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Comparison on Sustainability of Moment Resistance Connection Methods in Steel Design

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Abstract
There are different components of steel structure like column, beam, etc., to connect them connections are required. To resist the moment, the moment resistance connection is needed. The main focus of this study is to investigate the design of split beam and clip angle connection, which one seems to be more effective according to their cost. This study presents a design methodology that can be applied to connect beam to secondary beam and column to beam. From this we can select the suitable section, which provides more moment resisting capacity, safety and most economical connection with sustainability.

Keywords
IS 800 :2007 Code, Moment Resistance, Split Beam, Clip Angle.

Introduction
The steel structures it is composed of various different components such as column, beam etc. To make a structure we need to connect different components with the help of connections.
Connections are the structural elements used for joining different members of steel framework.
There are different types of classification under Beam to Column Connection.
1) Moment resisting Connections 2) Shear resisting Connections
The Moment resisting Connections are categorized in two types i.e.
Split beam connection and Clip angle connection as shown in figure 1 and 2 [1,4].
Clip angle – The connections which are used for connecting a beam to secondary beam and column to beam. The clip angles are bolted or welded to the column and beam [5].
Split beam – It is an I-section which is cut into two half's and used to connect a beam to secondary beam and column to beam. The split beam connections are bolted or welded to the column and beam to make a stiff connection.

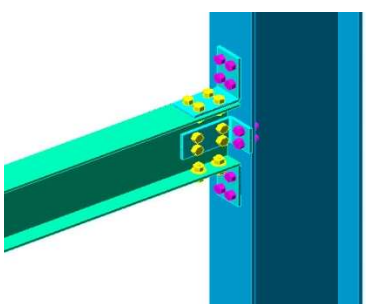

Fig 1: Clip Angle[1] (Source- Reference No 1)

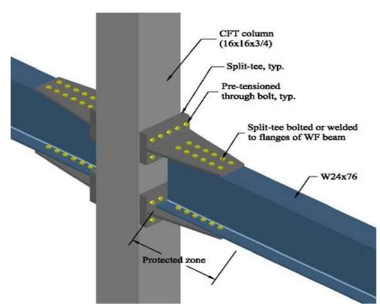

Fig 2 : Split Beam[4] (Source- Reference no.2)

Methodology
Nowadays the world is shifting towards the steel structure because of its ease of working and it provides good economy over RCC structures [8]. That is why steel structures are more preferable. The study includes the design of beam to column connection in which beam section and column section are of fixed dimension. The design procedure includes all parameters which are necessary for selecting a suitable section for the connection which provides maximum safety and also helps to decide the most economical and sustainable type of section for connection [2]. Following specification for comparisons is as follows:

Table No.1: Model Description [6,7]

	BEAM ISMB 400	**COLUMN ISHB 300**
WEIGHT PER METRE	61.6 KG/M	63.0 KG/M
DEPTH OF SECTION (h)	400 MM	300 MM
WIDTH OF FLANGE(b)	140 MM	250 MM
THICKNESS OF FLANGE(tf)	16 MM	10.6 MM
THICKNESS OF WEB (tw)	8.9 MM	9.4 MM
Bolt grade 4.6 and steel grade 410, Fy=250Mpa, fub= 400Mpa Other specification, Ɣmb =1.25, Ɣw=1.25, Ɣmo=1.10 ; Reference from Indian steel table and IS 800 : 2007		

Table no.1 shows the specification of Beam ISMB 400 and Column ISHB 300: Reference from Indian steel table and IS 800 : 2007 [6,7].

Problem Statement

A beam ISMB400 transmitting a factored reaction of 120KN and factored moment of 50KN.m to the flange of column ISHB300.

