

$$h = 4.59 \times 12 = 55.06''$$

$$I_1 = 1515$$

$$I_2 = 1515$$

$$k = \frac{h}{l} = \frac{55.06}{234.0} = 0.24$$

$$N = k + 1 = 1.24$$

$$L = R = \frac{3Pl}{8} = 8775.0$$

$$G_r = G_s = \frac{Pl}{2} = 11700.0$$

$$M_x^0 = \frac{Pl}{4} = 5850.0$$

$$M_C = -\frac{R(3k+4) - 2L}{6N} = -3203.59''^k$$

$$M_B = -\frac{2L - R}{3N} = -2367.83''^k$$

$$M_A = -\frac{M_0}{2} = -1183.9''^k$$

$$M_x = M_x^0 + \frac{x'}{l} M_B + \frac{x}{l} M_C$$

$$= +2727.21''^k$$

$$V_A = \frac{G_r - M_B + M_C}{l} = 46.43^k$$

$$V_C = P - V_A = 53.57^k$$

$$H_A = H_C = \frac{3M_A}{h} = 64.51^k$$

By ERK Client U.S. NAVY Subject MISCELLANEOUS STRUCTURE
Date 9-2-76 Job No. 27-271-28 Calculation BOAT FENDER ANALY

BEAM STRESS CHECK

$$\text{MAX. MOMENT} = M_c = 3203.59 \text{ in}^k$$

$$\sigma = \frac{M}{S} = \frac{3203.59}{168.3} = 19.03 \text{ ksi} < 21.6 \text{ ok}$$

$$F_b = 0.6 F_y = 0.6(36) = 21.6 \text{ ksi}$$

CONCLUSION

18" ϕ x 0.75" WALL WITH A STRESS OF 19.03 ksi
IS GOOD AND WILL WITH STAND 100k IMPACT LOAD
APPLIED AT THE MID POINT OF THE FENDER.

