Your Name: Nick Carino

for Floor Theses Document Title or Description (max. 254 characters): Circle: Same as cover (or fill in below) Design Calculations (incomplete set) Include work order no. and floor no. if applicable Roll # (e.g., CORR-4): RD-1 Doc. ID (report #, dwg. #): Author Organization: Lackede Stee Document Date: **Document Author Name:** KEYWORDS - HIGHLIGHT ALL THAT APPLY . . . Level 1 Bankers Trust WTC 4 - South Plaza Bldg: Project 6 Project 7 WTC 5 - North Plaza Bldg. Concourse Project 8 WTC 6 - Customs House **Electrical Substation** WFC 1 - Oppenhiemer Dow Liberty Plaza WTC 7 WFC 2 - Tower B **PATH Station** WTC Complex Project 1 WFC 3 - American Express WTC Plaza WFC 4 Tower D Project 2 Project 3 WTC 1 - North Tower Add WTC 2 - South Tower Project 4 WTC 3 - Marriot Hotel Project 5 Level 28530 States West, Technique and California Dates and Account of the control مراضعتها والمعش الا The transfer of the second Accident analysis & risk Mech./elec. Add **Architectural** News coverage Data request Police Emergency management Security Structural Evacuation Fire protection Tenant alterations Fire service Hervella Production of the Asset Service Control of the Control of からままない あいかいとんい 流りかがけんであり、から 1993 explosion Deck Human comfort Splices A/E fitout Deflection HVAC Sprinkler Index Stability A-242 Demolition Inspection A-36 (Design) Stairways A-497 Doors Insulation Standards Joist Steel Air cooled condensers Drawings L-50 Steel composition Analysis Eastern States Steel Angles Loads Stiffness Egress Antenna Elevator Maintenance Structural review Artifacts Marking Survivor Emergency communications Mesh reinforcement Asbestos Equipment Tenant list Model Testina Beams Escalator Bow tie Exterior columns Mullion Tie Bracing Fabrication Operations Triad Brid in truss Family member Paint Truss Calculations Fire alarms Partition layout Vestibule **Photos** Vibration Carpet Fireproofing Ceilings Fire spread **Pipes** Walls Chillers Flammability Plumbing Water supply Cladding Floor Probability, uncertainty Weather Reinforcing (strengthening) Collapse Floor load Weight Columns Floor slab Renovation Weld size Communication systems Floor system Repair Wind Safety Windows Composite truss Floor trusses Security system Computer output Foundations Yield strength Shear knuckle Computer program Frame Shear test Concrete Frame analysis <u>Add</u> Shop drawings Connections Frequency Construction Fuel Shortening Contract Furniture layout Slurry wall Generators Smoke control Core beams Guidelines Smoke test Core columns **Dampers** Gypsum board Spandrel beam Debris Hat truss Specifications

X

LACLEDE STEEL COMPANY STRUCTURAL DETAILS WORLD TRADE CENTER TOWERS PORT OF NEW YORK AUTHORITY

Detail No.	<u> Tit le</u>	Date Transmitted	Approved
ST-101	Typical 32" composite truss web Intermediate Panei - Full Scal	e	
ST-102	Typical web chord sections 32" composite trusses - Full S	Scale	
ST-103	Intermediate panel details 24" standard trusses 32" composite trusses - Full S	Scale	
ST-104	Intermediate prinel details 28" composite trusses 32" composite trusses - Pull 5	Scale	
ST-105	Corner intersection details Continuity of 32" - 60' span composite trusses (CT3, CT3A a CT4) into 28" composite trusse (CT9) in 35' span - Full Scale	es	
ST-106	Typical column bearing end dete of 32" composite trusses 2" x 2" damping unit extension Scale ½" = 1"		
ST~106A	Column bearing end detail show diagonal angle bracing attach 32" composite trusses  Scale 4" = 1"	ing ment	
ST-106B	Column bearing end detail Typical extended shallow bear end - 32" composite trusses Scale 5" = 1"	ing	
ST-106C	Column bearing end detail show damping unit extension for 28" composite trusses 24" standard trusses Scale 4" = 1"	ing	

Detail No.	Tit le	Date Transmitted	Approved
ST-1D6D /	Column bearing end detail showing diagonal angle bracing attachment 28" composite trusses 24" standard trusses Scale 5" = 1"		
ST-106E	Column bearing end oetail Typical extended shallow bearing end 28" composite trusses 24" standard trusses Scale 3" = 1"		
ST-107	32" composite truss details Approximate 60' span Type CT1, CT2, CT3, CT3A and CT4 - Scale 15" = 1'0"		
ST-108	32" composite truss details Approximate 35' span Type CT5 and CT6 Scale 15" = 1'0"		
ST-109	28" composite truss details Corner construction Type CT7, CT8 & CT9 Scale 15" = 1'D"		
ST-110	24" standard truss details 2D'0" transverse ST8, S710, ST11 and ST12 (duct) 13'4" transverse ST13 Scale 15" = 1'0"		

LACLEDE STEEL COMPANY
FLOOR ORID PANEL & PANEL LOCATIONS
WORLD TRADE CENTER TOWERS
PORT OF NEW YORK AUTHORITY

Detail No.	<u>Title</u>	Date <u>Transmitted</u>	Approved
L-100	Typical floor plan panel designation, location, applicable moments and end reatures design - Scale	truss e design ction for	
L-101	Quarter plan - Typic showing panel design loaction, truss destruss web configura Scale 1/8" = 1	nation, truss ignation and tion	

## LACLEDE STEEL COMPANY DESIGN CALCULATIONS WORLD TRADE CENTER TOWERS PORT OF NEW YORK AUTHORITY

		D	
Sheet No.	Design Data	Date Transmitted	Approved
D1D0-1 thru 7	Basic Design Data		
D1D1	Chord Angle Properties 2" x 1/2" angles		
D1D2	Chord Angle Properties 3" x 2" angles		
D1D3	Round Web Properties		
D1D4	Miscellaneous Section Properties	•	
D1D5-T1	Design Data Truss Mk. 2032Tl		
D105-T2	Design Data Truss Mk. 2032T2		
D1D5-T3	Design Data Truss Mk. 2032T3		
D105-T3A	Design Data Truss Mk. 2032T3A		
D105-T4 '	Design Data Truss Mk. 2032T4		
D105-T5	Design Data Truss Mk. 2032T5		
D105-T6	Design Data Truss Mk. 2032T6		
D105-T7	Design Data Truss Mk. C28T7		
D105-T8	Design Data Truss Mk. C28T8		
D105-T9	Design Data Truss Mk. C28T9		
D105-T1D	Design Data Truss Mk. S24Tl0		
D105-T11	Design Data Truss Mk. S24Tll		
D105-T12	Design Data Truss Mk. S24T12		
D105-T13	Deaign Pata Truss Mk. S24T.3		
D105-ET1	Deaign Data Extended End Truss Nk. 2C32ET1		
D105-ET2	Design Data Extended End Truss Mk. 2C32ET2		
D105-ET3	Design Data Extended End Truss Mk. 2C32ET3		

Sheet No.	Casign Data	Date Transmitted	Approved
D105-ET 3A	Design Data Extended End Truss Mk. 2032ET3A		
D105-ET4	Design Data Extended End Truss Mk. 2032ET4		
D105-ET5	Design Data Extended End Truss Mk. 2032ET5		
D105-ET6	Design Data Extended End Truss Mk. 2032ET6		
D1D5-ET7	Design Data Extended End Truss Mk. C28ET7		
D1D5-ET10	Design Data Extended End Truss Mk. S24ET10		

D1D0-1 Date February 6, 1967

#### WORLD TRADE CENTER FLOOR GRID TRUSSES BASIC DESIGN DATA

Based on double truss units. Mark 2CT or 2ST ... Single truss components. Mark CT or ST ...

#### DIMENSIONS:

Unless specifically noted otherwise, see "ST" Details.

Truss clearspan in feet = L. Overall length of truss minus end bearings in feet  $(2 \times 5" = 10")$ . Example:  $5^{\alpha'9}$ " overall length. Clearspan L =  $5^{\alpha'9}$ " minus 10" or  $5^{8}$ :11" or  $5^{8}$ .92'.

