

SUPPLEMENT
TO
AGRICULTURAL SHELTER SHED
CALCULATIONS.
(dated 26/3/89)

By

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	1/	Hold down reactions at post footings.
	2/	Simple post footing design.
	3/	Connection Design: a) Post to base plate. b) Post to truss plate.
Detail ① A3-89A0002	4/	Connection Design: a) truss plate to truss.
Detail ② A3-89A0002	5/	Estimation of tensile load separating apex of roof truss.
	6/7/	Connection Design: a) apex of roof truss.
	8/9/	Connection Design Drawings: roof apex

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HOLD DOWN REACTIONS AT POST FOOTINGS

moments about A

	N	F	u	d	M = N(F.u.d)
WWLRx	1.4	4.09	1	3.29	18.84
WWLRy	1.4	11.22	1	2.32	36.44
roof DL	1	3.7	-1	4.70	-17.39
LWLRy	1.4	14.54	1	7.08	144.12
LWLRx	1.4	5.29	-1	3.29	-24.37
LWLWx	1.4	6.66	-1	1.23	-11.47
wall DL	1	0.4	-1	9.40	-3.76

reaction at B	15.15	-1	9.4	142.42	-142.42
				0.00	ok

moments about B

LWLWx	1.4	6.66	-1	1.23	-11.47
LWLRx	1.4	5.29	-1	3.29	-24.37
LWLRy	1.4	14.54	-1	2.32	-47.23
roof DL	1	3.7	1	4.7	17.39
WWLRy	1.4	11.22	-1	7.08	-111.21
WWLRx	1.4	4.09	1	3.29	18.84

reaction at A	16.81	1	9.4	-158.04	158.04
				0.00	ok

sum of vertical forces

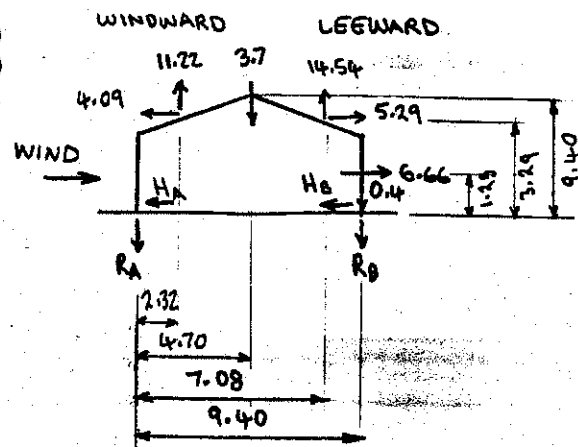
	N	F	u	force
reaction A	1	16.81	-1	-16.81
WWLRy	1.4	11.22	1	15.71
roof DL	1	3.70	-1	-3.70
LWLRy	1.4	14.54	1	20.36
wall DL	1	0.40	-1	-0.40
reaction B	1	15.15	-1	-15.15

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Horizontal reaction = $-4.09 + 5.29 + 6.66 = 7.86 \text{ kN}$ > individual reactions (H_A, H_B) at each post.

KEY :

- DL := Dead Load
- WWLRx := Windward Wind Load Roof (x-component)
- WWLRy := Windward Wind Load Roof (y-component)
- LWLRx := Leeward Wind Load Roof (x-component)
- LWLRy := Leeward Wind Load Roof (y-component)
- LWLWx := Leeward Wind Load Wall (x-component)
- N := Design Factor
- F := magnitude of force
- u := direction of force
- d := length of moment arm
- M := moment



SIMPLE POST FOOTING

(uplift load assumed to be calculated with design factors for stability. (clause 3.3.2 AS1250-1981))

	soil	concrete
density (Kg/m ³)	1730.00	2400.00
footing width (mm)	900.00	900.00
footing length (mm)	900.00	900.00

