

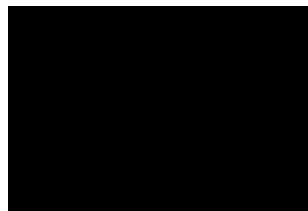


STRUCTURAL ANALYSIS
OF
LIFTING AND TRAILERING
A TYPICAL
LOG CABIN MOBILE HOME

PREPARED BY

RICHARD M. LEWIS BSc. CEng. MIMechE MIEE
Chartered Engineer

Signed



.....

Dated 17th May, 2016

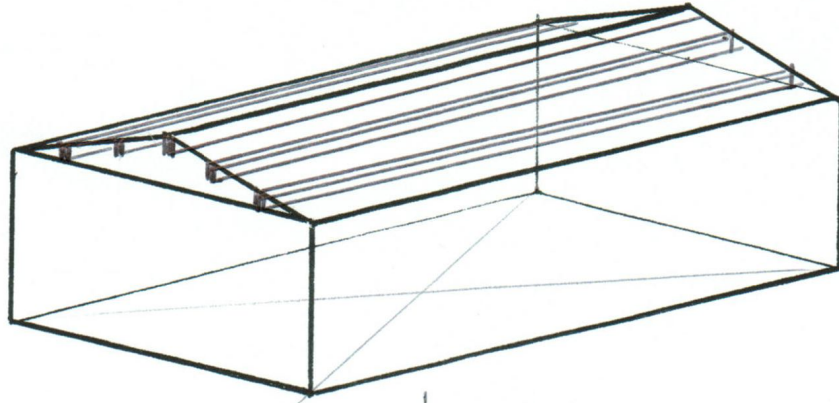


Summary and Conclusions

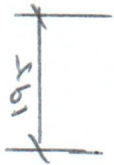
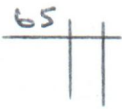
1. Self weight of unit is 2760 kgs. This is considered very light duty and easily manageable. Well within the lifting capability of crane and well within the carrying capacity of lorry trailer.
2. The structural timber chassis design shares the load into 15 individual beams and the ends of all beams are tied by a structural side member each side of the unit. Max. load carried by each chassis beam is 184 kgs. Every beam is tied to the central ridge beam by a steel wire and tensioner arrangement providing a capacity of 3000 kgs. each so a safety margin of x 16. Deflection at ends of beams is 18 mm, this occurs at the end of each beam and does not therefore create a relative difference in sag. The cabin base remains level.
3. Longitudinal sag is controlled by hoisting to a steel lifting boom with independently adjustable winches. Under load there is insignificant deflection of the boom 1.62 mm at the centre and 10.9 mm at the ends. This is accommodated by adjustment of the winches.
4. There is a significant stiffening effect provided by the walls acting as deep panels which will not deflect in the absence of sliding between the logs. Such sliding is resisted by frictional forces between the members and keying effects of partition walls, trusses and end walls.
5. Whereas a frame type wall structure could fail due to "racking" effects, the log structure does not suffer from racking effects at all.
6. Longitudinal roof beams and chassis side members provide additional resistance to sagging.
7. The unit is easily supported straddling the bed of the lorry trailer. The overhanging chassis beams cantilever from the lorry bed to support the side walls. Each wall and partition wall adds strength and end restraint.
8. The lifting boom with winches is easily fabricated. It is working well within its SWL.
9. The preparation for lift and materials necessary are readily available and easily fitted.
10. By this method the cabin is physically capable of being moved from one place to another.

Consider stiffening effect of Roof beams

Combined effect.