Length of member, clear of attachments = " $\mathcal{L}$ "

#### Depth of Truss

Composite type "C" (Measured top of shear member to bottom of lower chord.)

Standard type "S" (Measured out to out of chord members.)

Total depth of composite section =  $^{\prime\prime}D_{t}^{-\prime\prime}$ 

#### TOLLHANCES:

Overall length 1/4"+ or 1/4"-.

Depth 1/8"+ or 1/8"-.

#### LOADS:

Total load = Live load + Dead load

Applicable for composite design.

Applicable for combined slat and top chord design and bottom chord design.

Construction load = Applicable Fead load

Applicable for top and bottom chord steel design.

Dead load = Actual weight of structural system in pounds per square foot.

Live load = Assigned live load for panel area in pounds per square foot.

Design load in pounds per square foot = "w"

Applicable design load in pounds per foot equals design load in pounds per square foot times spacing of trusses in feet " . . . . . . . . . . "W"

#### TOTAL MOMENT:

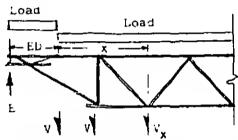
"M" (In inch pounds) =  $WL^2 \times 1.5$ .

#### END\_REACTION:

"H" (In pounds) = "W" x .5 (overall length of truss in feet).

#### SHEAR:

At first top chord panel in pounds = V = R- (W x ED)

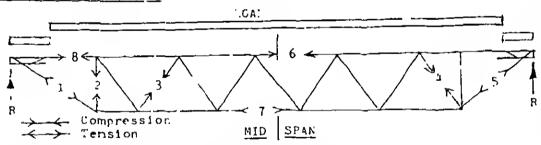


ED = Distance first top chord panel point to truss end.

Shear at other points in pounds =  $V_X = (F-F^+ \times W)-W$  (distance to first top chord panel point in feet .

(In to case less than 50% of end reaction "F".

#### DESIGNATION OF MEMBERS:



- l. End diagonal (long end) tension member
- 2. First panel vertical (long end) compression
- Second panel compression diagonal
- 4. First panel remter (short end) compression
- End diagonal (short end) tension
- b. Top chord critical compression member at mid span
  - . rottom chord critical tension member at mid span
- b. End top chord compression member (long end)

#### MATERIALS:

A-36 steel . . . . . . . . 36 ksi minimum yield strength

A-441 modified . . . . . . . . 50 kg1 minimum yield strength low alloy "H" Series.

See sheets D101 through D103 for Properties of Sections.

APPLICABLE PORMULAE: Stress Determination (Web or Chord Members)

#### A-36 steel

(36 kai f<sub>w</sub> = Minimu

fy = Minimum Yield Strength 36,000 psi

minimum yield)

 $f_s = Tension 22,000 psi$ 

 $f_{sc} = \text{Compression for } \ell/r (127 18,540 - .574 (\ell/r)^2 \text{ psi}$ 

for l/r > 127 149,000,000 ps1

 $\ell$  = clear distance between attachments

r = least radius of gyration

#### A-441 stee1

(50 ks1

fy = Minimum Yield Strength 50,000 ksi

minimum yield?

 $f_S = Ten::ion 30,000 psi$ 

 $f_{SC} = Compression for \ell/r (108 25,750 - 1.108 (\ell/r)^2 psi$ 

for  $\ell/r$  108 200 149,000,000 ps1

Continuous members shall be designed for only axial compressive stress when the panel length clear of attachments does not exceed 24". When the panel length clear of attachments exceeds 24", the top chord shall be designed as a continuous member subject to combined axial and bending stress and shall be of proportion that the quantity -

$$\frac{\Gamma_a}{30,000} + \frac{\Gamma_b}{F_b}$$

uoes not exceed unity at the panel point, or that the quantity -

$$\frac{f_a}{F_a} + \frac{f_b C_m}{F_b (1 - \frac{f_a}{F_a})}$$

does not exceed unity at the mid panel.

Permissible axial unit compressive stress = "Fa"

Permissible bending unit stress = "Fb"

Permissibl compressive stress factor (column equation

$$\frac{149,000,C}{(L/r)^2}$$
 : psi) = "Fe

### LACLEDE STEEL COMPANY

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Actual axial unit compressive stress =	fa
Actual bending unit stress =	$\iota^{p}$
MAXIMUM SLENDERNESS RATIOS:	
Top chord panels (interior) = 85 Top chord end panels = 120 Compression members other than top chord = 700 Tension members = 240	
PILLERS OH TIES:	
Members in compression composed of two components shall have fillers or ties spaced so that the ratio of Lir of each component shall not exceed the ratio of Lir of the whole member. The minimum "r" shall be used in calculating the critical ratio Lir of any component.	
SHEAR CONNECTORS:	
Shall be considered to provide a minimum 15 ksi horizontal shear per web end connector imbedded in the concrete. This is for 3,000 psi concrete. ( $f_c$ )	
DEFLECTION:	
Applicable deflection formula for uniform load.	
Maximum deflection $\Delta = \frac{25.88 \text{ (WL}^4)}{29,000,0001}$	
COMPOSITE SLAB AND JOIST DESIGN:	
Design values	
Total depth of combined slab and truss in inches =	$D_{\mathbf{t}}$
Effective width of concrete flange in inches equal to 2 x 8t =	Beff
Distance from top of concrete flange to neutral axis of concrete flange =	у 1
Distance from top of concrete flange to neutral axis of top chord angles =	у <sub>2</sub>
Fistance from top of concrete flange to neutral axis of bottom chord angles =	у 3
Distance from top of concrete flange to neutral axis of composite section =	<b>y</b>
Distance from neutral axis of composite section to neutral axis of concrete frange =	d <sub>1</sub>

## LACLEDE STEEL COMPANY

D100-5
Date <u>February 6, 1967</u>

	_ ·
Distance from neutral axis of composite section to neutral axis of top chord angles =	d,
Distance from neutral axis of composite section to neutral axis of bottom chord angles =	a <sub>3</sub>
<pre>Distance from neutral axis of composite section to outermost fibers of compression chord =</pre>	c l
Elstance from neutral axis of composite section to outermost fibers of tension chord =	c 5
Allowable congrete strength $f_c = 3,000$ pounds psi.	
Allowable steel strength =	ſs
Allowable concrete compressive stress $\Gamma_c' = 1.350$ pounds psi.	
Actual concrete compressive stress =	r ec
Allowable steel compressive stress =	r <sub>sc</sub>
Modular ratio = 15 =	Es Ec
SECTION PROPERTIES: (hefer to Sheets 1/101 through D103)	
Moment of inertia of concrete =	I <sub>c</sub>
Moment of inertia of top chord angles =	ITCA
Moment of Inertia of bottom chord angles =	IBCA
Moment of Inertia of composite system =	IS
Area of concrete flange =	A <sub>c</sub>
Area of top chord angles =	ATCA
Area of bottom chord angles = $\frac{1}{a}$	AFCA
c <sub>1</sub> d <sub>1</sub> d <sub>2</sub>	
d <sub>3</sub> y <sub>3</sub> S	eutral xis of omposite ystem
Neutral Bottom	

#### FORMULAE:

Resisting moment = "RM"

Allowable unit stress times the applicable Section Modulus = (applicable  $f \times S$ ).

Section Modulus'about the axis of bending)=  $S = \frac{1}{C_1 \text{ or } C_2}$ 

#### QUALITY CONTROL AND INSPECTION:

#### Material Test Reports

Since all steel employed in the fabrication of trusses is produced in the furnaces and mills of Laclede Steel Company, certified mill test reports showing heat numbers, chemistry, and physical properties for all steel components will be provided.

#### Hesistance Welding

Truss panel points will be connected by electronically controlled resistance welding providing two times the strength of the connected members at full design load.

Angle chords of carbon and alloy steel to be of weldable grade with contact surfaces cleaned of scale by shot blasting prior to welding.

Welds to be subject to "on-iine" testing by measured hydraulic wedge action tester with spot checking of finished panel point welds by testing in vertical double shear to two times design load value.

