

STRUCTURAL ADVICE

Project: Weber's Circus
 Client: Natalie and Rudy Weber
 Description: Structural Engineering Calculations

Job No: 120519
 Date: July 2012
 Referenced Drawings: 120519/S01 & 120519/S02

Code Ref.	Calculations	Output
	Check Ground Contact Bearing Pressure $N^* = 46 \text{ kN}$ Steel Base plate area: $= 6 (0.15 \times 0.8)$ $= 0.72 \text{ m}^2$ $q_{ult} = 46 \text{ kN} / 0.72 \text{ m}^2$ $= 63 \text{ kPa}$ Hence ground having relatively modest bearing pressure will satisfactorily assimilate imposed pressure. The exercise of experience and judgement in site selection will also be required in the avoidance of problematic soils.  Tarek El-Ansary, Consulting Structural Engineer  Tarek El-Ansary MIE Aust CPEng Chartered Professional Engineer Membership No. 180355 The Institution of Engineers, Australia	



STRUCTURAL ADVICE

Job No: 120519
Date: July 2012
Referenced Drawings: 120519/S01 & 120519/S02

Page: of

STRUCTURAL ADVICE

Project: Weber's Circus
 Client: Natalie and Rudy Weber
 Description: Structural Engineering Calculations

Job No: 120519
 Date: July 2012
 Referenced Drawings: 120519/S01 & 120519/S02

Code Ref.	Calculations	Output
	Check Compressive Capacity of 76.1 OD x 2.3 CHS under tie pre-tension $L_e = 1.2 \times 4000 \quad (A_g = 533\text{mm}^2)$ $= 4800\text{mm}$ $r_x = r_y = 26.1\text{mm}$ $N^* = 15 \cos 41^\circ$ $= 11.3 \text{ kN}$ Modified Compression Member Slenderness $k_f = 1.0$ $\lambda_n = (L_e/r) \sqrt{k_f \sqrt{f_y}/250}$ $= 4800 / 26.1 \times \sqrt{1.0 \times 350}/250$ $= 217$ $\alpha_b = -1.0$ $\alpha_c = 0.160$ Limit State Requirement for compression members $N^* \leq \phi N_s \text{ and } N^* \leq \phi N_c$ $N_s = k_f A_n f_y$ $= 1.0 \times 533 \times 350 \times 10^{-3}$ $= 186.55 \text{ kN}$ $N_c = \alpha_c N_s$ $= 0.160 \times 186.55 \text{ kN}$ $= 29.8 \text{ kN}$ $\phi N_c = 0.9 \times 29.8 = 26.8 \text{ kN} \gg N^* = 11.3 \text{ kN} \therefore \text{ok}$	



ANSARY

CONSULTING ENGINEERS

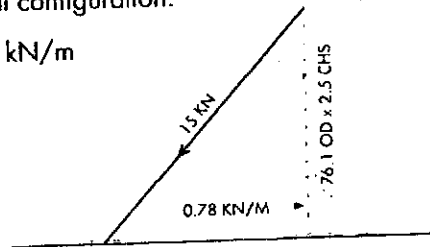
LEVEL 4, 28 UNIVERSITY AVE CANBERRA CITY ACT 2601 GPO BOX 2133 CANBERRA CITY ACT 2601 TEL: (02) 6230 7007 FAX: (02) 6230 7005 EMAIL: ansary@bigpond.net.au

STRUCTURAL ADVICE

Project: Weber's Circus
 Client: Natalie and Rudy Weber
 Description: Structural Engineering Calculations