27144 N.



x 5 nos.

$$I_{xx} = \frac{325 \times 195^3}{12} = 200.8 \times 10^6 \text{ mm}^4$$

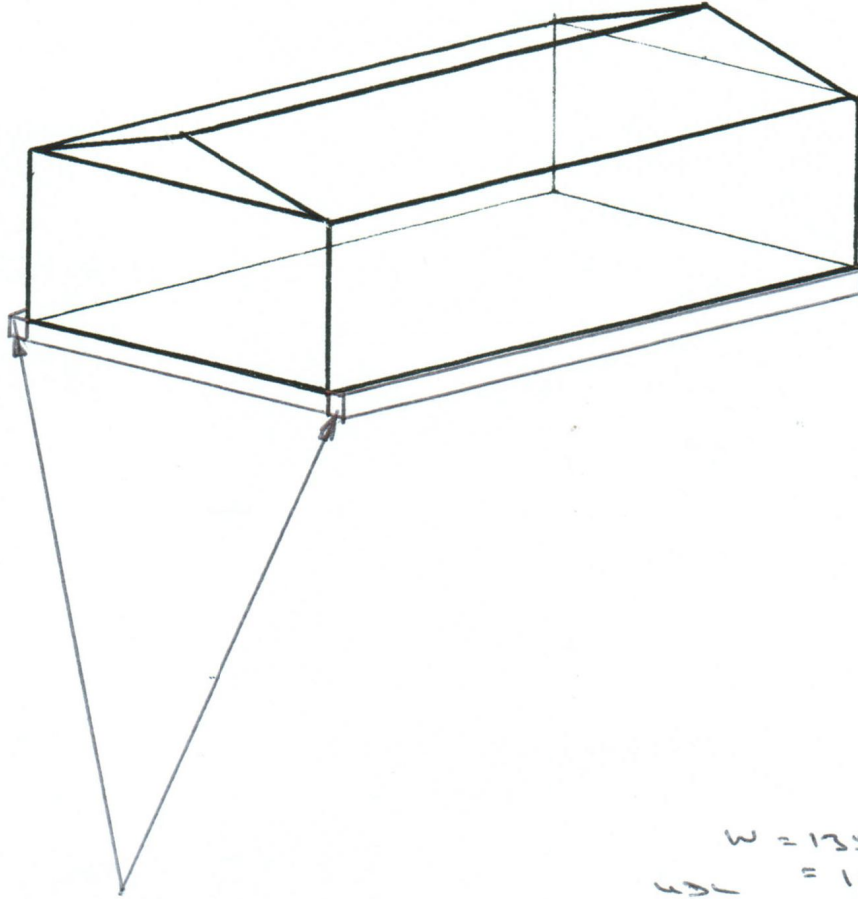
$$E = 9000 \text{ N/mm}^2$$

$$\delta = \frac{5 \times W \times l^3}{384 E I} = \frac{5 \times 27144 \times 7000^3}{384 \times 9000 \times 200.8 \times 10^6} = \frac{64 \text{ mm}}{\text{max deflection at centre.}}$$

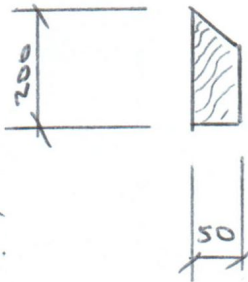
This is indication of stiffening effect provided by roof beam.

The deflection will not occur as it is resisted by wall panels and ceiling beam/wooden.

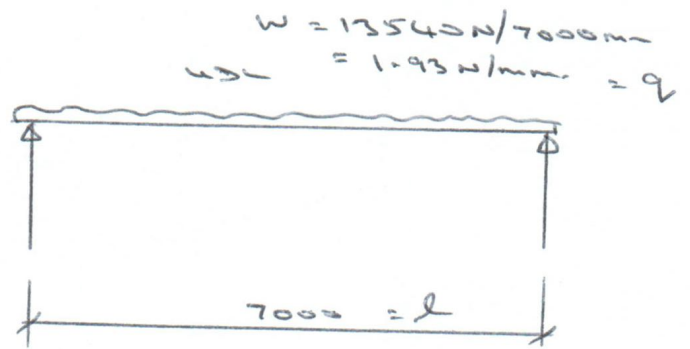
Consider stiffening effect of side members of structural chassis



Q77 2 No.



