Notes by-

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* Lacing & Battening for Built up compression member

* Diff. members (components) of built up section should be placed uniformly at a max. possible dist. from axis of col^m^ for greater strength of col^m^. & they are connected together so as to act as a single column.

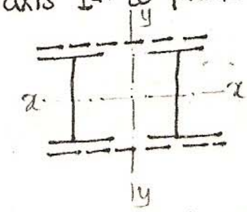
* Lacing : Eccentric load.
: Flat bars used.
also angle, channel, tubular sections are used, for lacing of very heavy column.

Battening :- ~~Ecc~~ axial comp. load. & where components are closer.
· Plates are used for "battens."

IS : 800 - 1984 / Cl. 5.7, 5.8 Recommedations :-

a] General Requirement :-

(GATE) ① r @ axis ⊥ar to plane of lacing ≮ r @ right angle to that axis.



$r_y \not< r_x$

② No variation in lacing throughout the length.

③ Cross members (except tie plates) should not be provided along the length of col^m^ with lacing system.

④ In single lacing system on opposite side of main components should be in same direct^n^ so that one be shadow of other.

⑤ Tie plates are provided at ends of lacing & at points of interpution. Design of tie plate is similar to batten.

b] Design Specification :-

① Inclinat^n^ of lacing with vertical = θ = 40° - 70°.

② $\lambda_{max} = 145$

③

Type of lacing	effective length (l_e)
i) single lacing ; riveted at ends.	length bet^n^ inner end of lacing = l
ii) Double lacing ; riveted at ends & at intersection.	0.7 times length bet^n^ inner end rivets on lacing bar = $0.7l$
iii) welded lacing.	0.7 times dist. bet^n^ inner end of eff. length of weld at end = $0.7l$

④ For flat bar (b×t) ; $\lambda_{max} = \frac{l_e\sqrt{12}}{t} \not> 145$.

⑤ For riveted or welded lacing system ; $\frac{L}{r_{min}} \not> 50$ or $0.7 \cdot \lambda_{max}$. [whichever is less]

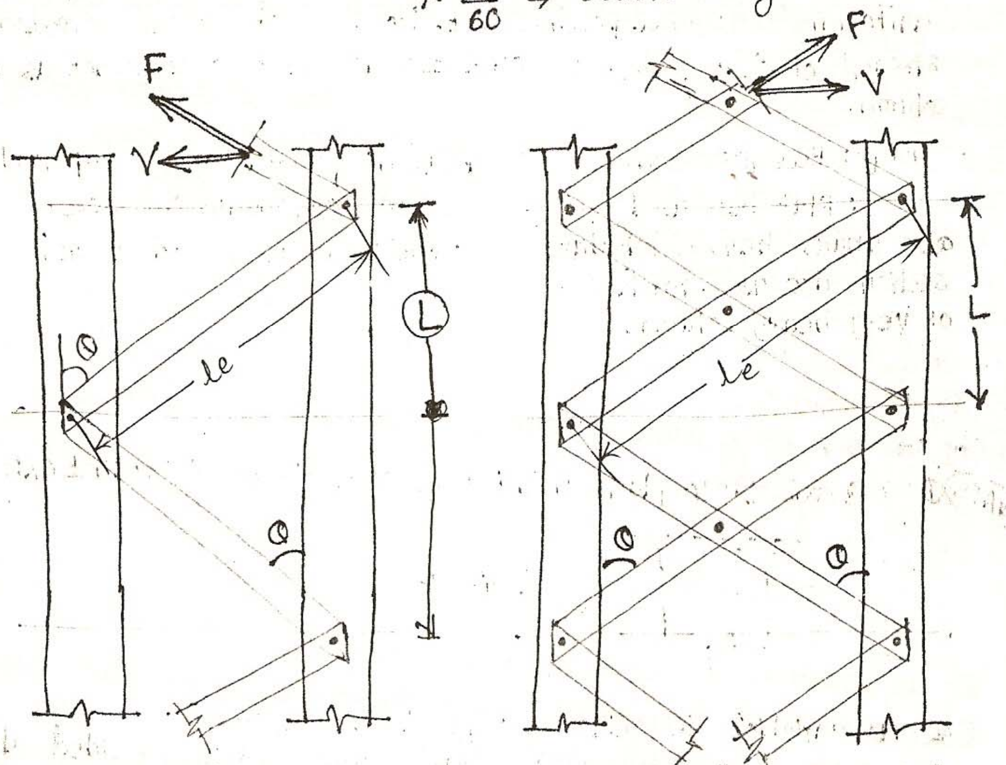
Where L = Dist. bet^n^ centres of connect^n^ of lattice bars to each component
r_{min} = r_{min} . of components of comp. member.