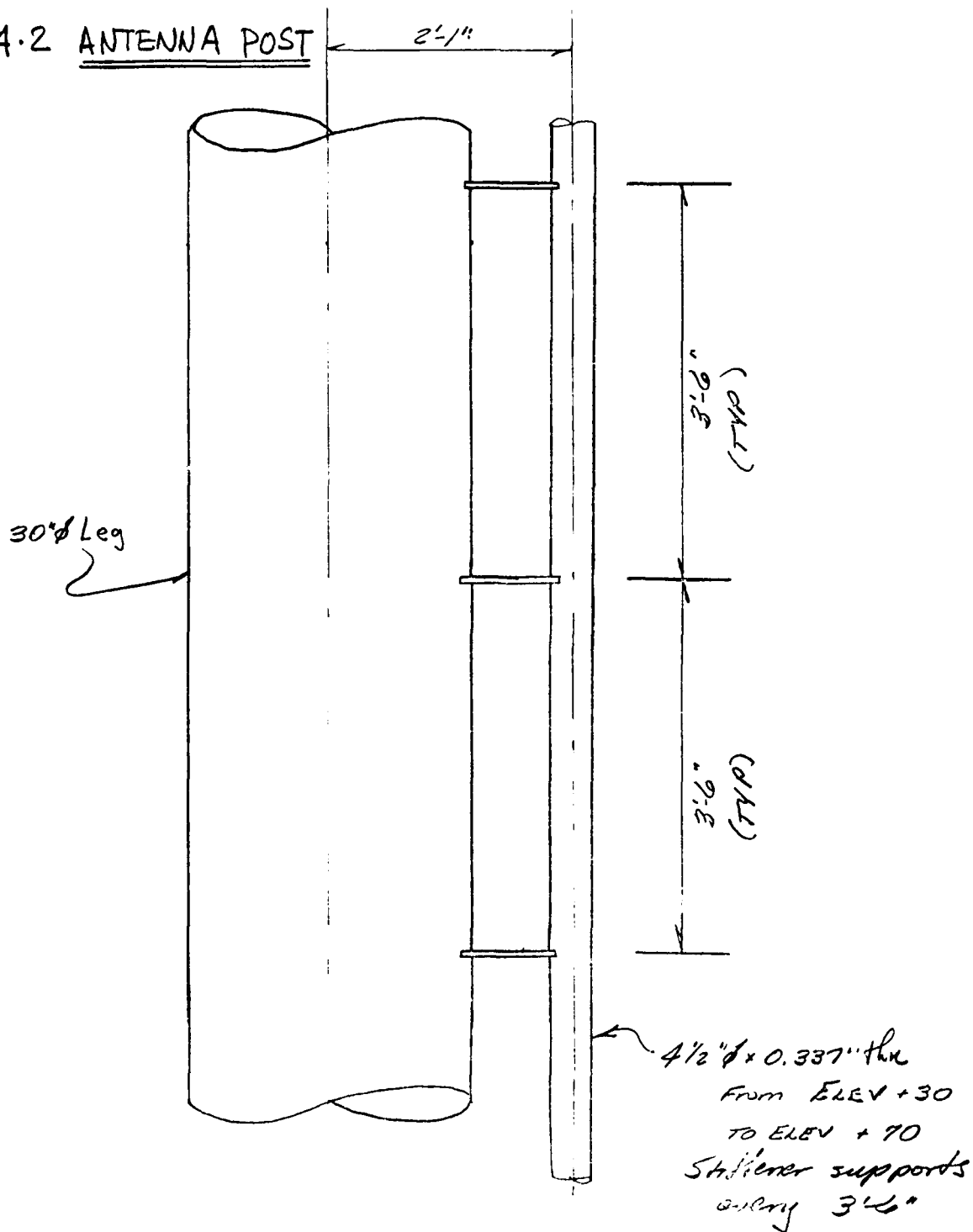
SECTION 4
EQUIPMENT SUPPORT DETAILS

4.1 INTRODUCTION

Support details for antenna post and solar panel framing are presented in this section.

By ESP Client U.S. Navy Subject Miscellaneous Structures
 Date 6-1-76 Job No. 27-771-98 Calculation Antenna Post