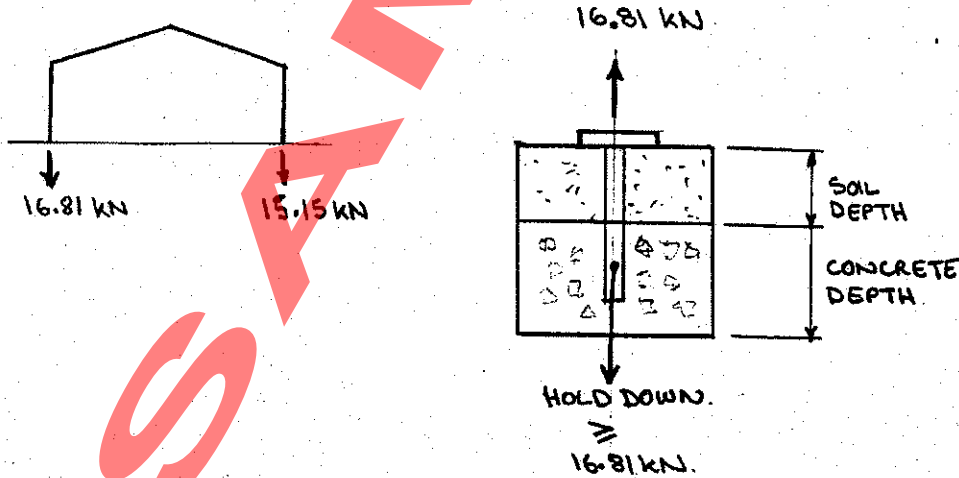
cross sectional area(m ²) (A)	0.81	0.81
permissible soil bearing (KPa)	107.00	
Bearing load (KN) (P)	4.1	= (deadloads of roof and wall)
soil bearing pressure (KPa)	5.06	= (P/A)
bearing design factor	21.14	ok

footing depth (mm)	400.00	600.00

volume (m ³)	0.32	0.49
mass (Kg)	560.52	1166.40
loads (KN)	5.50	11.44
applied hold down load (KN)	16.94	
uplift load (KN)	16.81	
design factor	1.01	ok
		(required 1 or more)

THEREFORE : footing size

soil covering 900x900x400 mm
concrete block 900x900x600 mm



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BOLTED JOINT DESIGN

BOLT SPECIFICATION

pitch (p)	1.75 mm
nominal diameter (d)	12.00 mm
pitch diameter	10.86 mm
minor diameter	9.85 mm
mean diameter	10.36 mm

stress area (As)	84.27 mm ²
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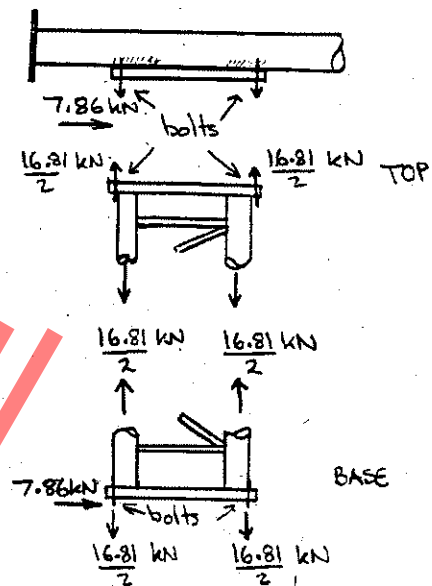
property class	4.6
proof strength	225.00 MPa
yield strength (Fyt)	250.00 MPa
ultimate tensile strength (Fuf)	400.00 MPa

Permissible stresses bolt	
tensile (Ftf)	150 MPa
shear (Fvf)	82.5 MPa

number of bolts used (n)	4
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JOINT LOADINGS

tensile (F)	16810 N
shear (V)	7860 N



{maximum likely}

Load Design factor (DF1)	1
Load Design factor (DF2)	1.4

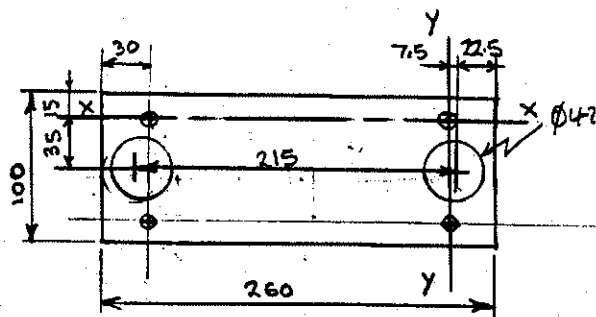
normal stress (fn)	49.87 MPa	= DF1 * F / n * As
shear stress (fv)	32.65 MPa	= DF2 * V / n * As

combined stresses (AS1250-1981 clause 9.5.3)
following expression required less than unity
 $(fv/Fvf)^2 + (fn/Ftf)^2 = 0.27$ ok

THEREFORE :- 4 x M12 class 4.6 bolts suitable.