Structural Softwood.



max defl-

$$\delta = \frac{5 \times w \times l^3}{384 \times E \times I}$$

$$= \frac{5 \times 13540 \times 7000^3}{384 \times 9000 \times 33.3 \times 10^6}$$

$$= \frac{2 \text{ mm}^3}{\frac{2}{\text{mm}^2} \times \text{mm}^4} = \frac{2 \text{ mm}^3}{2 \text{ mm}^2} = \text{mm}$$

$$= 20 \text{ mm}$$

E = modulus of elasticity
for Pine wood.
 $= 9000 \text{ N/mm}^2$

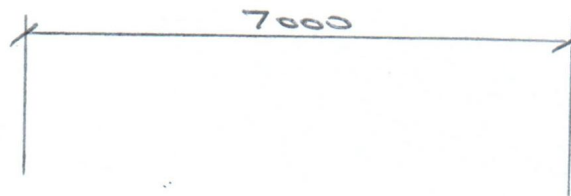
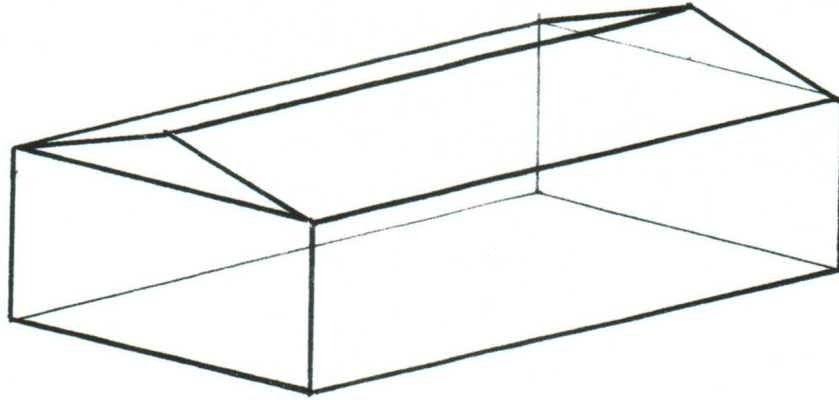
I = area moment of inertia

$$I_{xx} = \frac{b h^3}{12} = \frac{50 \times 200^3}{12} = 33.3 \times 10^6 \text{ mm}^4$$

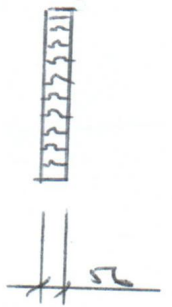
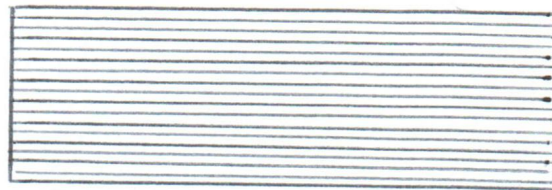
Provide additional stiffening

OK

Consider stiffening effects of walls.