4.2 ANTENNA POST

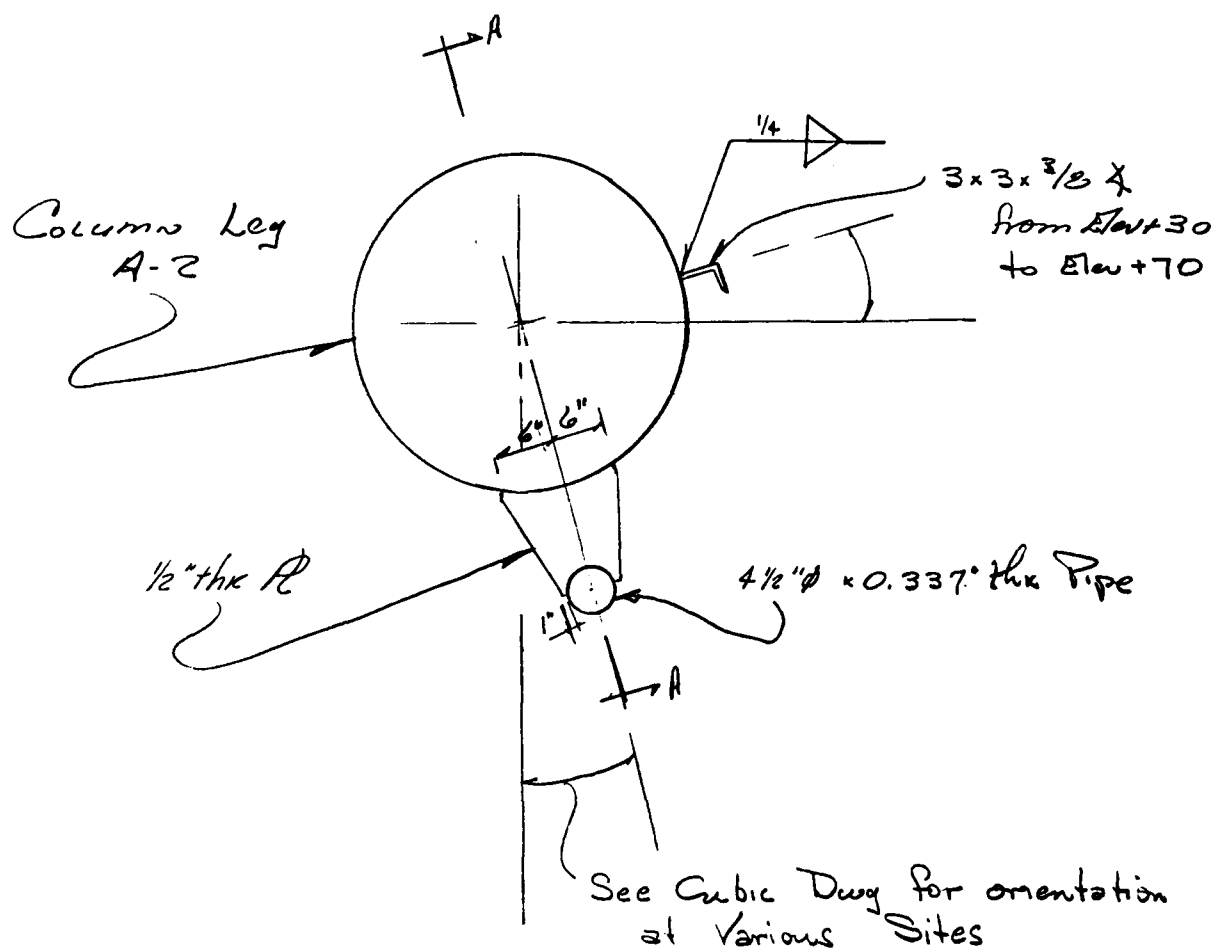


Put ϕ brace
 3" below top &
 3" above bottom of
 End of Pipe - Cap
 ends of pipe w/ 1/4" PL

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Sheet 4.03 of 14

By ESP Client U.S. Navy Subject Miscellaneous Structures
Date 6-1-76 Job No. 21-221-9B Calculation Antenna Post



By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-21-76 Job No. 27-771-98 Calculation Solar Panel Support Details

Wind Forces

Ref.: Page 9.24, Report No. 27-771-92

APPENDIX C. THREE PILE CONCEPT CALCULATIONS

$$F = 0.00256 C_s A C_H V_{30}^2$$

F = force in lbs

V_{30} = velocity @ EL.(+) $30'$ = 150 knots = 173 mph

C_s = 1.5 for flat surfaces

= 1.0 for cylindrical surfaces

A = projected area of surface (SQ. FT)

C_H = height coefficient = $(H/30)^{2/7}$

$$\text{Let } q_{30} = 0.00256 C_s C_H V_{30}^2$$

$$q_{30} = 0.00256 \times 1.5 \times (173)^2 = 115 \text{ psf}$$

$$\text{@ EL.(+) } 64'-6" \quad \left(60 + \frac{1}{2} \times 10.4 \cos 30^\circ = 64.5' \right)$$