CONNECTION PLATE DESIGN

thickness (t)	7 mm
length (l)	260 mm
width (w)	100 mm
edge clearance (Dc)	15 mm
edge clearance (ed)	30 mm
hole diameter (Dh)	13 mm



second moment of area (I)	X-X	6688.50 mm ⁴	Y-Y	2115.17
section modulus (Z)		1911.00 mm ³		604.33

moment arm distance (rm)	35 mm	7.50
bending moment on plate (M)	294175 Nmm	63037.50

Permissible bending stress (Fb)	165 MPa	
Bending stress (sb)	153.94 MPa	104.31 both ok

Permissible bearing stress (Fp)	187.5 MPa	
bearing stress (sp)	50.03 MPa	ok = F / (d * t * n)

THEREFORE :- connection plate 260x100 x 7mm thick suitable

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WELDED JOINT DESIGN

weld material strength (Fuw) 84.00 MPa
 total weld length (Lw) 360 mm = (4 x 90mm welds)
 weld height (h) 3.54 mm
 bending modulus (Zw) mm²
 twisting modulus (Jw) mm³

tensile load (F) 16810 N
 shear load (V) 7860 N

Design factor loads (N) 1
 Design factor loads (N2) 1.4

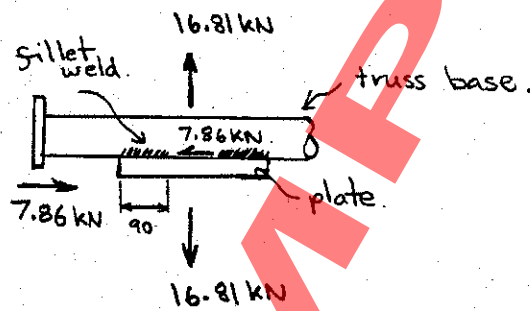
normal stress (fn) 18.66 MPa = $N*F / (0.707*h*Lw)$
 shear (fv) 12.21 MPa = $N2*V / (0.707*h*Lw)$

Combined stresses (AS1250-1981 clause 9.8.2(b))
 permissible weld stress 47.88 MPa = $0.57*Fuw$
 equivalent stress 28.21 MPa = $SQRT(fn^2 + 3*fv^2)$

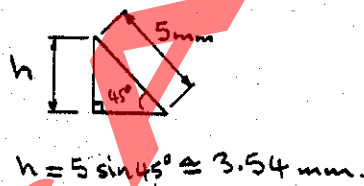
weld size suitable if equivalent stress less than permissible stress.

permissible 47.88 > 28.21 ok

THEREFORE :- 4 x 90mm welds suitable



approximation of existing weld.



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LOAD ON APEX OF TRUSS (treating truss as simply supported beam)

moments about A

	N	F	u	d	M = N(F.u.d)
roof DL	1	3.29	-1	4.70	-15.46
WWLR	1	11.374	1	2.35	26.73
LWLR	1	14.711	1	7.05	103.71

<u>reaction at B</u>	<u>12.23</u>	-1	9.4		114.98
					-114.98

0.00 ok

moments about B

roof DL	1	3.29	1	4.7	15.46
LWLR	1	14.711	-1	2.35	-34.57
WWLR	1	11.374	-1	7.05	-80.19

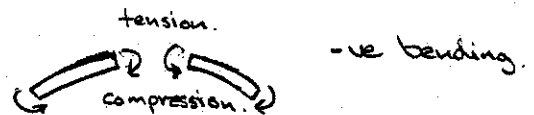
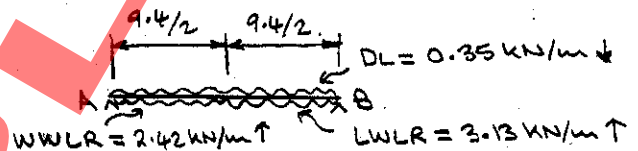
<u>reaction at A</u>	<u>10.56</u>	1	9.4		-99.29
					99.29

0.00 ok

Sum of vertical forces

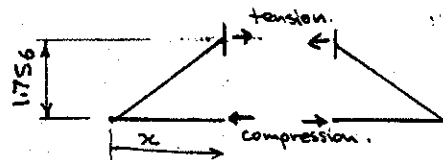
	N	F	u	force
reaction A	1	10.56	-1	-10.56
roof DL	1	3.29	-1	-3.29
WWLR	1	11.37	1	11.37
LWLR	1	14.71	1	14.71
reaction B	1	12.23	-1	-12.23