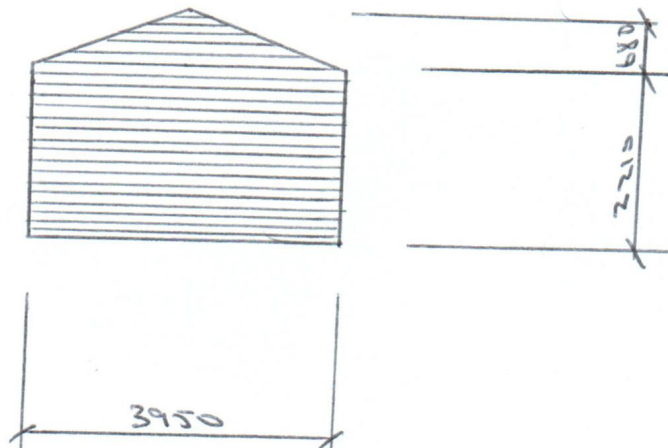


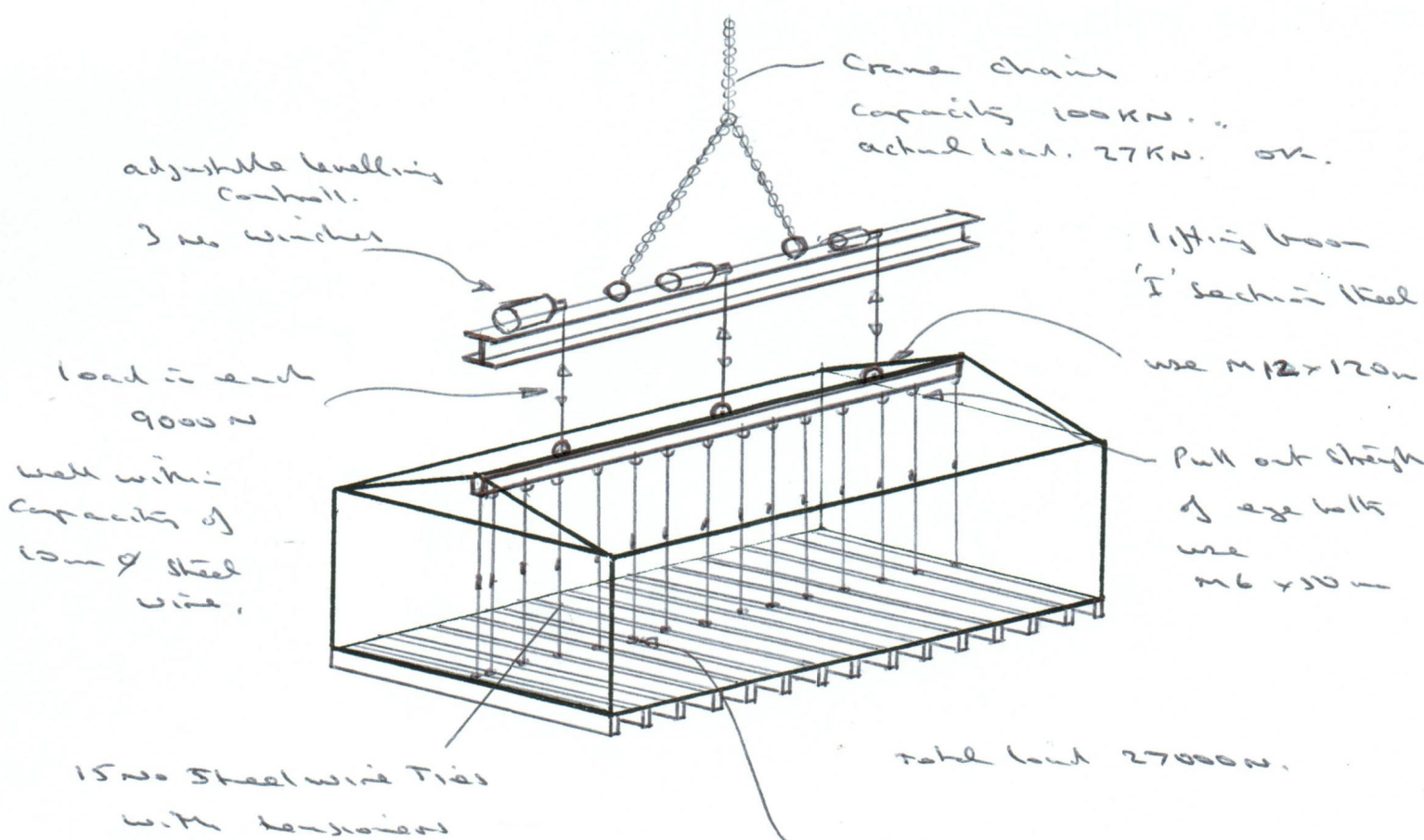
Acts as a
stiffening panel
can be analysed
as a beam.