Any panel point welds indicated to have less than the established factor for weld shear strength will be are welded, subsequent to testing.

Full design load tests will be effected on full size and full length truss components by hydraulic loading in a test frame with load measurement by electric load cell and center span deflection check.

Load tests with recorded deflection and recovery data will be made on a minimum of one of each identified truss style involved in the panel construction.

#### Physical Tension Tests

Tension tests on truss components, chord angles, and webs will be performed on selected sample members included in the normal truss fabrication.

#### Inspection and Access to Plant

Free access to the plant of the truss manufacturer and the

#### LACLEDE STEEL COMPANY

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Date February 6, 1967

available inspection and test facilities will be offered the qualified inspectors representing the purchaser for observation of the test and inspection procedures outlined herein.

Any testing requested beyond that identified herein shall be for the account of the purchaser.



LACLEDE STEEL COMPANY SAINT LOUIS, MISSOURI

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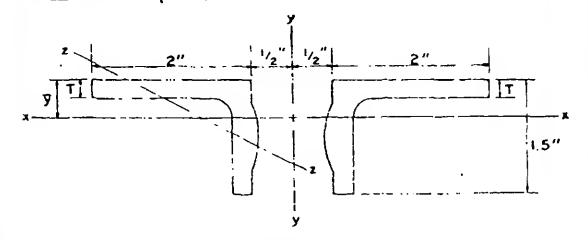
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TRUSS SECTION COMPONENTS
TRUSS ANGLE SECTIONS
DESIGN SECTION PROPERTIES



#### 2"x 1 2" x T

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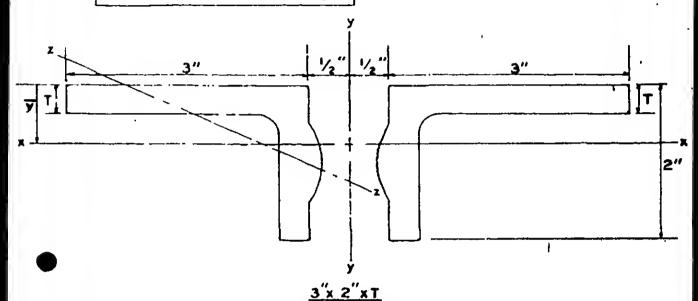
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DESIGN SECTION PROPERTIES



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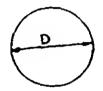
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TRUSS SECTION COMPONENTS
TRUSS WEB SECTIONS
DESIGN SECTION PROPERTIES

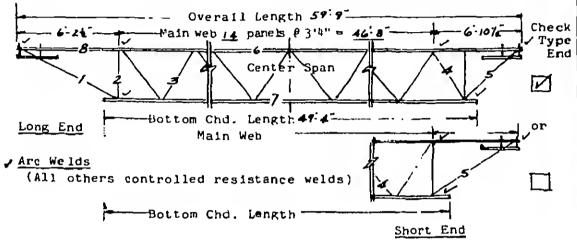


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AREA		6,4		ę. #			
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LBS/FT							

#### WORLD TRADE CENTER FLOOR GHID TRUSSES DESIGN DATA

Truss Mk. 2(32T1-599

Truss Component Mk. C3271-599



#### NOTES:

Main Web - Continuous uniform section throughout Member Mk. 3. (Top chord fillers same section as Main Web - at midpoint 10 center web panels minimum.)

MEMBERS REQUIRED PE	R TRUSS	COMPONENT	S or C/	_	
		Grade		Total Length	Weight
Member	Mk.No.	Steel	<u>Size</u>	-tember	Member
Top Chord	6-8	A-441	2-2" 112 0.25" 4		
Bottom Chord	7	A-36	2-3 +2 +0.37 X		
Main Web	3	A- 34	1.09 014		
Compression Wet	4	A-441	1.14 014		
Vertical End Struts	2	A-36	1.09"014		
Long End Diagonal	1	A-441	1.14 oca		
Short End Diagonal	5	A-441	1.14° p.i.A		

LACLEDE STEEL COMPANY

D105- T | -Sheet 14

SPECIAL SECTIONS

(Extended, square ends, etc.)

#### WORLD TRADE CENTER FLOOR ORID TRUSSES DESIGN DATA

```
TRUSS UNIT MARKED 2C32T1 Refer to drawings ST 101, 6, 7.
 Clearspan "L" = 58.92 fc. Spacing = 6.67 ft.
  Applicable Total Moment = 4.570,000 inch pounds.
            Based on iza lba./sq. ft. Total Load "w".
 Applicable End Reaction = 25,500 pounda.
            Based on 128 lbs./sq. ft. Total Load "w".
 Applicable Total Constr. Noment a 1,740,000 inch pounds.
            Based on 50 15s./aq. ft. Construction Load.
  Applicable Constr. End Reaction = 10,000 pounds.
            Based on 60 lbs./sq. ft. Construction Load.
  "V" Shear at End Panel . 22,940 pounds. ED . 3.00 ft.
WEB MEMBER #1 Uistance from End Panel = 0.0 ft.
  Applicable Shear V_x = 22.940 lbs.
                                            f<sub>v</sub> • <u>50,000</u> ps1
 Slope = 2.65
                                             f<sub>s</sub> = 30,000 ps1
  l = ____ in.
                                            fsc = ____ psi
 Reqd. Area = 2.03 sq. in. Use 2-1.14 or Area = 2.04 sq. in.
WEB NEMBER #2 Distance from End Panel = 0.0 ft.
  Applicable Shear V<sub>x</sub> = <u>22,940</u> lbs.
                                            f<sub>v</sub> = <u>36,000</u> ps1
  Slope = 1.00
                                             fs = ____ psi
  1 = 25.5 in.
                                            fac = /3.5/0 ps1
  Reqd. Area = 1.69 sq. in. Use 2-1.09 or Area = 1.87 sq. in.
WEB MEMBER #3 Distance from End Panel - 4.87 ft.
  Applicable Shear V_x = 18.780 lbs.
                                            f<sub>v</sub> = <u>36,000</u> ps1
  Slope = 1.162
                                             fs = ____ psi
  l = 29.5 in.
                                            fac = // 820 psi
  Regd. Area = 1.85 sq. in. Use 2-1.09 bis Area = 1.87 sq. in.
```

WEB MEMBER 14 Distance from End Panel = 3.04 ft.

Applicable Shear  $V_x = 20.340$  lbs.  $f_y = 50.000$  ps1

Slope = 1162 ps1

l = 29.5 in.  $f_{8C} = 13.850$  psi

Reqd. Area = 171 sq. in. Use 2-1.4" oin Area = 2.04 sq. in.

WEB MEMBER #5 Distance from End Panel = 00 ft.

Applicable Shear  $V_x = 22,940$  lbs.  $f_y = 50,000$  psi

l =\_\_\_\_\_ in.  $f_{SC} =$ \_\_\_\_\_ psi

Reqd. Area = 1.68 sq. in. Use 2-1.14 ora Area = 2.04 sq.1n.

CHORD MEMBER #6 Consists of 4-Z": /1" + 0.25" Angles

Construction Load Design Area = 3.60 sq. in.

Applicable Moment = 1,740,000 in. lbs.  $f_v = 50.000$  ps1

l = <u>33375</u> in.

f<sub>3</sub> = \_\_\_\_\_ psi

 $r_{x} = 0.44$  in.  $r_{sc} = 19.380$  ps1

 $r_2 = 0.31$  in. (with fillers in middle 60% of span)

1 = 75.0 r,

 $\frac{\underline{f}_{a}}{2r_{z}} = \underline{538} \qquad \frac{\underline{f}_{a}}{F_{a}} + \frac{\underline{f}_{b} \, \underline{f}_{m}}{F_{b} (1 - \underline{f}_{a})} = \underline{0.949} \text{ less than } 1$ 

 $f_a = 17.250$  psi

Fa = 19.380 psi

F<sub>b</sub> = <u>30.000</u> psi

Fe = 25.950 psi

Use  $4-2" \times 1'/2" \times 0.25" 4's$  Area = 3.60 sq. in.

CHORD MEMBER #7 Consists of 4-3"x2"x0.37" Angles

Total Load Design Area = 7.32 sq. in.