$$C_s = \left(\frac{64.5}{30} \right)^{2/7} = 1.244$$

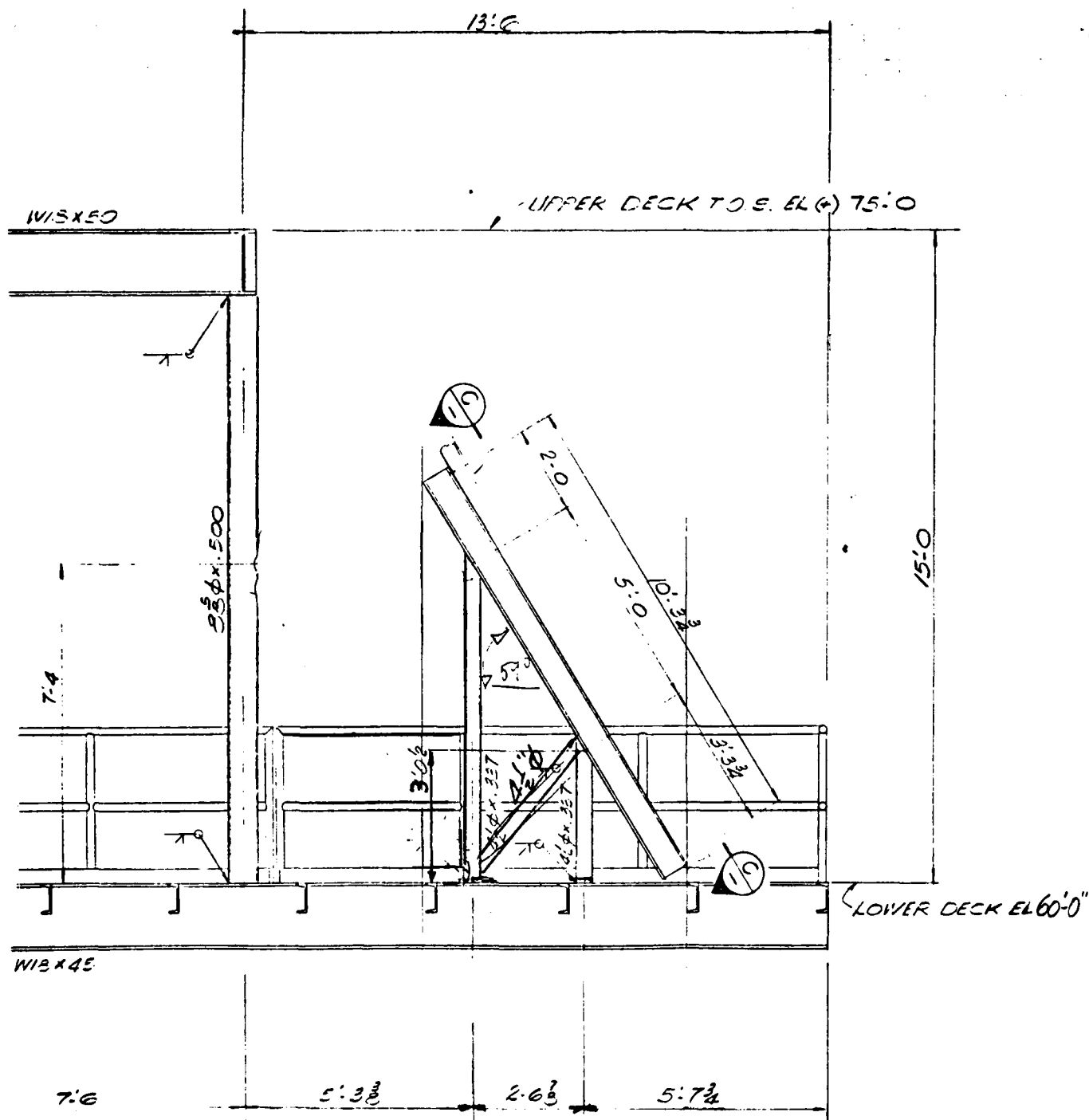
$$q_{64.5} = 115 \times 1.244 = 143 \text{ psf}$$

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By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-21-76 Job No. 27-771-98 Calculation Solar Panel Support Details

Date 7-21-76 Job No. 27-771-98 Calculation Solar Panel Support Details



14.5 x 50

UPPER DECK T.O.S. EL (+) 75.0

005-500

7-4

15:0

302

227

LOWER DECK EL 60'-0"

W1B x 45

7:6

۵:۵

2.69

 $5:7\frac{3}{4}$

By C. Chern Client U.S. NAVYSubject Miscellaneous StructuresDate 7-22-76 Job No. 27-771-98Calculation Solar Panel Support Details

$$\text{Projected Area } A = 11.5 \times (10.5 \cos 30^\circ) \\ = 104.6 \text{ SQ. FT}$$

$$\text{Total Wind Force } F = 143 \times 104.6 \\ = 14,958 \text{ Lbs}$$

Assuming that solar panel framings are flexible so that a uniformly distributed wind load may be transferred to the panel supports.