There is no relative sliding between logs
racking effects are negligible
frictional forces exceed potential to slide.

Partition walls
trusses
and end walls
provide lateral
support to long walls
and provide a
keying effect
to prevent sliding
of logs relative
to each other.

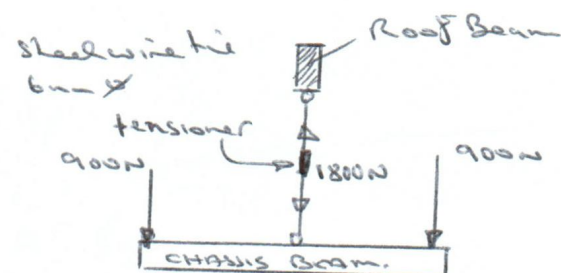




load in each tie
 $= 1800 \text{ N}$
 OK.

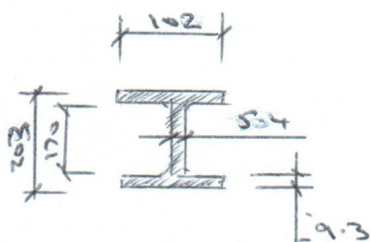
well within capacity
 of steel wire
 use 6mm Ø

Pull out strength of eye bolts.
 use M6 x 50 mm.



Consider deflection of lifting beam.

See Spreads
 analysis.

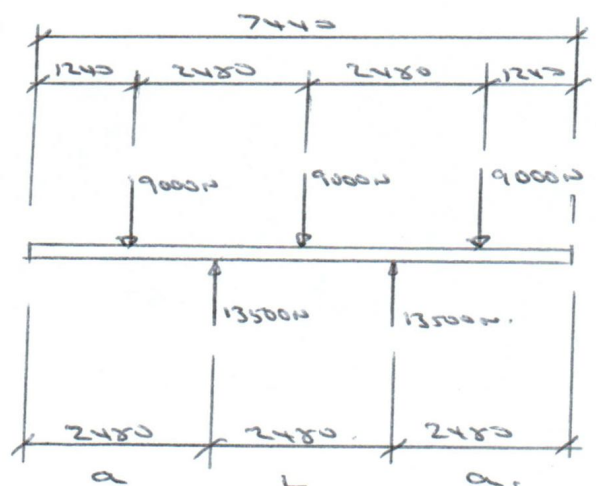


$$\begin{aligned}
 A &= 29.4 \text{ cm}^2 \\
 I_x &= 2105 \text{ cm}^4 \\
 &= 21050000 \text{ mm}^4 \\
 &= 21 \times 10^8 \text{ mm}^4
 \end{aligned}$$