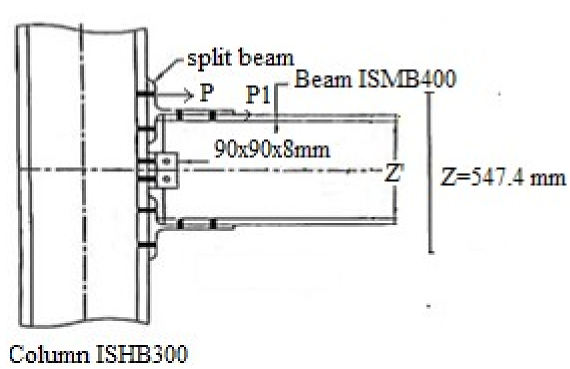

Fig 3 : Split Beam Connection

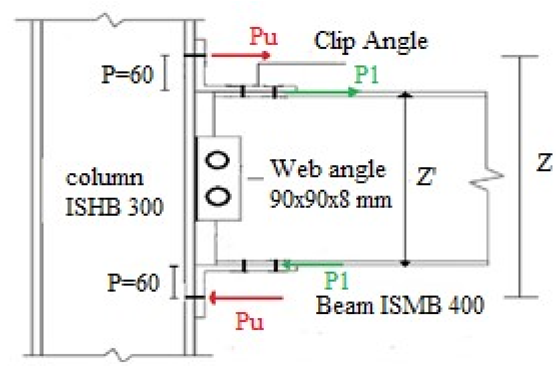

Fig 4: Clip Angle Connection

Fig 3 shows the connection between beam and column using split beam connection and Fig 4 Shows the connection between beam and column using clip angle connection [10].

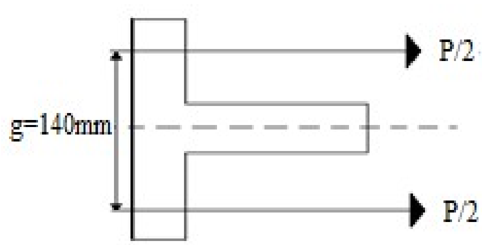

Fig 5: Split Beam (ISWB 300)

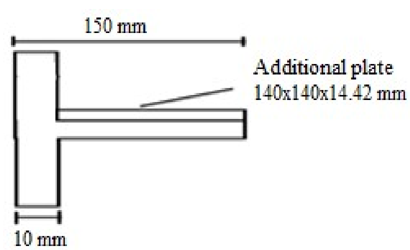

Fig 6: Arrangement of Additional Plate

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Table No. 2: Design of Split Beam [3,6,7,9]

1. Tensile strength of bolt Tu = (0.9fub/ γmb) x 0.78 x (π/4) x φ^2 Tu = 70.57 KN	**2. Calculation for tension in bolt(Z= 547.4 mm Reference fig 1)** Ptu = Mu/ Z Ptu = 91.34 KN	Reference IS 800 :2007 [7] (clause-10.3.5 page 76) and (clause.-11.4.1 page 85)
3. Shear strength in one bolt $= 0.78 \times \frac{\pi^2}{4} \times \varphi^2 \times (f_Y)/(\sqrt{3} \times \gamma_{mo})$ = 45.27 KN	**4. Tension induced in each bolt** Pu = P / (Minimum number of bolts) Pu = 91.43 / 4 Pu = 22.835 KN < Tu (Hence Safe) Now , P1 = Mu / Z' (Z'=400mm from fig.3) P1 = 125 KN	Reference IS 800 :2007 [7] (clause-10.3.3 page 75)
5. Take 4 bolts in two rows. Shear in each bolts = 125/4 =31.25 < 45.27 KN Hence Safe	**6. Design of split beams section (fig.5 shows the gauge distance *g*)** $Mu1 = \frac{p}{2} \times (\frac{g}{2} - \frac{tw}{2})$ Mu1 = 3030.904 x 10^3 N-mm	Reference IS 800 :2007 [3,7,9]
7. Moment Capacity $Mu1 = \frac{1.2 \times fy \times Z}{\gamma_{mo}}$ Where Z =b t^2/6 We get, t = 21.82 mm > 7.4 mm Hence, Unsafe We required more thickness = (21.82 – 7.4) = 14.42mm Additional plate of thickness 14.42mm is provided as shown in fig 6.	**8. Weight of split beam calculation** b = 280 mm weight per unit meter = 48.1 kg/m weight = 48.1 x 0.28 = 13.47 kg weight of addition plate = 4.43 kg Total weight of split beam = 17.9 kg	Reference IS 800 :2007 [6,7] (clause-9.2.1 Page 69)

Table No. 3: Design of Clip Angle [3,6,7,9]