#### CHORD MEMBER #7 (CONTD.)

Applicable Moment = 4.570.000 in lbs. fy = 36.000 psi

fs = 22.000 ps1 Dt = 33.00 in.

fac = \_\_\_\_ psi

Beff = 64.00 in.

t = \_\_\_\_\_\_\_1.00 in.

y<sub>1</sub> = <u>2.00</u> in.

do = 5.86 in.

y<sub>2</sub> = \_in.

d3 = 22./4 in.

 $y_3 = 32.44 \text{ in.}$ 

c<sub>1</sub> = /0.30 in.

dj = 8.30 in.

 $I_s = \sum [(I_c + A_c d_1^2) + (I_{TCA} + A_{TCA} d_2^2) + I_{BCA} + A_{BCA} d_3]$ 

$$\frac{1}{y} = \frac{\sum (A_c y_1 + A_{TCA} y_2 + A_{BCA} y_3)}{\sum (A_c + A_{TCA} + A_{BCA})}$$

 $\bar{y} = 10.30$  in.

 $I_S = 4917 \text{ in.}^4 : 2C32T1)$ 

Resisting Moment =  $f_S \times \frac{1_S}{c_S} = 4.770.000$  in. lbs.

Use 4-3":2":037" 4's Area = 7.32 sq. in.

Composite Design Top Chord Check

Total Load Lesign

fc = 3,000 ps1

Applicable Moment = 4.670,000 in. lbs.  $f_0^{\dagger} = 1.350$  psi

$$f'_{cc} = \frac{|r|_{c_0}}{15I_S} = 640$$
 psi

CHORD MEMBER #8 Consists of 4-2". 1/2" x 0.25" Angles

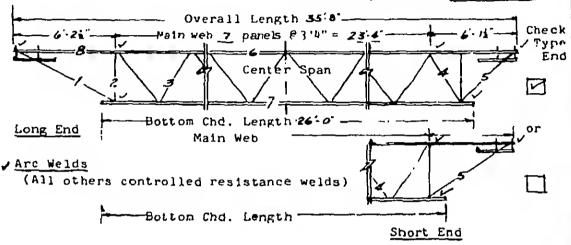
Area = 3.60 sq. in.

(SAME AS MEMBER 6)

#### WORLD TRADE CENTER FLOOR ORID TRUSSES DESIGN DATA

Truss Mk. 2632T5- 599

Truss Component Mk. C3275- 599



#### NOTES:

Main Web - Continuous uniform section throughout Member Mk. 3. (Top chord fillers same section as Main Web - at midpoint web center web panels minimum.)

MEMBERS REQUIRED F	ER TRUSS	COMPONENT	5 or C	<u> </u>	
Member	Mk.No.	Grade of Steel	Size	Total Length Member	Weight Member
Top Chord	6-8	A-441	2-2-11-10.25-4		
Bottom Chord	7	A - 36	2-2"+11 +0 =54		
Main Web	3	A - 36	0.92"019		
Cir::ession Web	4	A-441	0 18" DIA		
Vertical End Strut	s 2	A-36	O.AZ" DIA		
Long End Diagonal	1	A-441	0.92" DIA		
Short End Diagonal	5	A-441	0.92" 514		

### LACLEDE STEEL COMPANY

D105- T 5 -Sheet 1A

#### SPECIAL SECTIONS

(Extended, square ends, etc.)

#### WORLD TRADE CENTER FLOOR GRID TRUSSES DESIGN DATA

```
TRUSS UNIT MARKED 2032 TS Refer to drawings ST 101, 6.8.
 Clearspan "L" = ___34.83_ ft. Spacing = __ 4.47 ft.
 Applicable Total Moment = 1,920,000 inch pounds.
                                                 31 PARTIAL
           Based on 154 lbs./sq. ft. Total Load "w".
 Applicable End Reaction = 16,000 pounds.
           based on 154 lbs./sq. ft. Total Load "W".
 Applicable Total Constr. Moment = 585,000 inch pounds.
           Based on 46 lbs./sq. ft. Construction Load.
 Applicable Constr. End Reaction = 5470 pounds.
           Based on 46 lbs./sq. ft. Construction Load.
 "V" Shear at End Panel = 14,920 pounds. ED = 3.0 ft.
WEB MEMBER #1 Distance from End Panel = 0.0 ft.
 Applicable Shear V_x = 14.920 lbs. f_y = 50.000 psi
 Slope = 2.65
                                         f = 30,000 psi
  l = ____ in.
                                         fsc = ____ ps1
 Read. Area = 1.32 sq. in. Use Z-0.92 or Area = 1.33 sq. in.
WEL MEMBER #2 Distance from End Panel = 0.0 ft.
 Applicable Shear V_x = 14,920 lts. f_y = 36,000 psi
 Slope = 1.00
                                         f<sub>s</sub> = ______ psi
  l = 26.0 in.
                                         fsc = 11,200 psi
 Reqd. Area = 1.33 sq. in. Use 2-0.92 or Area = 1.33 sq. in.
WEB MEMBER #3 Distance from End Panel = 4.87 ft.
  Applicable Shear V_x = 9.920 lbs. f_y = 36.000 psi
  Slope = _ 1.162
                                          fs = _____ psi
  l= 30.0 in.
                                         fsc = 8,750 psi
  Reqd. Area = 1.3Z sq. in. Use Z · 0.92" or Area = 1.33 sq. in.
```

WEB MEMBER #4 Distance from End Panel = 3.21 ft. (ED = 2.08') Applicable Shear V<sub>x</sub> • 12,570 lbs. fy • 50,000 psi Slope = \_\_1/42 r<sub>s</sub> = \_\_\_\_ psi l = 300 in. fsc = 9,970 psi Heqd. Area = 1.47 sq. in. Use Z - 0.98 Dia Area = 1.51 sq. in. WEB MEMBER #5 Distance from End Panel . O.O ft. (ED = 2 00') Applicable Shear  $V_x = 15,865$  lbs.  $f_y = 50,000$  psi Slope = 190 f = .50,000 psi l = \_\_\_ in. fsc = \_\_\_ psi Reqd. Area = 1.01 sq. in. Use 2-0.92" or Area = 1.33 sq.in. CHORD MEMBER #6 Consists of 4-2" 11/2 x 0 25" Angles Construction Load Design Area = 3.60 sq. in. Applicable Moment = 585,000 in. lbs.  $f_v = 50,000$  psi l = <u>33.375</u> in. r<sub>s</sub> = \_\_\_\_\_ psi r<sub>X</sub> = <u>0.44</u> in. fsc = 19,380 ps1  $r_z = 0.31$  in. (with fillers in middle 60% of span) 1 = 75.8  $\frac{f_a}{2r_a} = \frac{f_b}{F_d} + \frac{f_b}{F_b(1 - \frac{f_a}{F_b'})} = \frac{0.410}{0.410} \text{ less than 1}$  $f_a = 7.500$  psi fb = \_\_\_\_\_748 psi F<sub>b</sub> = 30,000 psi F = 25,950 psi

CHORD MEMBER #7 Consists of 4 - 2" x 1 1/2" x 0.25" Angles

Use 4-2:11/2" x 0.25" 4's Area = 3.60 sq. in.

Total Load Design Area = 3.60 sq. in.

#### CHORD MEMBER #7 (CONTD.)

Applicable Moment = 1,920,000 in lbs. fy = 36,000 psi

f = 22.000 ps1

 $D_{t} = _{-}$  33.00 in.

fsc = \_\_\_\_ pai

Beff = <u>64.00</u> in.

t = 4.00 in.

y<sub>1</sub> = <u>2.00</u> in.

 $d_2 = 2.46$  in.

y<sub>2</sub> = 4.44 in.

dz = 25.66 in.

y = \_ 32,56 in.

d<sub>1</sub> = 4.90 in.

 $c_2 = 26.10$  in.

 $I_{s} = \sum [(I_{c} + A_{c}d_{1}^{2}) + (I_{TCA} + A_{TCA}d_{2}^{2}) + I_{BCA} + A_{BCA}d_{3}]$ 

$$\frac{1}{\lambda} = \frac{\sum (A_{C}\lambda_{1} + A_{T}CA\lambda_{2} + A_{B}CA\lambda_{3})}{\sum (A_{C}\lambda_{1} + A_{T}CA\lambda_{2} + A_{B}CA\lambda_{3})}$$

$$\bar{y} = 6.90$$
 in.