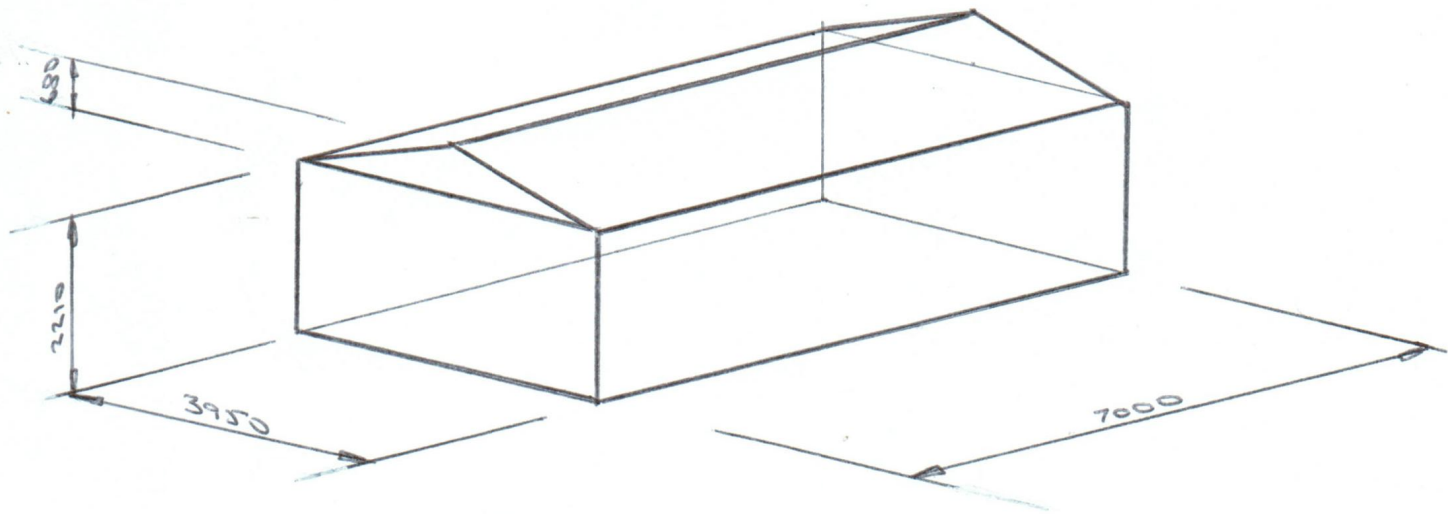
Modulus of elasticity
 $E_{\text{steel}} = 200000 \text{ N/mm}^2$

$$W = 3 \times 9000 \text{ N} = 27000 \text{ N.}$$

$$w = \frac{27000}{7440} = 3.63 \text{ N/mm}$$



SELF WEIGHT OF MOBILE HOME LOG CABIN



External walls $7.190 + 7.190 + 4.140 + 4.140 = 22.66 \text{ m}$

Internal walls $4.140 + 3.218 = 7.36 \text{ m}$

$30.02 \text{ m} \times 22.66$

$662 \times 0.056 = 3.69 \text{ m}^3 \times 430 \text{ kg/m}^3 = \underline{1587 \text{ kg}}$

Floor $3.838 \times 6.888 \times 0.019 \times 430 = \underline{109 \text{ kg}}$

Struct. Stalls $19 \text{ m} \times 0.15 \times 0.08 \times 3.95 \times 430 = \underline{242 \text{ kg}}$

Roof Beams $5 \text{ m} \times 0.165 \times 0.058 \times 7.44 \times 430 = \underline{153 \text{ kg}}$

Roofing $2 \times 2.259 \times 7.44 \times 0.019 \times 430 = \underline{275 \text{ kg}}$

Roof Lumber $[(2 \times 2.259 \times 7.44) / 3] \times 20 = \underline{224 \text{ kg}}$

Roof Insulation $[(2 \times 2.259 \times 7.44) / 2.88] \times 10 = \underline{117 \text{ kg}}$

Floor Insulation $[(3.838 \times 6.888) / 2.88] \times 6 = \underline{55 \text{ kg}}$

total = 2760 kg

27000 N.

$$y_{max} = \frac{WL^2}{384EI} (5L^2 - 24a^2) \quad @ \quad x = \frac{L}{2}$$

$$= \frac{3.63 \times 2480^2 (5 \times 2480^2 - 24 \times 2480^2)}{384 \times 200000 \times 21 \times 10^6}$$

$$= \frac{2.609 \times 10^{15}}{1.613 \times 10^{15}}$$

$$y_{max} = \text{defl- at center of beam}$$

$$= \underline{\underline{1.62 \text{ mm}}} \quad \text{OK.}$$

$$y_{max} = \frac{Wa}{24EI} (L^3 - 6La^2 - 3a^3) \quad @ \quad x_1 = 0$$

$$= \frac{3.63 \times 2480 (2480^3 - 6 \times 2480 \times 2480^2 - 3 \times 2480^3)}{24 \times 200000 \times 21 \times 10^6}$$