0.00 ok



BENDING MOMENT AT CENTRE position 4.7 m

reaction (moment)	-49.647	=	-10.56x
roof DL (moment)	-3.8658	=	-0.35x ² /2
WWLR (moment)	26.7289	=	2.42x ² /2



TOTAL MOMENT -26.784 KNm produced by couple of tension and compression in top and base of beam.

lever arm 1.756 m
force 15252.9 N tension

KEY :

- DL := Dead Load 0.35 KN/m
- WWLR := Windward Wind Load Roof 2.42 KN/m
- LWLR := Leeward Wind Load Roof 3.13 KN/m
- N := Design Factor
- F := magnitude of force
- u := direction of force
- d := length of moment arm
- M := moment

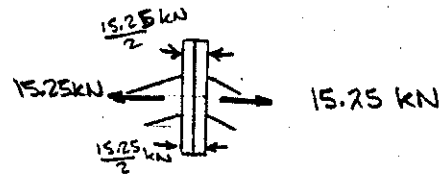
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BOLTED JOINT DESIGN

BOLT SPECIFICATION

pitch (p)	1.75 mm
nominal diameter (d)	12.00 mm
pitch diameter	10.86 mm
minor diameter	9.85 mm
mean diameter	10.36 mm
stress area (As)	84.27 mm ²
property class	4.6
proof strength	225.00 MPa
yield strength (Fyt)	250.00 MPa
ultimate tensile strength (Fuf)	400.00 MPa



Permissible stresses bolt
tensile (Ftf)
shear (Fvf)

150 MPa
82.5 MPa

number of bolts used (n)

4

JOINT LOADINGS

tensile (F) 15252.9 N

Load Design factor (DF1)

1

normal stress (fn)

45.25 MPa

= DF1*F/n*As

tension check ,permissible

150 >

45.25 ok

THEREFORE :- 4 x M12 class 4.6 bolts suitable.

CONNECTION PLATE DESIGN

thickness (t)	9.2 mm	(plate and angle)
length (l)	100 mm	see FIG1 & FIG2.
width (w)	100 mm	
edge clearance (Dc)	15 mm	
edge clearance (ed)	15 mm	
hole diameter (Dh)	13 mm	

second moment of area (I) 4801.91 mm⁴
section modulus (Z) 1043.89 mm³

moment arm distance (rm) 18 mm
bending moment on plate (M) 137276.27 Nmm

Permissible bending stress (Fb) 165 MPa
Bending stress (sb) 131.50 MPa ok

THEREFORE :- connection plate 100x100 x 6.2mm thick

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WELDED JOINT DESIGN

weld material strength (F_{uw}) 414.00 MPa
total weld length (L_w) 64 mm (2 x 32mm parallel welds)
weld height (h) 3.54 mm
bending modulus (Z_w) 341.33 mm²
twisting modulus (J_w) mm³

moment arm 18 mm
moment (M) 137276.1 N
shear load (V) 7626.45 N

Design factor loads (N) 1
Design factor loads (N_2) 1

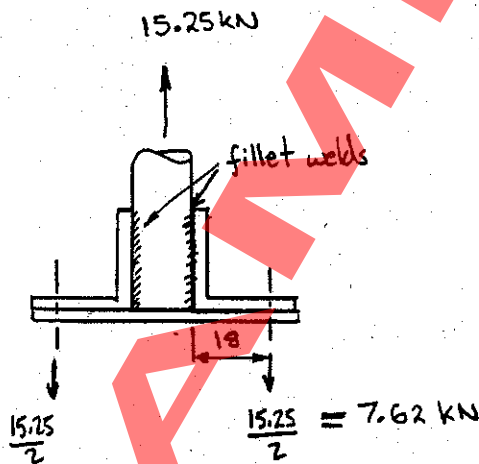
normal stress (f_n) 160.67 MPa = $N \cdot M / (0.707 \cdot h \cdot Z_w)$
shear (f_v) 47.61 MPa = $N_2 \cdot V / (0.707 \cdot h \cdot L_w)$

Combined stresses (AS1250-1981 clause 9.8.2(b))
permissible weld stress 235.98 MPa = $0.57 \cdot F_{uw}$
equivalent stress 180.62 MPa = $\text{SQRT}(f_n^2 + 3 \cdot f_v^2)$

weld size suitable if equivalent stress less than permissible stress.