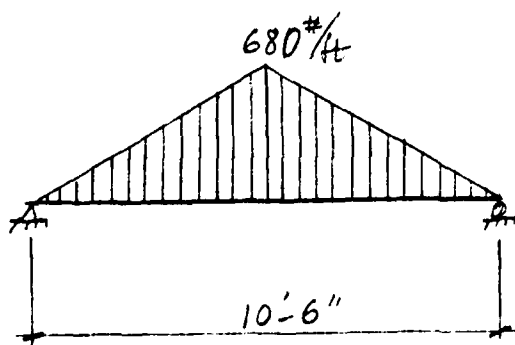
Ref. to wind area shown in Pg. 4.09

$$A = \frac{1}{2} \times 9.5 \times (5.5 \cos 30^\circ) = 22.6 \text{ SQ. FT}$$

$$\text{Wind Force} = 143 \times 22.6 = 3,232 \text{ Lbs}$$

$$\text{Triangular load at peak } 3,232 = \frac{1}{2} w \times 9.5$$

$$w = 680 \text{ \#/ft}$$



AISC 2-198

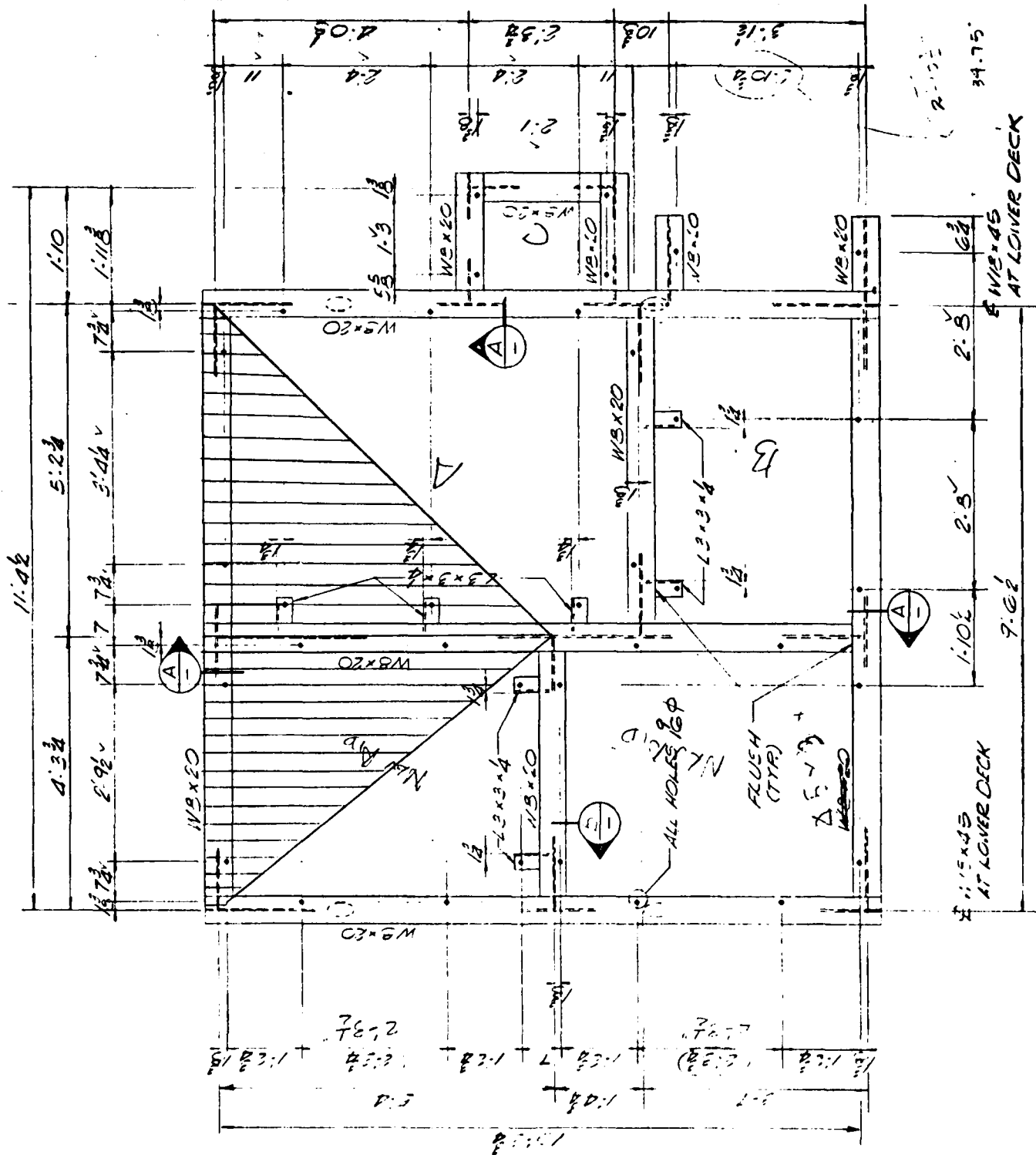
Case #3

$$W = 3,232 \text{ \#}$$

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Sheet 4.09 of 14

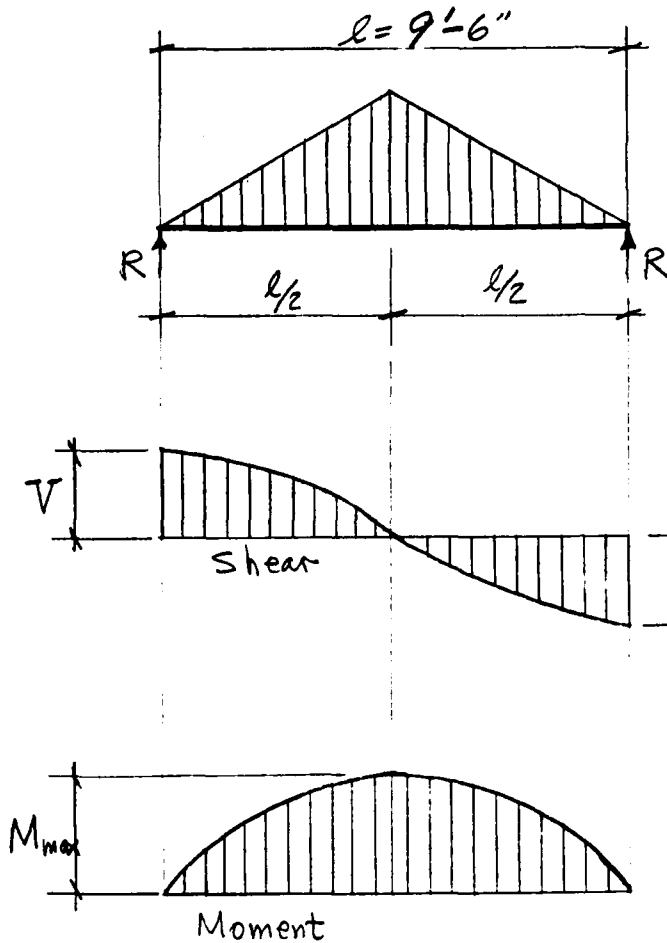
By C. Chern Client U. S. NAVY Subject Miscellaneous Structures
Date 7-22-76 Job No. 22-771-98 Calculation Solar Panel Support Details



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By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-22-76 Job No. 27-771-98 Calculation Solar Panel Support Details



$$R = V = \frac{W}{2} = 1,616 \text{ \#}$$

$$M_{max} = \frac{Wl}{6}$$

$$= \frac{3,232 \times 9.5}{6} \times \left(\frac{12}{1,000}\right)$$

$$= 61.4 \text{ \"K}$$