Job No: 120519
 Date: July 2012
 Referenced Drawings: 120519/S01 & 120519/S02

Code Ref.	Calculations	Output
	Check Side Poles 76.1 x 2.5 CHS Grade 350 $N^* = 15 \cos 41^\circ$ $= 11.3 \text{ kN}$ Bending due to Cross Wind Action ..Side pole spacing is 650mm; ..there are 72 side poles in the total configuration. $w = 0.65 \times 1.0 \text{ kPa} = 0.65 \text{ kN/m}$ $M^* = w l^2 / 8$ $= 0.65 (4.0)^2 / 8$ $= 1.30 \text{ kNm}$ $M^* \leq \phi M_s$ $M_s = f_y Z_e$ (Table 2.1 gives $f_y = 350 \text{ MPa}$) $Z_e = \text{lesser of } 1.5 Z_x \text{ or } S_x \text{ whichever is lesser}$ $1.5 Z_x = 1.5 (9.55 \times 10^3) = 14.3 \times 10^3 \text{ mm}^3$ $S_x = 12.5 \times 10^3 \text{ mm}^3$ $\therefore Z_e = 12.5 \times 10^3 \text{ mm}^3$ $\phi M_s = 0.9 \times 350 \times 12.5 \times 10^3$ $= 3.94 \text{ kNm} > M^* = 1.30 \text{ kNm} \therefore \text{ok}$ Hence 76.1 x 2.3 CHS satisfactory in sustaining side wind pressure	



STRUCTURAL ADVICE

Project: Weber's Circus
 Client: Natalie and Rudy Weber
 Description: Structural Engineering Calculations

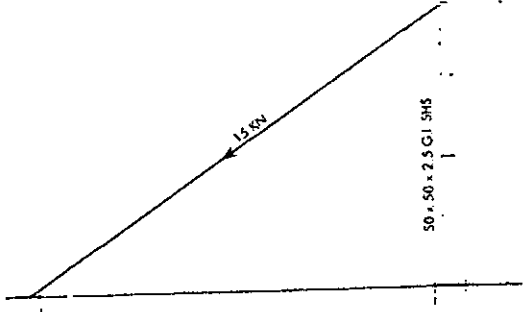
Job No: 120519
 Date: July 2012
 Referenced Drawings: 120519/S01 & 120519/S02

Code Ref.	Calculations	Output
	Modified Compression Member Slenderness $k_f = 1.0$ $\lambda_n = (L_e/r) \sqrt{k_f} \sqrt{f_y}/250$ $= 13440 / 200.9 \times \sqrt{1.0} \times \sqrt{450}/250$ $= 90$ $\alpha_b = -1.0$ $\alpha_c = 0.737$ Limit State Requirement for compression members $N^* \leq \phi N_s \text{ and } N^* \leq \phi N_c$ $N_s = k_f A_n f_y$ $= 1.0 \times 2164 \times 450 \times 10^{-3}$ $= 973.8 \text{ kN}$ $N_c = \alpha_c N_s$ $= 0.737 \times 973.8 \text{ kN}$ $= 717.7 \text{ kN}$ $\phi N_c = 0.9 \times 717.7$ $= 645.9 \text{ kN} \gg N^* = 46 \text{ kN} \therefore \text{ok}$ Hence Box Truss King pole Columns are Satisfactory	

STRUCTURAL ADVICE

Project: Weber's Circus
 Client: Natalie and Rudy Weber
 Description: Structural Engineering Calculations

Job No: 120519
 Date: July 2012
 Referenced Drawings: 120519/S01 & 120519/S02

Code Ref.	Calculations	Output
AS4100 Section 6.0 Table 2.1	<u>Check King Poles as Compression Member</u> Box Section fabricated from 50 x 50 x 3 SHS fully welded 450mm panel dimension Steel Grade 450, $f_y = 450 \text{ MPa}$ $I_x = 0.195 \times 10^6 \text{ mm}^4$ $A_g = 541 \text{ mm}^2$ Combined I_x $I_x = \sum I_x + Ad^2$ $= (0.195 \times 10^6 + 541(225 - 25)^2) \times 4$ $= 87.3 \times 10^6 \text{ mm}^4$ Combined A_g $A_g = 4(541 \text{ mm}^2)$ $= 2164 \text{ mm}^2$ $r_x = r_y = \sqrt{I_x / A_g}$ $= \sqrt{87.3 \times 10^6 / 2164}$ $= 200.9 \text{ mm}$ Effective Length $L_e = k_e \times l \quad k_e = 1.2$ $= 1.2 \times 11200$ $= 13440 \text{ mm}$ 	



CONSULTING ENGINEERS

LEVEL 4, 28 UNIVERSITY AVE CANBERRA CITY ACT 2601 GPO BOX 2133 CANBERRA CITY ACT 2601 TEL: (02) 6230 7007 FAX: (02) 6230 7005 EMAIL: ansary@bigpond.net.au

