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COMPARATIVE STUDY OF COMPRESSIVE FORCE BORNE BY EQUAL VERSUS UNEQAL ANGLE UNDER I.S.CODE:800-1984

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1-Abstract-

Under I.S. Code:800-1984, various steel angel sections of equal or unequal sizes are used in trusses as compression member to bear compressive force for which slenderness ratio as well as end conditions and permissible compressive stress are required to get know the compressive force. Though for equal sectional area, unequal angle and equal angle may be used, however unequal single angels are more preferred as compression member because of higher strength. The paper reveals that both angels like ISA-150*150*10 and ISA-200*100*10 have individual sectional area 2903 square mm, wherein length has been kept 2000 mm and both ends kept singly riveted as well. By designing and doing calculation it has been decided that unequal angle whose long leg is connected with gusset plate has 1.27 say 1.3 times greater strength and short leg connected has 1.006 than equal angel. Due increasing strength by say 30% it has been promoted to use single unequal angle for its long leg is connected to gusset plate rather than equal angle.

Double equal angles with either or one side to gusset plate has compressive strength by 27.7% say 30% much over than unequal angles of its long leg connected one side to gusset plate or even something more in other conditions of unequal angles.

Finally it is abstracted that while using single angle as per compressive load, single unequal angle is preferred. Similarly while using double angles, equal angles are chosen to have better compressive strength.

2-Key Words:-

Slenderness ratio, permissible compressive stress, cross sectional area, correction factor, interpolation etc.

3-Introduction-

Since long steel structures are used as truss members in bridges and for slopping roof, wherein tensile as well as compressive forces of various magnitudes are usually come on various members. Members are designed to bear such magnitude forces under I.S. Code-800-1984 or I.S.Code:800-2007, for which single or double angels or equal or unequal angels are used as per requirement. I.S.Code-800-1984 is usually treated as working stress and I.S.Code:800-2007 as limit state. Because of easy calculation and simple conceptual way, I.S.Code:800-1984 has been taken to get design result of such compression members in the form of equal/ unequal angle. According to steel table for similar cross sectional area bearing angels decided to select, so as distinction in compressive strength could be assessed. For determining the compressive force on compression members, buckling may possible, for this slenderness ratio which is the ratio between the effective length to the least radius of gyration,

by this way permissible compressive stresses are determined duly interpolation to multiply it with its cross sectional area with suitable correction factor too.

4-Methodology-

To make the technical title relevant it is mandatory to take an illustration for this single ISA-150*150*10 mm and ISA-200*100*10 mm Fe-250 grade steel angle sections have taken for 2000 mm length, with equal sectional area of 2903 square mm. Ends are kept single riveted, so as effective length could be 2000mm. As per steel table rvv=29.3 mm, rxx=64.6 mm, ryy=26.4 mm. Gusset plate thickness=20 mm.

(a)Derivation for Single Equal Angle for Compressive Strength

Slenderness ratio= Effective length/least radius of gyration

Slenderness ratio (l/rvv)=2000/29.3=68.26

l/rvv=60----------compressive stress=122 N/ sq mm

l/rvv=70----------stress=112 N/sq mm

l/rvv=68.26----------stress=122-8.26=113.74 N/ sq mm (through interpolation)

Compressive Strength=(cross sectional area)(compressive stress)(multiplying factor)

Compressive Strength=2903*113.74*0.8=264149.776 N

(b) Derivation for Single Unequal Angle, when short leg is connected with gusset plate.

Slenderness Ratio=l/ryy=2000/26.4=75.75

l/ryy=60----------stress=122 N/ sq mm

l/ryy=70----------stress=112 N/sq mm

l/ryy=75.75----------stress=122-7.575=114.425 N/ sq mm

Compressive Strength=2903*114.425*0.8=265740.62 N

Strength ratio=264149.776:265740.62=1:1.006

% age increase=(265740.62-264149.776)100/264149.776=0.6%

(c)Derivation for Single Unequal Angle, when long leg is connected with gusset plate.