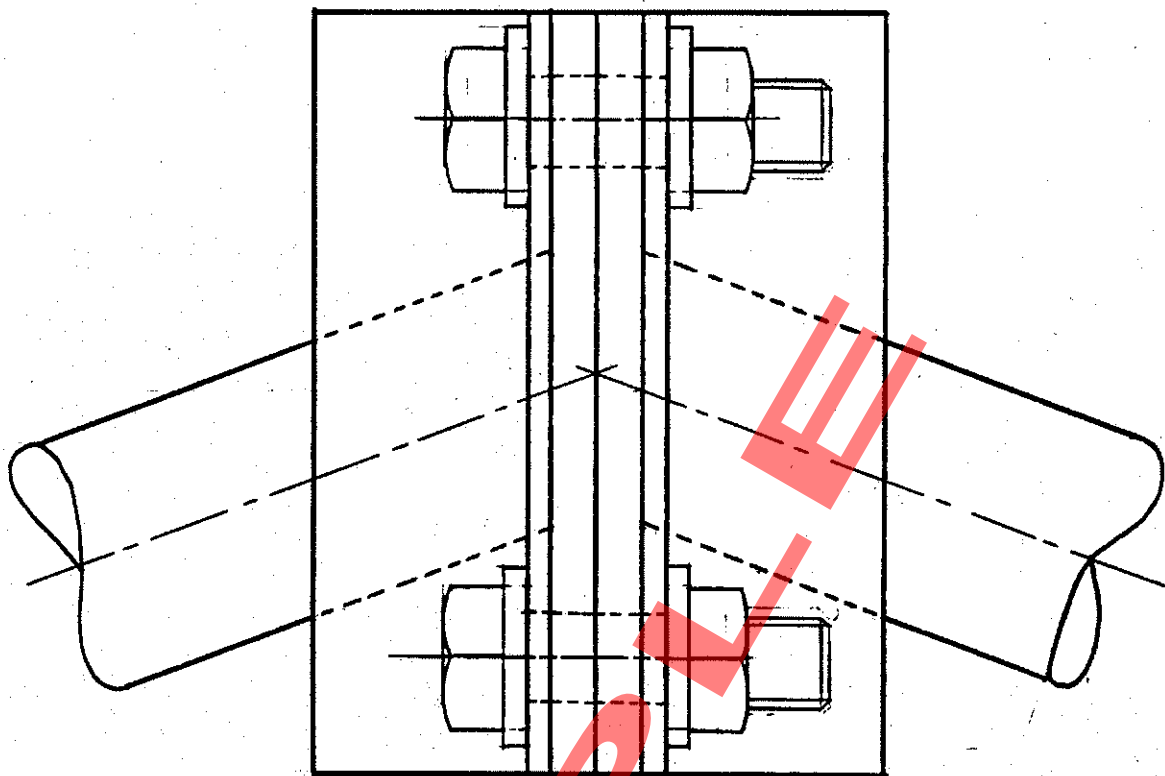
permissible 235.98 > 180.62 ok

THEREFORE :- 2 x 32mm welds for each angle piece :suitable



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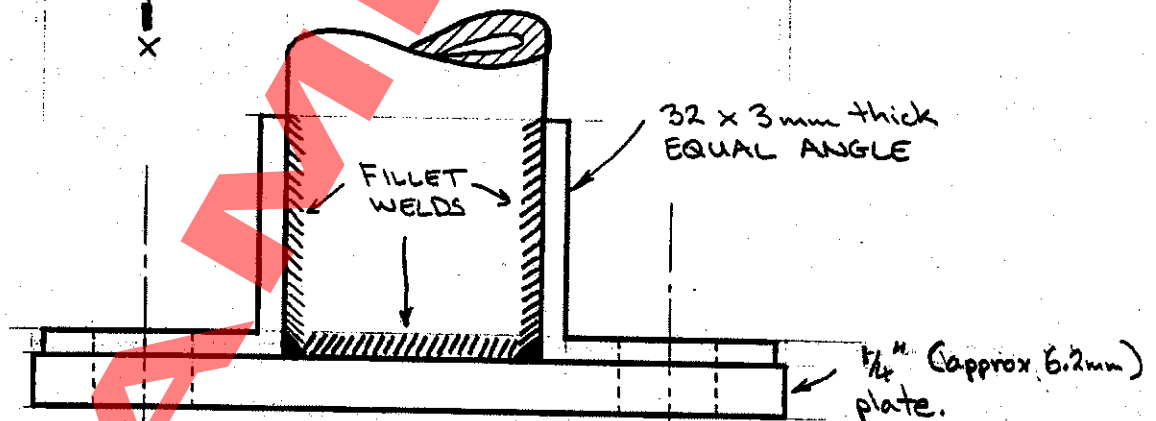