Resisting Moment =  $f_s \times \frac{I_s}{G_s} = 2.380,000$  in. ivs.

Use 4-2"x 1/2" x 0.25" X's Area = 3.60 sq. In.

#### Composite Design Top Chord Check

Total Load Design

fc = <u>3.000</u> psi

Applicable Moment = 1.920,000 in. Its.  $f_c^{\prime} = 1.350$  psi

CHURD MEMBER #6 Consists of 4-2 x11/2 x 0.25 Angles

Area = 3.60 sq. in.

(SAME AS MEMBER 5)

## LACLEDE STEEL COMPANY STRUCTURAL DETAILS WORLD TRACE CENTER TOWERS PORT OF NEW YORK AUTHORITY

Detail No.	<u>Title</u>	Oate <u>Transmitted</u>	Approved
ST-101	Typical 32" composite truss web Intermediate Panel - Full Scale	•	
ST-102	Typical web chord sections 32" composite trusses - Full So	cale	
ST-103	Intermediate panel details 24" standard trusses 32" composite trusses - Full So	cale	
ST-104	Intermediate panel details 28" composite trusses 32" composite trusses - Full So	cale	
ST-105	Corner intersection details Continuity of 32" - 60' span composite trusses (CT3, CT3A as CT4) into 28" composite trusses (CT9) in 35' span - Full Scale	nd s	
ST-106	Typical column bearing end deta of 32" composite trusses 2" x 2" damping unit extension Scale 3" = 1"		
ST-106A	Column bearing end detail shows diagonal angle bracing attachm 32" composite trusses  Scale 3" = 1"		
ST-106B	Column bearing end detail Typical extended shallow bearing end - 32" composite trusses  Scale 3 = 1"	ng	
ST-106C	Column bearing end detail showidamping unit extension for 28" composite trusses 24" standard trusses  Scale 3" = 1"	ng	

0 4 - 4 3 11	m	Date	Annound
Detail Ho.	<u>Title</u>	Transmitted	Approved
S <b>T-</b> 1 D6D	Column bearing end detail showing diagonal angle bracing attachment 2b" composite trusses 24" standard trusses Scale 5" = 1"		
ST-106E	Column bearing end detail Typical extended shallow bearing end 28" composite trusses 24" standard trusses Scale 5" = 1"		
ST-1	32" composite truss details Approximate 60' span Type CT1, CT2, CT3, CT3A and CT4 - Scale 15" = 1'0"		
ST-108	32" composite truss details Approximate 35' span Type CT5 and CT6 Scale 14" = 1'0"		
ST-109	28" composite truss details Corner construction Type CT7, CT8 & CT9 Scale 15" = 1'0"		
ST-110	24" standard truss details 20'0" transverse ST8, ST10, ST11 and ST12 (duct) 13'4" transverse ST13 Scale 15" = 1'0"		

LACLEDE STEEL COMPANY
PLOOR ORID PANEL & PANEL LOCATIONS
WORLD THADE CENTER TOWERS
PORT OP NEW YORK AUTHORITY

Detail No.	Title	Oate Transmitted	Approved
L-100	Typical floor plan - showing panel designation, truss location, applicable design moments and end reaction for truss design - Scale 1/8" = 1'	0"	
L-101	Quarter plan - Typical floor showing panel designation, tru loaction, truss designation an truss web configuration  Scale 1/8" = 1'0"		

# LACLEDE STEEL COMPANY DESIGN CALCULATIONS WORLD TRADE CENTER TOWERS PORT OF NEW YORK AUTHORITY

	Date	
Sheet No.	Design Dsta Transmitted	Approved
D100-1 thru 7	Basic Design Data	
D101	Chord Angle Properties 2" x 1/2" angles	
D102	Chord Angle Properties 3" x 2" angles	
D103	'ound Web Properties	
D104	Miscellaneous Section Properties	
D105-T1	Design Data Truss Mk. 2032T1	
D105-T2	Design Data Truss Mk. 2C32T2	
D105-T3	Design Data Truss Mk. 2C32T3	
D105-T3A	Design Data Truss Mk. 2C32T3A	
D105-T4	Design Data Truss Mk. 2C32T4	
D105-T5	Design Data Truss Mk. 2C32T5	
D105-T6	Design Data Truss Mk. 2C32T6	
D105-T7	Design Data Truss Mk. C28T7	
D105-T8	Design Data Truss Mk. C28T8	
D105-T9	Design Data Truss Mk. C28T9	
D105-T10	Design Data Truss Mk. S24T10	
D105-T11	Design Data Truss Mk. S24Tll	
D105-T12	Design Dats Truss Mk. S24T12	
D105-T13	Design Dats Truss Mk. S24Tl3	
D105-ET1	Dealgn Data Extended End Truss Mk. 2032ET1	
D105-ET2	Design Dats Extended End Truas Mk. 2C32ET2	
D105-ET3	Design Dats Extended End Truss Mk. 2032ET3	

Sheet No.	Design Data	Date Transmitted	Approved
D1D5-ET3A	Design Data Extended End Truss Mk. 2032ET3A		
D105-ET4	Design Data Extended End Truss Mk. 2C32ET4		
D1D5-ET5	Design Data Extended End Truss Mk. 2032ET5		
D105-ET6	Design Data Extended End Truss Mk. 2032ET6		
D1D5-ET7	Design Data Extended End Truss Mk. C28ET7		
D105-ET10	Design Data Extended End Truss Mk. S24ET1D		

## WORLD TRADE CENTER FLOOK GRID TRUSSES BASIC OFFICE DATA

Based on double truss units. Mark 2CT or 2ST ... . Single truss components. Mark CT or ST ...

#### DIMENSIONS:

Unless specifically noted otherwise, see "ST" Details.

Truss clearspan in feet = L. Overall length of truss minus end bearings in feet (2 x 5" = 10"). Example:  $59^{19}$ " overall length. Clearspan L =  $59^{19}$ " minus 10" or  $58^{11}$ " or  $58.92^{11}$ .

Length of member, clear of attachments = "L"

#### Depth of Truss

Composite type "C" (Measur.d top of shear member to bot om of lower chord.)

Standard type "S" (Measured out to out of chord members.)

Total depth of composite section =  $p_t$ 

#### TOLLRANCES:

Overall length 1/4"+ or 1/4"-.

Depth 1/8"+ or 1/8"-.

#### LOADS:

Total load = Live load + Dead load

Applicable for composite design.

Applicable for combined slat and top chord design and bottom thord design.

Construction load = Applicable lead load

Applicable for top and bottom chord steel design.

Dead load a Actual weight of structural system in pounds per source foot.

Live load = Assigned live load for panel area in pounds per square fcot.

Design load in pounds per square foot = "w"

#### TOTAL MUMENT:

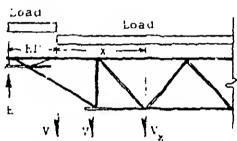
"M" (in inch pounds) =  $WE^2 \times 1.5$ .

#### ENU REACTION:

"h" (In rounds) = "W" x . " (overall length of truss in feet).

#### "HLAR:

At first top chord pane; in pounds = V = H- (W x ED)

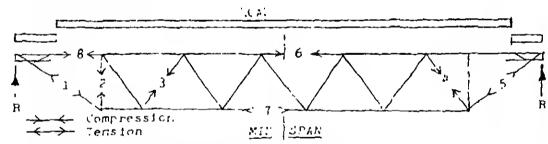


El' = Distance first top chor: panel point to trus: end.

Shear at other points in pounds  $r(V_x) = (F_x F_y) \times W_y \times$ 

(In no case less than per of end reaction "F".)