$$\Delta_{max} = \frac{Wl^3}{60EI}$$

(center)

Try $4 \times 5 \times 3 \times \frac{3}{8}$

$$S_x = 2.24 \text{ in}^3$$

$$I_x = 7.37 \text{ in}^4$$

$$\sigma_b = \frac{M}{S_x} = \frac{61.4}{2.24} = 27.4 \text{ ksi}$$

AISC
A36 Steel

Allowable

$$\sigma_b = 22 \times 1.33 = 29.3 \text{ ksi} > 27.4 \text{ ksi}$$

O.K.

By C. Chern Client U. S. NAVY Subject Miscellaneous Structures
 Date 7-22-76 Job No. 27-771-98 Calculation Solar Panel Support Details

$$\Delta_{\max} = \frac{3.232 \times (9.5 \times 12)^3}{60 \times 30,000 \times 7.37} = 0.36''$$

Ref. to Wind area shown in Pg. 4.12

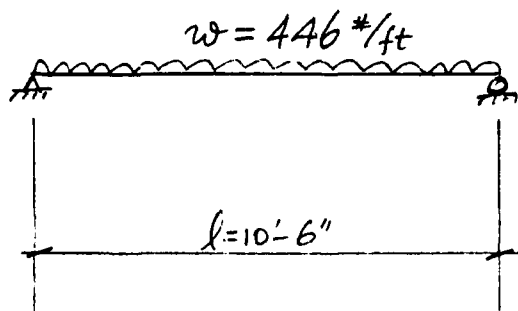
$$A = \frac{1}{2}(10.5 + 5.25) \times 2.2 + \frac{1}{2}(10.5 + 5.25) \times 2.6$$

$$= 37.8 \text{ SQ. FT}$$

$$\text{Total Wind Force} = 143 \times 37.8 \times \cos 30^\circ$$

$$= 4,681 \#$$

$$\text{Equivalent uniform load} = \frac{4,681}{10.5} = 446 \#/\text{ft}$$



$$M_{\max} = \frac{wl^2}{8} = \frac{446 \times 10.5^2 \times 12}{8 \times 1000}$$