$$= \frac{1.099 \times 10^{15}}{1.008 \times 10^{14}}$$

$$y_{max} = \text{defl- at ends of beam.}$$

$$= \underline{\underline{10.9 \text{ mm}}} \quad \text{OK}$$

$$L = 2480 \text{ mm}$$

$$a = 2480 \text{ mm}$$

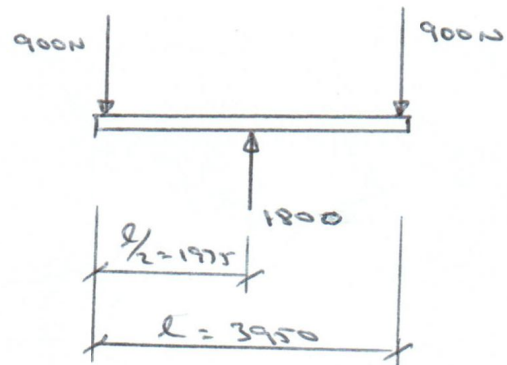
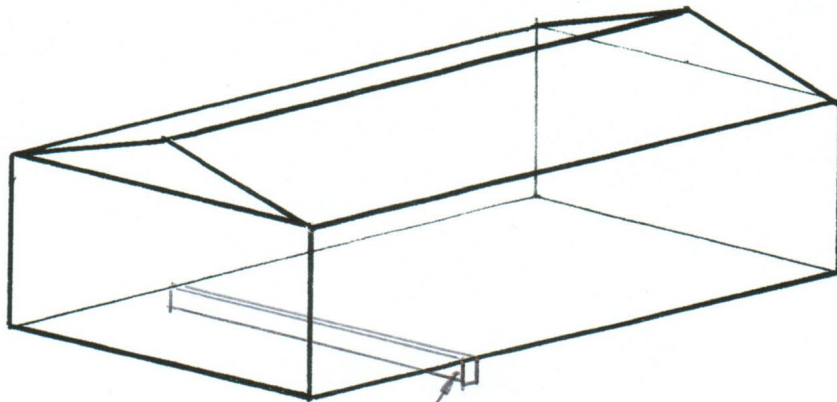
$$W = 27000 \text{ N}$$

$$w = 27000/7440 = 3.63 \text{ N/mm}$$

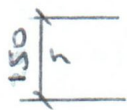
$$E = 200000 \text{ N/mm}^2$$

$$I = 21 \times 10^6 \text{ mm}^4$$

Consider deflection of Structural beams in Chassis



Q77 15 No.
@ 5000 crs.



Structural
Softwood.

E = modulus of elasticity
For Pine Wood = 9000 N/mm^2

I = area moment of inertia.

$$I_{xx} = \frac{bh^3}{12} = \frac{50 \times 150^3}{12} = 14 \times 10^6 \text{ mm}^4$$

max defn occurs
at centre of span

Relative defn at ends
= 0

max defn at centre.

$$\Delta_{\text{max}} = \frac{wl^3}{48EI} = \frac{1800 \times 3950^3}{48 \times 9000 \times 14 \times 10^6} = 18 \text{ mm} - \text{max}$$

$$\frac{\frac{N \times \text{mm}^3}{\frac{N}{\text{mm}^2} \times \text{mm}^4}}{\frac{N \times \text{mm}^3}{\frac{N}{\text{mm}^2} \times \text{mm}^4}} = \frac{N \times \text{mm}^3}{N \times \text{mm}^2} = \text{mm}$$

OK

Consider imposed loading whilst in transit

The cabin could be subjected to
wind load
snow load.
wind uplift.

The attached generic calculation proves stability
in static position for a max size unit
6000 x 15000mm.

unit speed is set at 24-15 approx 50 mph road speed

The structure passes all tests analysed.

Consider Size and Weight on Lowboy Trailer