#### PESIGNATION OF MEMBERS:



- i. End diagonal (long end) tension member
- ". First pane: vertica: (long end) compression
- 3. Second panel compression diagonal
- First panel member (short end) compression
- End diagonal (short end) tension.
- the Top chord critical compression member at mid span
- . bottom chord critical tension Lember at mid span
- c inc top chord compression member (long end)

#### MATERIALCE

A-36 steel . . . . . . . 36 ksi minimum yield strength

A-441 modified . . . . . . . 50 ksi minimum yield strength low alloy "H" Series.

See sheets D101 through D103 for Properties of Sections.

APPLICABLE FORMULAE: Stress petermination (Web or Chord Members)

#### A-36 steel

(36 kg1

 $f_V$  = Minimum Yield Strength 36,000 psi

minimum yield)

fs = Tension 22,000 psi

 $f_{SC} = \text{Compression for } \ell/r (127 - 18,540 - .574 (\ell/r)^2 \text{ psi}$ 

for Ur) 127 149,000,000 ps1

 $\mathcal{L}$  = clear distance between attachments

r = least radius of gyration

#### A-441 Steel

(50 ks1

fy = Minimum Yield Strength 50,000 ksi

minimum yleld)

 $f_s$  = Tension 30,000 psi

fsc = Compression for  $\ell/r < 108$  75,750 - 1.108  $(\ell/r)^2$  psi for  $\ell/r > 108 < 200$   $\frac{149,000,000}{(\ell/r)^2}$  psi

Continuous members shall be designed for only axial compressive stress when the panel length clear of attachments does not exceed 24". When the panel length clerr of attachments exceeds 24", the top chord shall be designed as a continuous member subject to combined axial and bending stress and shall be of proportion that the quantity -

$$\frac{\Gamma_a}{30,000} + \frac{\Gamma_b}{F_b}$$

uoes not exceed unity at the panel point, or that the quantity -

$$\frac{f_a}{F_a} + \frac{f_b C_r}{F_b (1 - \frac{f_a}{F_a'})}$$

uoes not exceed unity at the mid panel.

Permissible axial unit compressive stress =

Permissible bending unit stress =

Permissible compressive stress factor (column equation

$$\frac{149,000,000}{(L/r)^2}$$
 psi) = "Fe"

D100-4 Date <u>Pebruary 6, 1967</u>

Actual axial unit compressive stress	. fa
Actual bending unit stress =	. f <sub>b</sub>
AXIMUM SLENDERNESS RATIOS:	
Top chord panels (interior) = 85  Top chord end panels = 120  Compression members other than top chord = 200  Tension members = 240	
PILLERS OR TIES:	
Members in compression composed of two components shall have fillers or ties spaced so that the ratio of $\ell$ /r of each component shall not exceed the ratio of $\ell$ /r of the whole member. The minimum "r" shall be used in calculating the critical ratio $\ell$ /r of any component.	e
SHEAR CONNECTORS:	
Shall be considered to provide a minimum 15 ks; horizontal shear per web end connector imbedded in the concrete. This is for 3,000 ps; concrete. ( $f_c$ )	
DEFLECTION:	
Applicable deflection formula for uniform load.	
and the second s	
Maximum deflection $\Delta = \frac{25.88 \text{ (WL}^4)}{29,000,000}$	)
Maximum deflection $\Delta = \frac{25.88 \text{ (WL}^2)}{29,000,000}$ COMPOSITE SLAB AND JUIST DESIGN:	)
	)
COMPOSITE SLAB AND JUIST DESIGN:	
COMPOSITE SLAB AND JUIST DESIGN: Design values	
COMPOSITE SLAB AND JUIST DESIGN:  Design values  Total depth of combined slab and truss in inches =  Effective width of concrete flange in inches equal to	· D <sub>t</sub>
COMPOSITE SLAB AND JUIST DESIGN:  Design values  Total depth of combined slab and truss in inches =  Effective width of concrete flange in inches equal to 2 x 8t =  Distance from top of concrete flange to neutral axis of	. D <sub>t</sub> . beff . y <sub>1</sub>
COMPOSITE SLAB AND JUIST DESIGN:  Design values  Total depth of combined slab and truss in inches =  Effective width of concrete flange in inches equal to 2 x 8t =  Distance from top of concrete flange to neutral axis of concrete flange =  Distance from top of concrete flange to neutral axis of	. D <sub>t</sub> . berr . y1
COMPOSITE SLAB AND JUIST DESIGN:  Design values  Total depth of combined slab and truss in inches =  Effective width of concrete flange in inches equal to 2 x 8t =  Distance from top of concrete flange to neutral axis of concrete flange =  Distance from top of concrete flange to neutral axis of top chord angles =	. D <sub>t</sub> . berr . y1

[istance from neutral axis of composite section to neutral axis of top chord angles =	q <sup>5</sup>
Distance from neutral axis of composite section to neutral axis of bottom chord angles =	<sup>d</sup> 3
Distance from neutral axis of composite section to outermost fibers of compression chord *	c 1
Distance from neutral axis of composite section to outermost fibers of tension chord =	c 5
Allowable concrete strength $f_c = 3,000$ pounds psi.	
Allowable steel strength =	ſs
Allowable concrete compressive stress $f_c^* = 1.350$ pounds psi.	
Actual concrete compressive stress =	ιςc
Allowable steel compressive stress =	fec
Modular ratio = 15 =	Es Ec
SECTION PROPERTIES: (Refer to Sheets 1:101 through D103)	
Moment of inertia of concrete =	<sup>I</sup> c
Moment of inertia of top chord angles =	ITCA
Moment of inertia of bottom chord angles =	IBCA
Moment of inertia of composite system =	Is
Area of concrete flance =	Ac
Area of trp chord angles =	ATCA
Area of tottom chord angles =	AFCA
eff	
c1	
1 - 1 1 - A	eutral kis of omposite
	ystem
Neutral incitom C	

D100-6

Cate February 6, 1967

## FORMULAE:

Resisting moment - "RM"

Allowable unit stress times the applicable Section Modulus =  $(applicable f \times S)$ .

Section Modulus (about the axis of bending) =  $S = \frac{1}{C_1 \text{ or } C_2}$ 

## QUALITY CONTROL AND INSPECTION:

## Material Test Reports

Since all steel employed in the fabrication of trusses is produced in the furnaces and mills of Laclede Steel Company, certified mill test reports showing heat numbers, chemistry, and physical properties for all steel components will be provided.

## Resistance Welding

Truss panel points will be connected by electronically controlled resistance welding providing two times the strength of the connected members at full design load.

Angle chords of carton and alloy steel to be of weldable grade with contact surfaces cleaned of scale by shot blasting prior to welding.

We lus to be subject to "on-line" testing by measured hydraulic wedge action tester with spot checking of finished ranel point welds ty testing in vertical double shear to two times design load value.

Any panel point welds indicated to have less than the established factor for weld shear strength will be are welded, subsequent to testing.

Full design load tests will be effected on full size and full length truss components by hydraulic loading in a test frame with load measurement by electric load cell and center span derlection check.

Load tests with recorded deflection and recovery data will be made on a minimum of one of each identified truss style involved in the panel construction.

### Physical Tension Tests

Tension tests on truss components, chord angles, and webs will be performed on selected sample members included in the normal truss fabrication.

## Inspection and Access to Plant

Free access to the plant of the truss manufacturer and the

D100~7
Date February 5, 1967

available inspection and test facilities will be offered the qualified inspectors representing the purchaser for observation of the test and inspection procedures outlined herein.

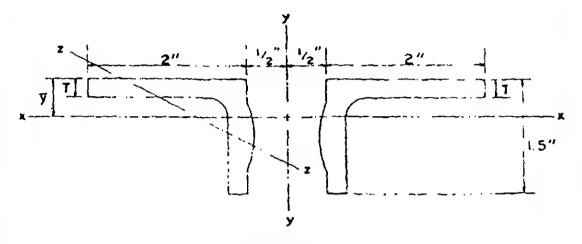
Any testing requested beyond that identified herein shall be for the account of the purchaser.