$$= 73.8 \text{ "K}$$

Try $\angle 5 \times 3 \times \frac{1}{2}$

$$S_x = 2.91 \text{ in}^3; I_x = 9.45 \text{ in}^4$$

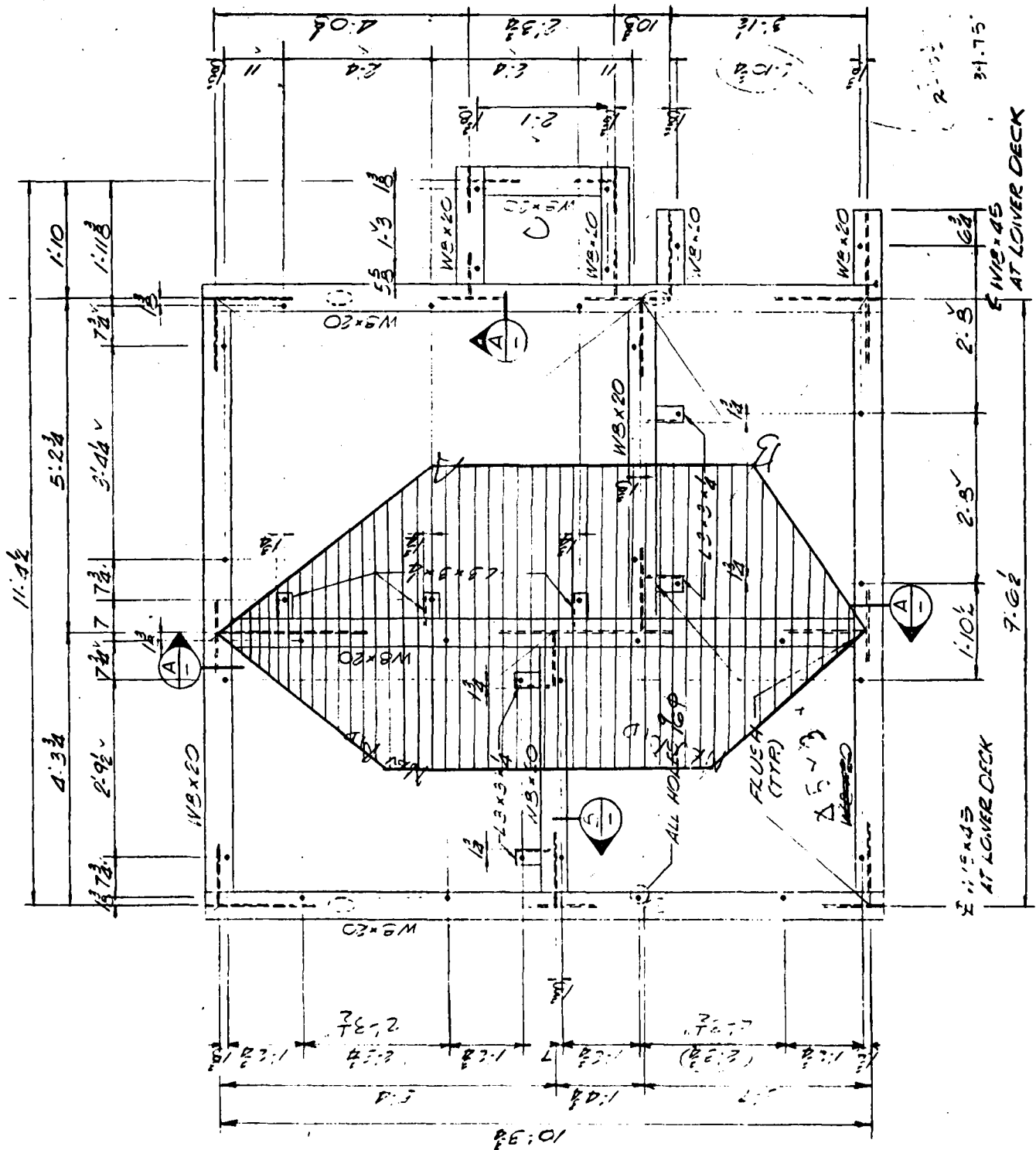
$$\sigma_b = \frac{73.8}{2.91} = 25.4 \text{ ksi} < 29.3 \text{ ksi O.K.}$$

$$\Delta_{\max} = \frac{5wl^4}{384EI} = \frac{5 \times 446 \times (10.5)^4 \times (12)^3}{384 \times 30,000 \times 9.45} = 0.43''$$