⑥

Nominal Rivet dia. (mm)	22	20	18	16
Min. width of lacing bars (mm)	65	60	55	50

⑦ Min. thk. of lacing bar : $t \not< \frac{L}{40} \Rightarrow$ single lacing

$\not< \frac{L}{60} \Rightarrow$ Double lacing.

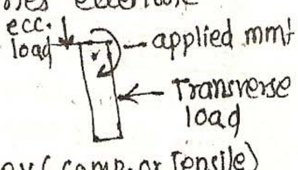


Single lacing.   Double lacing.

⑧ Lacing of comp. member should be designed to resist transverse shear V = 2.5 % axial load in member.

This shear is equally divided amoung all transverse lacing system in parallel planes.

The lacing system should be designed to resist additional shear due to bending if any comp. member carries eccentric load, applied end moment &/or lateral loading



⑨ In single lacing system on two parallel plane (comp. or Tensile) The force in each bar ;

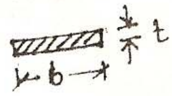
$$F = \frac{V}{2\sin\theta}$$

⑩ for double lacing system on two parallel planes, the force (C or T) in each bar,

$$F = \frac{V}{4\sin\theta}$$

⑪ If the flat lacing bars of width b & thk. 't' have rivets of dia 'd'.

comp. stress in each bar $= \frac{\text{Force}}{\text{Gross area}} = \frac{F}{b \cdot t} \not> \sigma_{ac}$



Tensile stresses in each bar $= \frac{\text{Force}}{\text{Net area}} = \frac{F}{(b-d)t} \not> \sigma_{at}$

⑪ End connections :- a) Riveted Connection

① If ~~single~~ Rivet is used to join batten seperately (fig (a))

$\therefore$ No-of Rivets reqd = $\dfrac{F}{\text{Rivet value}}$

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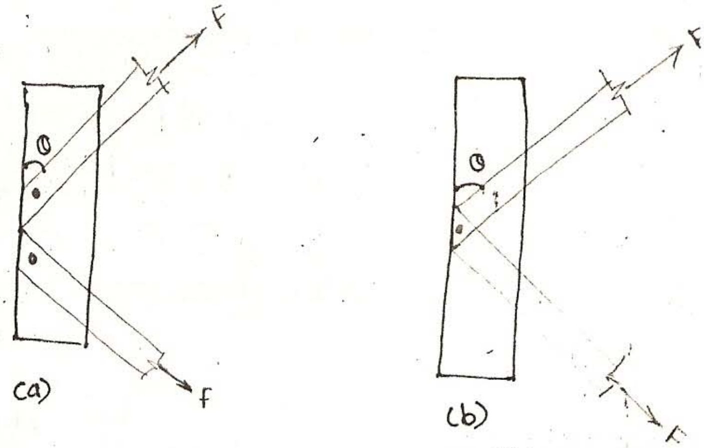


(a) (b)