LACLEDE STEEL COMPANY SAINT LOUIS, MISSOURI
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BY L.J.S. DATE 2-6-67 THE PORT OF NEW YORK AUTHORITY
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TRUSS SECTION COMPONENTS
TRUSS ANGLE SECTIONS
DESIGN SECTION PROPERTIES



2"x1"z" x T

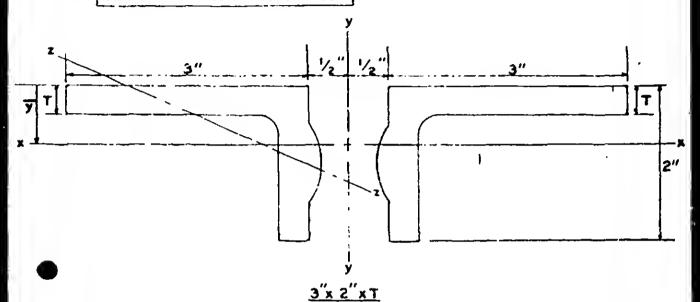
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TRUSS SECTION COMPONENTS
TRUSS ANGLE SECTIONS
DESIGN SECTION PROPERTIES



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TRUSS SECTION COMPONENTS TRUSS WEB SECTIONS DESIGN SECTION PROPERTIES

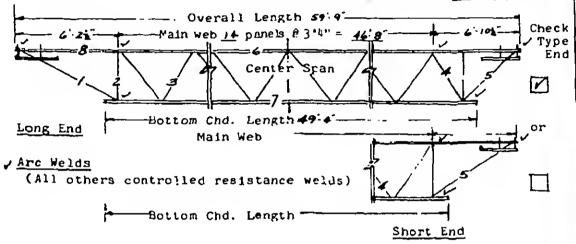


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## WORLD TRADE CENTER PLOOR ORID TRUSSES DESIGN DATA

Truss Mk. 2C32T1-599

Truss Component Mk. C32T1-599



## NOTES:

Main Web - Continuous uniform section throughout Member Mk. 3. (Top chord fillers same section as Main Web - at midpoint // center web panels minimum.)

MEMBERS REQUIRED PER	R TRUSS	COMPONENT	S or C_/	_	
		Grade of		Total Length	Weight
Member	Mk.No.	<u>Steel</u>	<u>S1ze</u>	Member	Member
Top Chord	6-8	A-441	Z-2" + 11/2 = 025" 4		
Bottom Chord	7	A-36	2-5-2-0.374		
Main Web	3	A-36	1.09 PIA		
Compression Wer	Ŋ	A-441	1.14DIA		
Vertical End Struts	2	A-36	1.09°01A		
Long End Diagonal	1	A-441	1. 14 014		
Short End Diagonal	5	A-441	1 14 014		

# LACLEDE STEEL COMPANY

D105- T/ -Sheet 1A

SPECIAL SECTIONS

(Extended, square ends, etc.)

### WORLD TRADE CENTER FLOOR ORID TRUSSES DESIGN DATA

```
TRUSS UNIT MARKED 263271 Refer to drawings ST 101, 6.7.
 Clearspan "L" = <u>58.92</u> fc. Spacing = <u>6.67</u> ft.
 Applicable Total Moment = 4, 670,000 inch pounds.
           Based on 126 lbs./sq. ft. Total Load "w".
 Applicable End Reaction = 25,500 pounds.
           Based on 128 lbs./sq. ft. Total Load "w".
 Applicable Total Constr. Moment = 1,740,000 inch pounds.
           Based on 50 lbs./sq. ft. Construction Load.
 Applicable Constr. End Reaction = 10,000 pounds.
           Based on 50 lbs./sq. ft. Construction Load.
 "V" Shear at End Panel = 22,940 pounds. ED = 3.00 ft.
WEB MEMBER #1 Distance from End Panel = 0.0 ft.
                                          fy = 50,000 ps1
 Applicable Shear V_x = 22.940 lbs.
                                           fg = 30,000 psi
 $lope ≈ 2.____
  l = ____ in.
                                          rsc = ___ psi
 Reqd. Area = 2.07 sq. in. Use Z-1.14 o/A Area = 2.04 sq. in.
WEB MEMBER #2 Istance from End Panel = __OO ft.
 Applicable Shear V_x = ZZ,940 lbs. \Gamma_y = 36,000 psi
 fs = _____ psi
  l = 255 in.
                                          fsc * 13.5/0 psi
  Reqd. Area = 1.69 sq. in. Use 2-1.09" or Ares = 1.87 sq. in.
WEB MEMBER #3 Distance from End Panel = 4.87 ft.
                                          f<sub>v</sub> • <u>36.000</u> psi
  Applicable Shear V_x = 18,760 lbs.
                                           f<sub>s</sub> • _____ psi
  Slope = 1.162
  l = <u>29.5</u> in.
                                           Reqd. Area = 1.85 sq. in. Use 2-1.09" Dia Area = 1.87 sq. in.
```

WEB MEMBER #4 Distance from End Panel - 304 ft. Applicable Shear  $V_x = 20,340$  lbs.  $\Gamma_y = 50,000$  ps1 Slope = 1162 r<sub>s</sub> = \_\_\_\_\_ psi l = 295 in. fac = 13,850 ps1 Heqd. Area = 1.71 sq. in. Use 2-1.4 or Area = 2.04 sq. in. WEB MEMBER #5 Distance from End Panel = 0.0 ft. Applicable Shear  $V_X = 22,940$  lbs.  $\Gamma_V = 50,000$  psi Slope = <u>Z.20</u> fa = 30,000 ps1 l = - in. fsc = \_\_\_\_ psi Reqd. Area = 1.68 sq. in. Use Z-1.14" D/A Area = 2.04 sq.in. CHORD MEMBER #6 Consists of 4-2-x1/2" 0.25" Angles Construction Load Design Area = 3.60 sq. in. Applicable Moment = 1,740,000 in. lbs.  $f_y = 50,000$  ps. l = 33.375 in. f<sub>s</sub> = \_\_\_\_\_ psi rx = <u>0.44</u> in. fsc = 19.380 ps1  $r_z = 0.51$  in. (with fillers in middle 60% of span) 1 = 75.8  $\frac{f_{a}}{2r_{a}} = \frac{f_{b} c_{m}}{F_{a}} + \frac{f_{b} c_{m}}{F_{b} (1 - \frac{f_{a}}{p^{2}})} = \frac{0.949}{0.949}$  less than 1 f<sub>a</sub> = \_\_ /7,250\_ psi Pa = 19.380 psi f<sub>b</sub> = \_\_\_ 8/0\_ psi P<sub>h</sub> = <u>30,000</u> psi F' = \_25,950 psi

CHORD MEMBER #7 Consists of 4-3"=2" = 0.37" Angles Total Load Design Area = 7.32 sq. in.

Use 4-2"x1/2"x0.25" 4's Area = 3.60 sq. 1n.

## CHORD MEMBER #7 (CONTD.)

Applicable Moment = 4.570,000 in lbs. fy = 36.000 psi

f<sub>s</sub> = 22.000 p31

Dt = \_\_\_ 33.00 in.

fsc = \_\_\_\_ psi

Beff = 64.00 in.

t = \_\_\_\_\_\_in.

y<sub>1</sub> = \_\_\_\_\_\_ 2.00 in.

dy = <u>586</u> in.

y<sub>2</sub> = 4.44 in.

d3 = 22./4 in.

c1 = /0.30 in.

d1 = \_\_\_ 8.30 in.

 $c_2 = 22.70$  in.

 $I_5 = \sum [(I_c + A_c d_1^2) + (I_{TCA} + A_{TCA} d_2^2) + I_{BCA} + A_{BCA} d_3]$ 

$$\frac{1}{y} = \frac{\sum (A_C y_1 + A_T C_A y_2 + A_B C_A y_3)}{\sum (A_C + A_T C_A + A_B C_A)}$$

ÿ = 10.30 in.

 $I_s = 49/3$  in. ( 2C32T1 )

Resisting Moment =  $f_S \times \frac{I_S}{C_2} = 4.770,000$  in. lbs.

Use  $4-3^{\circ} \times 2^{\circ} \times 0.37^{\circ} = 3^{\circ}$  Area = 7.32 sq. in.