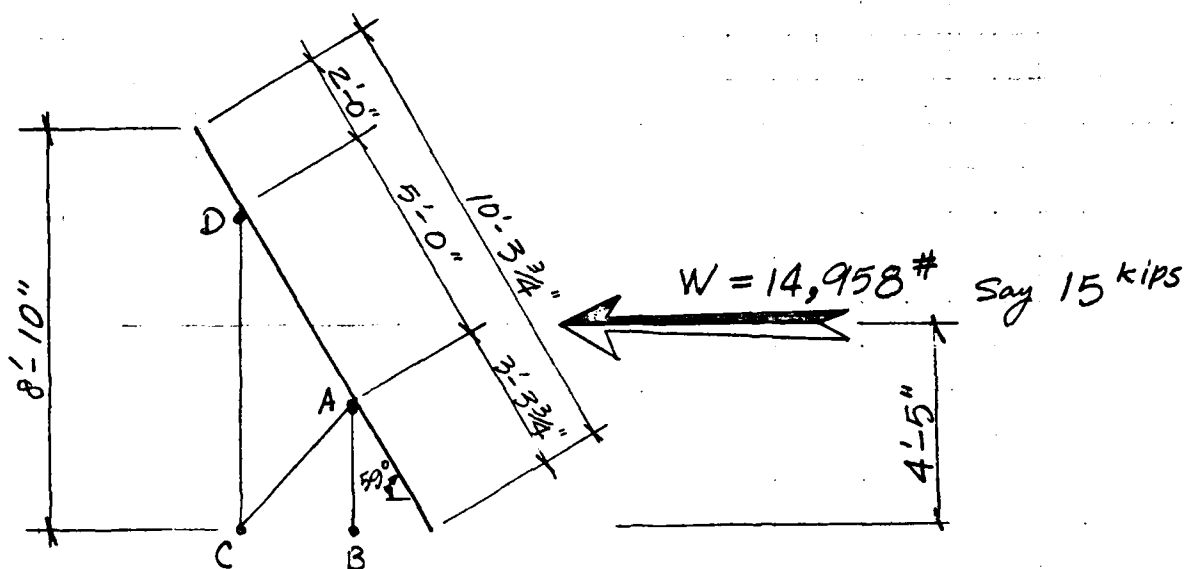
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Sheet 4.12 of 14

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-22-76 Job No. 27-771-9B Calculation Solar Panel Support Details



By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
 Date 7-22-76 Job No. 27-771-9B Calculation Solar Panel Support Details



$$\sum M_A = 0 \quad 14,958 \times (4.5 - 2.8) = (R_{co} \times 5 \sin 31^\circ) \times 2$$

$$R_{co} = \frac{14,958 \times 1.7}{2 \times 2.575} = 4,938 \# \text{ (Comp.)}$$

$$4\frac{1}{2}'' \phi \times .337'' \text{ WT} \quad A = 4.41 \text{ sq. in.}$$

$$f_a = \frac{4,938}{4.41} = 1.12 \text{ ksi}$$

$$r = 1.477''$$

$$\frac{KL}{r} = \frac{1 \times 6.1 \times 12}{1.477} = 49.5$$

$$F_a = 18.40 \text{ ksi}$$

$$\frac{f_a}{F_a} = \frac{1.12}{18.40} = 0.06$$

By C. Chern Client U.S. NAVY Subject Miscellaneous Structures
Date 7-22-76 Job No. 27-271-9B Calculation Solar Panel Support Details

$$\Sigma M_c = 0 \quad 14,958 \times 4.5 = 2 \times (R_{AB} \times 5 \sin 31^\circ)$$

$$R_{AB} = \frac{14,958 \times 4.5}{2 \times 2.575} = 13,070 \# \text{ (Tens.)}$$

$4\frac{1}{2}" \phi \times .337" \text{ WT}$

$$f_a = \frac{13.07}{4.41} = 2.96 \text{ ksi} < 22 \text{ ksi OK}$$

Joint A (Assuming DA carries no force)

$$R_{AC} \cdot \frac{1}{\sqrt{2}} = R_{AB}$$

$$R_{AC} = 13.07 \times \sqrt{2} = 18.48 \text{ kips (Comp.)}$$

$4\frac{1}{2}" \phi \times .337" \text{ WT}$

$$f_a = \frac{18.48}{4.41} = 4.19 \text{ ksi} < 22 \text{ ksi O.K.}$$

END
FILMED

4-86

DTIC