In this case,

No-of Rivets reqd = $\dfrac{2F\cos\theta}{\text{Rivet value}}$

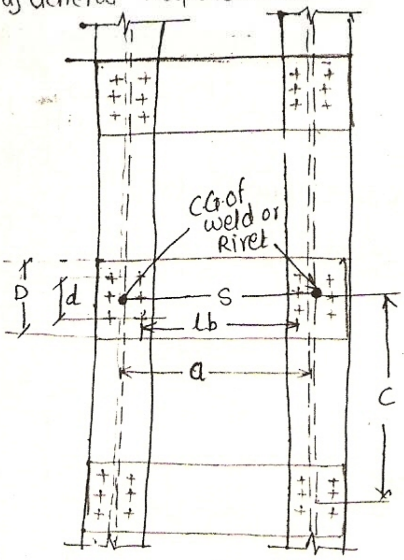
b) Welded connection :-

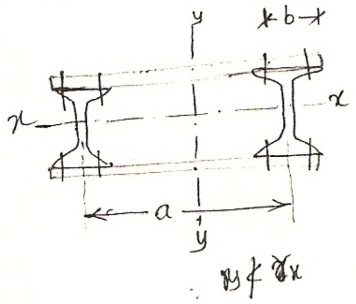
Lap Joint : overlap < $\frac{1}{4}$ thk. of bar or member. whichever is less.

Butt Joint : Full penetration butt weld or fillet weld on each side.

* Battens :- (5.8/Pg.51)

a) General Requirement .





$r_y \nless r_x$

① Batterns should be placed symmetrically @ x-x axis.

② Spacing should be uniform.

③ Battens should be placed opposite to each other at each end of member.

④ Min. 2 battens are essential so that member is divided in 3 parts longitudinaly.

(GATE) ⑤ Effective length of battened colm should be increased by 10%.

b) Design specifications :-

① Spacing of batten (c) :-

$\dfrac{c}{r_{min}} \ngtr 50$ or 0.7λ @ x-x axis.

② Effective depth (d) :-

$d > \frac{3}{4}a$	$\rightarrow$ Intermediate battens
$d > a$	$\rightarrow$ End battens
$d > 2b$	$\rightarrow$ Any batten.

Where d = eff. depth of batten i.e. dist. betn end rivet or end weld.

a = centroid dist. of member.

b = width of member in the plane of batten.

③ Thickness of battens :-

$$t > \frac{l_b}{50}$$

l_b = Dist. bet^n innermost connecting line of rivets or welds.

④ Transverse shear = $V = \frac{2.5P}{100}$ P = Total axial load on comp. member

⑤ Longitudinal shear = $V_1 = \frac{VC}{N \cdot S}$

C = spacing of battens.
N = No. of parallel planes of battens.
S = Min. transverse dist. bet^n centroid of rivet group or welding.

& a Moment = $\frac{V \times C}{2N}$

⑥ Check for longitudinal shear stress ;

$$\frac{V_1}{D \times t} \ngtr \tau_{va} = \text{Per. avg. shear stress} = 100 \text{ MPa}$$

where D = Overall depth of batten.
t = Thk. of batten.

⑦ check for bending stress = $\sigma = \frac{M}{I} \cdot y = \frac{M}{Z} = \frac{M}{\frac{1}{6} D \times t^2} \ngtr \sigma_{bc} / \sigma_{bt} = 150 \text{ MPa}$

Increase 'D' or 't' suitably if calculated shear stress & bending stress exceed the permissible value.

⑧ End connections :-

Design end connections to resist longitudinal shear V_1 & momen M. as calculated in step. No. ⑤.

For welded connection,

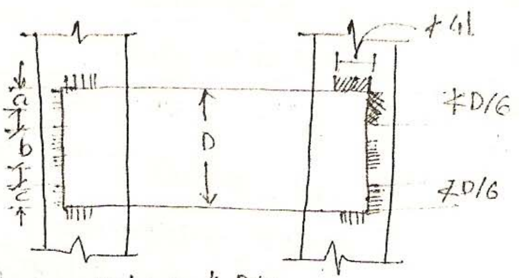
(i) $t_{ap} \nless 4t$

(ii) Total length of weld at edge of batten $\nless D/2$

(iii) length of weld at each edge of batten $\ngtr$ 1/3 of tot'l weld length.

(iv) Return weld along transverse axis of col^m $\ngtr 4t$.

where t = thickness } of batten.
D = Overall depth }



$a + b + c \nless D/2$.
t = Thick. of batten.