## Composite Design Top Chord Check

Total Load Design

 $f_c = 3,000 \text{ psi}$ 

Applicable Moment = 4.570,000 in. lbs.  $f_c' = 1.350$  psi

$$f_{cc}' = \frac{Mc_1}{45I_5} = 640$$
 ps1

CHORD MEMBER #8 Consists of 4-2"x 11/2 x 0.25" Angles

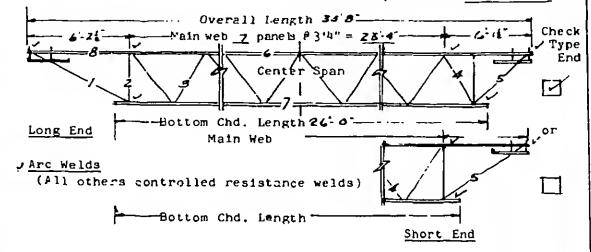
Area = 3.60 sq. in.

(SAME AS MEMBER 6)

### WORLD TRADE CENTER PLOOR GRID TPUSSES DESIGN DATA\_\_\_\_

Truss Mk. 2(32T5 - 358

Truss Component Mk. C32T5-358



### NOTES:

Main Web - Continuous uniform section throughout Member Mk. 3. (Top chord fillers same section as Main Web - at midpoint work center web panels minimum.)

Vertical Struts Mk. 2 - Same size as main web. End Bearing Struts - Same size as main web.

Composite Type - Webs extend above top chord \_\_\_\_\_\_\_\_"

MEMBERS REQUIRED PER	TRUSS	COMPONENT	S or C_ ✓		
Member	Mk.No.	Grade of Steel	Size	Total Length Member	Weight Member
Hember	MX - NO -	3000	2120	Men.be I	remoer
Top Chord	6-8	A- 441	2-2".11/2" = 0.25"4		
Bottom Chord	7	A-36	2-2",112",0.254		
Main Web	3	A-36	0.92" DIA		
Compression Wet	4	A - 441	0.18" DIA		
Vertical End Struts	2	A-36	0.92" DIA		
Long End Diagonal	1	A-441	0. 92" D.A		
Short End Diagonal	5	g- 44]	0.92" DIA		
Main Web Compression Wet Vertical End Struts Long End Diagonal	3 4 2 1	A-36 A-441 A-36 A-441	0.92" DIA 0.92" DIA 0.92" DIA		

# SPECIAL SECTIONS

(Extended, square ends, etc.)

## WORLD TRADE CENTER FLOOR GRID TRUSSES DESIGN DATA

```
TRUSS UNIT MARKED 2C32T5 Refer to drawings ST 101, 6, 8 .
 Clearspan "L" = 34.83 ft. Spacing = 6.67 ft.
                                                     31 PARTIAL
 Applicable Total Moment = 1,920,000 inch pounds.
           Based on 154 lbs./sq. ft. Total Load "w".
 Applicable End Reaction = 18,000 pounds.
            Based on 154 lbs./sq. ft. Total Load "w".
 Applicable Total Constr. Moment = _________ inch pounds.
            Based on 46 lbs./sq. ft. Construction Load.
 Applicable Constr. End Reaction = ______ pounds.
            Based on 46 lbs./sq. ft. Construction Load.
 "V" Shear at End Panel = 14.920 pounds. ED = 3.0 ft.
               Distance from End Panel = __OO ft.
                                            fy = <u>50,000</u> ps1
 Applicable Shear V_v = 14,920 lbs.
                                            f<sub>s</sub> = 30,000 ps1
 Slope = 265
  \mathcal{L} = \underline{\hspace{1cm}} in.
                                            fsc = _____ psi
 Heqd. Area = 1.32 sq. in. Use 2-0.92 or Area = 1.33 sq. in.
WEB MEMBER #2 Distance from End Panel = 0.0 ft.
 Applicable Shear V = 14.920 lts.
                                            f_v = 36,000 \text{ psi}
 Slope = 1.00
                                             f<sub>s</sub> = _____ psi
 \mathcal{L} = \underline{24.0} \text{ in.}
                                            fsc = 11,200 ps1
 Heqd. Area = 133 sq. in. Use 2-0.92 DIA Area = 1.33 sq. in.
WEB MEMBER #3 Distance from End Panel = 4.87 ft.
 Applicable Shear V_x = 9,920 lbs. f_y = 36,000 psi
 Slope = 1.162
                                            fs = ____ psi
  l = 30.0 in.
                                            fsc = 8.750 ps:
 Reqd. Area = 1.32 sq. in. Use Z-0.92 D.A Area = 1.33 sq. in.
```

Total Load Design

WEB MEMBER #4 Distance from End Panel = 3.21 ft. (ED · 2 06') Applicable Shear  $V_X = 12.570$  lbs.  $f_y = 50.000$  psi f<sub>s</sub> = \_\_\_\_\_ psi 1 = 30.0 in. f<sub>sc</sub> = \_\_\_\_9\_70 psi Reqd. Area = 1.47 sq. in. Use 2-0.98 pin Area = 1.51 sq. in. WEB MEMBER #5 Distance from End Panel = 0.0 ft. (ED = 2.08) Applicable Shear  $V_{\chi} = 15.865$  lbs.  $f_{\psi} = 50,000$  psi Slope = 1.90  $f_{s} = 30,000 \text{ ps1}$ l = \_\_\_\_ in. fsc = \_\_\_\_ ps1 Reqd. Area = 1.01 sq. in. Use 2-092 DIA Area = 1.33 sq.in. CHORD MEMBER #6 Consists of 4-2" 1 1/2" x 0.25 Angles Construction Load Design Area = 3.60 sq. in. Applicable Moment = 585,000 in. lbs.  $f_y = 50,000$  psi l = <u>33,375</u> in.  $f_s =$ \_\_\_\_\_psi  $r_{x} = 0.44$  in.  $f_{SC} = 19,380$  ps1  $r_z = 0.31$  in. (with fillers in middle 60% of span) 1 = 75.8 rv = 75.8  $\frac{f_a}{g_{r_a}} = \frac{f_b}{F_a} + \frac{f_b}{F_b(1 - \frac{f_a}{F_b})} = \frac{0.418}{0.418}$  less than 1  $f_a = 7500 \text{ psi}$ Fa = <u>19380</u> psi  $f_b = ___ 748_ psi$ Ph = 30,000 ps1 P = 25,950 psi Use  $4 - 2'' \cdot 1'/2'' \cdot 0.25'' 4's$  Area = 3.60 sq. in. CHORD MEMBER #7 Consists of 4-Z = 1/2 = 0.25 Angles

Area = 3.60 sq. in.

## CHORD MEMBER #7 (CONTD.)

Applicable Moment = 1,920,000 in 1bs. fy = 36,000 psi

 $r_n = 22000 ps1$ 

fsc = \_\_\_\_ psi

Beff = 64.00 in.

t = <u>4.00</u> in.

 $y_1 = 2.00$  in.

 $d_2 = 2.46 _1n.$ 

y<sub>2</sub> = <u>4.44</u> in.

d3 = 25.66 in.

y3 = 32.56 in.

 $c_1 = 6.90$  in.

d1 = \_\_\_\_\_4.90\_ 11.

 $c_2 = 26.10$  in.

 $I_{a} = \sum [(I_{c} + A_{c}d_{1}^{2}) + (I_{TCA} + A_{TCA}d_{2}^{2}) + I_{BCA} + A_{BCA}d_{3}]$ 

$$\frac{\overline{y}}{\Sigma} = \frac{\sum (A_C y_1 + A_T CA y_2 + A_B CA y_3)}{\sum (A_C + A_T CA + A_B CA)}$$

 $\bar{y} = 6.90$  in.

I<sub>5</sub> = <u>2826</u> in. 4 (<u>2632T5</u>)

Resisting Moment =  $f_s \times \frac{1_s}{s_0} = 2.380.000$  in. lbs.

Use  $4 - 2" \times 1/2" \times 0.25" 4 = 3.60$  sq. in.

## Composite Design Top Chord Check

Total Load Design

/fc = 3000 psi

Applicable Moment = 1,920,000 in. Its.  $f_c^{\dagger} = 1,350$  psi

CHORD MEMBER #8 Consists of 4-2'x 1/2 x 0 25 Angles

Area = 3.60 sq. in.

(SAME AS MEMBER 6)

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