STRUCTURAL ADVICE

Project: Weber's Circus
Client: Natalie and Rudy Weber
Description: Structural Engineering Calculations

Job No: 120519
Date: July 2012
Referenced Drawings: 120519/S01 & 120519/S02

Code Ref.	Calculations	Output
	SECTION 2 – Engineering Calculations STRUCTURE: BIG-TOP TENT FUNCTIONAL USE: PERFORMANCE AUDITORIUM The engineering calculations shall be read in conjunction with the Engineering Drawings included at Attachment A CHECK MAIN TENT KING POLES Kingpoles comprise 450mm box trusses fabricated from 50 x 50 x 3 SHS Tie Downs inclined at 54 degrees to the vertical axis Cable Tension 15 kN Compression Force in Kingpoles from Cable Tie Back tension: $N^*_{(1)} = 15 \cos 54 \text{ deg} = 8.8 \text{ kN} \downarrow$ Membrane Permanent Load (Tributary Area = 24m²) $N^*_{(2)} = 0.15 \text{ kN/m}^2 \times 24 \text{ m}^2 = 3.6 \text{ kN} \downarrow$ Wind Loading $V_z = 40 \text{ m/s}$ (i.e conservative acute cyclonic $\cong 144 \text{ km/h}$) $q_z = 0.0006 \times V_z^2 = 0.0006 \times (40 \text{ m/s})^2 = 1.0 \text{ kPa} \downarrow$ $N^*_{(3)} = 1.0 \times 24 \text{ m}^2 = 24 \text{ kN} \downarrow$ <u>Load Combination:</u> Cable Tension + Permanent Action + Wind Load $N^*_c = (2 \times 8.8 \text{ kN}) + 3.6 \text{ kN} + 24 \text{ kN} = 45.2 \text{ kN} \downarrow$	$N^*_c = 46 \text{ kN} \downarrow$



CONSULTING ENGINEERS

LEVEL 4, 28 UNIVERSITY AVE CANBERRA CITY ACT 2601 GPO BOX 2133 CANBERRA CITY ACT 2601 TEL: (02) 6230 7007 FAX: (02) 6230 7005 EMAIL: ansary@bigpond.net.au

STRUCTURAL ADVICE

Project: Weber's Circus

Job No: 120519

Client: Natalie and Rudy Weber

Date: July 2012

Description: Structural Engineering Calculations

Referenced Drawings: 120519/S01 & 120519/S02

Code Ref.	Calculations	Output
	SECTION 1 – Design Parameters & Key Assumptions Terrain Category 2 Temporary Structure No Shielding No reduction to allowable wind speeds Tie-back straps rated to 25 kN Multi-strand Cable rated to 1MN Allowable Bearing Pressure (Ground) = 250 kPa Mild Steel Pegs Ø36mm diameter Membrane PVC having 30 kN/m ultimate tensile capacity Permanent Actions (tent) $15\text{kg/m}^2 = 0.15\text{ kPa}$ Imposed Actions (tent) = nil Wind Velocity $40\text{m/s} = 144\text{ km/h}$ (transportable to cyclonic regions) Ground Preparations – Vendor/operator experience <u>Referenced Australian Standards (Engineering Design):</u> - AS/NZS1170.2 – 2002 Permanent Imposed & other Actions - AS/NZS1170.2 – 2002 Wind Actions - AS4100 – 1998 Steel Structures - Circular Hollow Sections to AS/NZS 1163 C350 LO - Square Hollow Sections to AS/NZS 1163 C450 LO	



TABLE OF CONTENTS

SECTION 1-- DESIGN PARAMETERS & KEY ASSUMPTIONS	2
SECTION 2 -- ENGINEERING CALCULATIONS	3 - 9
ATTACHMENTS	10 +
DESIGN CERTIFICATION	
ENGINEERING DRAWINGS	
a) 120519/S01 OVERALL LAYOUT	
b) 120519/S02 STRUCTURAL DETAIL	
SAFE WORK METHOD STATEMENT (SWMS)	13