1. Tensile strength of bolt (Ref. Fig 4) Tu = (0.9fub/ γmb) x 0.78 x (π/4) xφ^2 Tu = 70.57 KN	**2. Calculation of tension in each bolt** PTu = Mu/ Z (i.e. Z=520mm) PTu = 96.15 KN Minimum 2 bolts are required Tension induced in each bolt Tu each = 96.15/2 Tu each = 48.077 KN < Tu Hence safe	Reference IS 800 :2007 [7] (clause-10.3.5 page 76) (clause-11.4.1 page 85)
3. Shear in bolt connecting clip angle with the flange of beam (Ref. Fig 4) P1 = Mu / Z'= 125 KN Shear in each bolt = P1/No. of bolts. By taking 4 bolts in 2 rows P1 = 31.25 KN < 45.27 KN Hence safe	**4. Moment Develop at clip angles Reduction factor = 60 %** $Mu = P_{tu} \times (g - \frac{tw}{2})$ x 0.6 Consider ISA 80 x 80 x 8mm Therefore, t = 8 mm Mu =323.11 X 10^3 N-mm	Reference IS 800 :2007 [3,7,9] (clause. 10.3.3 page 75)

5. Moment Capacity Mu= 1.2 x $\frac{fy}{\gamma_{mo}} \times Z$ Z = 11847 mm^3 Z= $bt^2/6$ t = 22.532 =25 mm (approx) similarly by following methods we have increased size of the sections finally selecting and Providing the Clip angle of 200x200x25 mm	**6. Weight of Clip angle calculation** Clip Angle (200 x 200 x 25)mm b=140 X 2 = 280 mm b= 0.28 m Weight per unit meter = 73.6 kg/m Wt = 73.6 x 0.28 = 20.6 kg	Reference IS 800 :2007 [6,7] (clause-9.2.1 Page 69)

Above Table no. 2 and Table no. 3 shows the detail design of column to beam connection using split beam and clip angle.

Result

From Table no. 2 step 8 getting the weight of split beam and Table no. 3 step 6 getting the weight of clip angle.

Therefore, Percentage Increase in steel = $\frac{\text{Weight of Clip angle} - \text{Total Weight of Split beam}}{\text{Total Weight of Split beam}} \times 100$

= 15.039 %

Conclusion

While comparing two different connections, i.e. Split beam (ISWB300) and Clip angle (200 x 200 x 25 mm) connections, for same beam and column, we observed that split beam is more stiffer as compared to the Clip angle Amount of steel required in split beam connection is less as compare to clip angle connection. About 15.039 % more steel is required in clip angle, hence split beam connection is economically more sustainable. Moment resisting capacity of split beam is more than clip angle and it is stiffer.

References

1. Autodesk Autocad structural detailing 2015 help.autodesk.com/view/STRDET/2015/ENU/?guid=GUID-730B089D-2AE5-4FA2-AEB8-4BABD1894151
2. Bassam A. Burgan, Michael R. Sansom ‚Sustainable steel construction, The Steel Construction Institute, Silwood Park, Ascot, SL5 7QN, UK.
3. Dr. N. Subramanian, ‚Code of Practice on Steel Structures -A Review of IS 800: 2007ʻ, Computer Design Consultants, Gaithersburg, MD 20878, USA.
4. Erica C. Fischer, Zhichao Lai and Amit H. Varma Design of Connections For Composite Special Moment S (C-Smf) With Concrete-Filled Steel Tube (CFT) 8th International conferences on behavior of steel structure Aron Shanghai, China, July13,2015.
5. Fisher, J.W., and Struik, J.H.A., (1974), "guide to Design Criteria for Bolted and Riveted Joints", Wiley, Chichester, Version II.
6. Indian steel table by S. Ramamrutham, B.E. (civil): M.I.C.E.,M.I.E. (India),Dhanpat rai publication company (P) ltd.
7. IS 800: 2007 Indian Standard "Code of Practice For General Construction In Steel — Code of Practice" (Third Revision)
8. Kushalkumar Yadav, Prashant D Hiwase and Ramesh V. Meghrajani "Study the behaviour of cold form c section purlins under bending" International Journal of Civil Engineering and Technology (IJCIET), Volume 9, Issue 5, May 2018, Pages 964–968 Publisher IAEME Publication.
9. L.S. Negi,"Design of Steel Structures", Tata McGraw-Hill Publishing Company (P) LTD, 2nd Edition 2008.
10. Owens, G.W., and Cheal, B.D., "Structural Steel work Connections", Butterworths,1989, Version II.
11. S. K. Duggal's "Limit State Design of Steel Structures" 2nd Edition,2010 published by Tata McGraw-Hill Education.