Slenderness Ratio=l/rxx=2000/64.6=30.96 say 31

l/rxx=30----------stress=145 N/ sq mm

l/rxx=40----------stress=139N/sq mm

l/rxx=31----------stress=144.4 N/sq mm

Compressive strength=2903*144.4*0.8=335354.56 N

Strength ratio=264149.776:335354.56=1:1.27

% age increase=(335354.56-264149.776)*100/264149.776=26.9% say 27%

(d)Equal double angle 150*150*10 mm when the gusset plate is in between two angles

Cxx=40.6 mm= Cyy, rxx = ryy=46.3, Ixx=Iyy=6224000 mm^4

Ixx=12448000 mm^4

Iyy=27313450.16 mm^4

rxx=46.3

l/rxx=2000/46.3=43.2

l/rxx40----------stress 139 N/mm^2

l/rxx 50----------stress 132 N/ mm^2

l/rxx 43.2----------stress 136.76 N/ mm^2

Compressive Force=2*2903*136.76*0.8=635222.85 N/ mm^2

(e) Equal double angle 150*150*10 mm when the gusset plate is one side of two angles.

Ixx=2.Ixx=12448000 mm^4

Iyy=12448000+5806$(40.6)^2$ = 22018378.16 mm^4

r=46.3 mm

l/r40----------stress=139

l/r50----------stress=132

l/r46.3----------stress=136.76 N/ mm^2

Compressive strength=136.76*0.8*5806=635222.85 N

(f) Unequal angles 200*100*10,whose long leg is connected with gusset plate either side.

Area of two angles=5806 sq mm, Cxx=69.6 mm, Cyy=20.10 mm

r=40

l/r=2000/40=50

Stress=132 N/ mm^2

Compressive Force=132*5806*0.8=613113.6 N

(f) Unequal angles 200*100*10,whose short leg is connected with gusset plate either side.

Ixx=4184000 mm^4

Iyy=60987744.96 mm^4

I(minimum)=4184000 mm^4

r min.=26.84

Slenderness Ratio=l/r min=2000/26.84=74.51

l/r70----------stress=112

l/r80----------stress=101

l/r74.5----------stress=107.5 N/ mm^2

Compressive Force=5806*107.5*0.8=499316 N

(g) Unequal angles200*100*10mm, when long legs are connected with gusset plate on one side.

Ixx=4184000 mm^4

Iyy=52325192.96 mm^4

r=26.84 mm

l/r=2000/26.84=74.5

l/r70----------stress=112 N/ mm^2

l/r80----------stress=101 N/ mm^2

l/r74.5----------stress=107.05 N/ mm^2

Compressive Force=497225.84 N

(h) Unequal angles200*100*10mm, when short legs are connected with gusset plate on one side.

Ixx=2420000 mm^4 Iyy=6529682.06 mm^4

r=33.53 mm, l/r=2000/33.53=59.65

l/r50----------stress=132

l/r60----------stress=122

l/r59.65----------stress=122.35 N/ mm^2

Compressive Force=122.35*0.8*5806=568291.28 N

5-Conclusion-

Since if we are using single equal and unequal angles bearing same area for which single unequal angle with size 200*100*10 mm, whose long leg is connected with gusset plate is having more compressive strength like 335354.56 N, then its short leg and then equal angle. The ratio is likely 1.27:1.007:1.00.

Since the double angles are concern, which are having equal and unequal sectional area are placed in various condition of like either side to gusset plate or one sided to gusset plate of 20 mm. Using methodology, it has been revealed that equal angles having size 150*150*10mm, if placed one side or either side to gusset plate is having more compressive strength like 635222.85 N, than unequal angles.

The grading exists with equal angles (either/one side to gusset plate) like 635222.85N, unequal angles of size 200*100*10 mm

to its short leg connected one side to gusset plate of 20 mm thick like 568291.28 N, than either side long leg connected with gusset plate like 499316N than long leg connected one side of gusset plate like 497225.84N. The ratio exist 1.277: 1.14: 1.004: 1.

Hence for using double angle as compression member, it is recommended to use equal angles on any position of gusset plate to get higher strength for economical use also. As the sectional area is same hence cost has no affect, however equal angles are showing more strength.

In case of single angle, unequal angle, whose long leg is connected with gusset plate, will show higher compressive strength and economy as well.

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