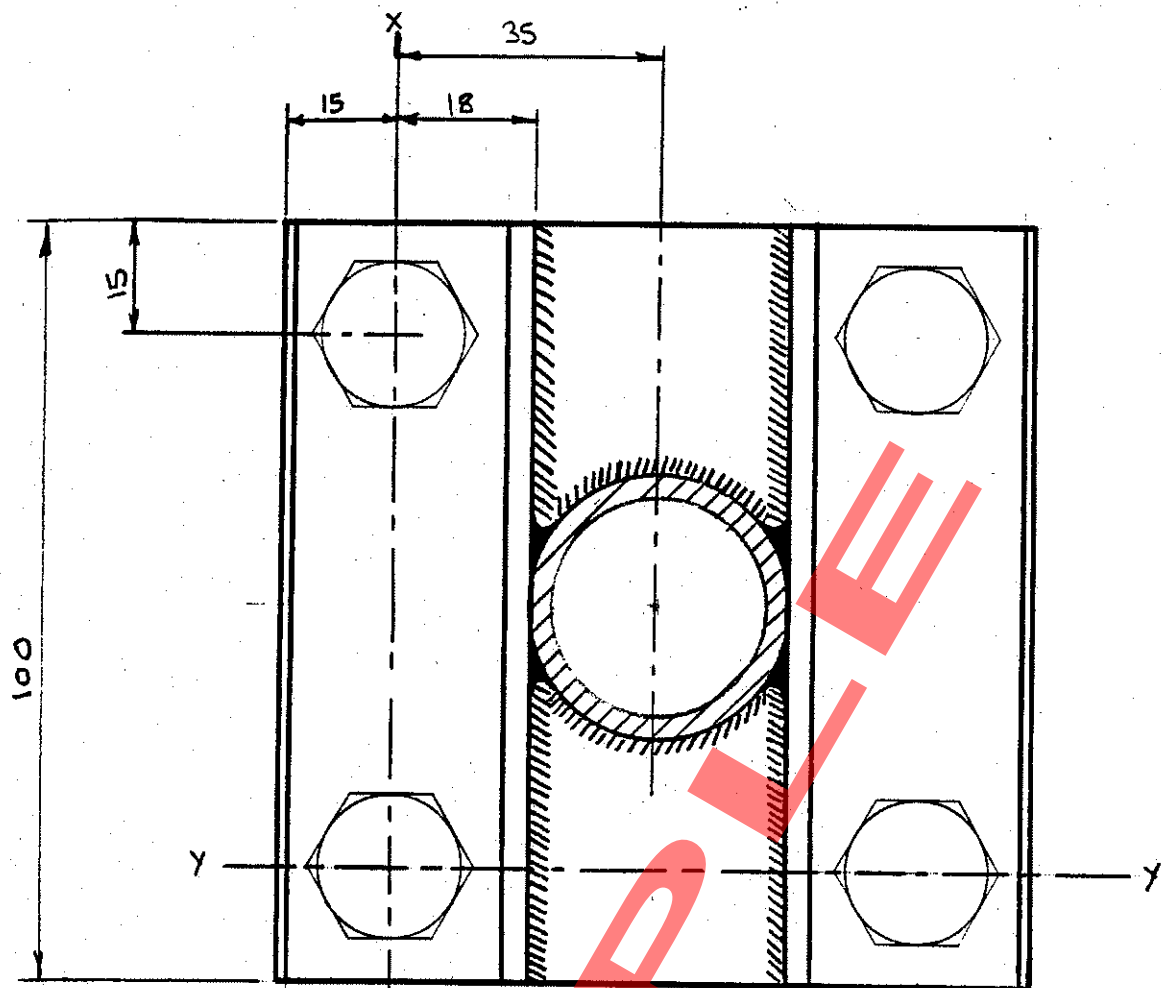
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TRUSS APEX CONNECTION (FIG 1)

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TRUSS APEX CONNECTION (FIG 2)

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