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Analytical evaluation and seismic performance of concrete encased steel composite beam to steel column joint

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Abstract— To reduce floor to floor height the composite beam TEC concept is used and the material used is steel. The technical, economical, and convenient TEC beam is developed as a new composite beam composed of structural tee, horizontal top stud, precast concrete, stirrup, and cast-in-place concrete slab. For making different sections of joint and compare the moment capacity of those joints and the parametric investigation of the joint is the main objective of this work and also to evaluate the cyclic performance of the best of among the joints and also to improve the seismic performance. The analytical study is carried out with FEA software to find out deflection, load and moment capacity. The different beam column joint is made with is concept such as the steel bracket length ratio, stud ratio etc. and also the concrete portion is filled with I section with changing B/ D ratio etc.

Index Terms— TEC concept, cyclic performance, seismic performance, moment capacity, parametric investigation. FEA, pushover analysis.

1 INTRODUCTION

Steel structures are used in composite constructions and this required simple construction, less man hours, and no formwork is needed. The steel composite beams are deeper than the reinforced composite beams.

The applications of encased composite columns can be found in low-rise and high-rise structures. The design of beam column joint that should produce building consisting of steel and reinforced structures which have advantage in materials such as mass, speed of construction, economy of rcc , damping, strength ,long- span capacity .The purpose of the paper is to investigate the moment capacity behavior of concrete steel composite beam column joint. The parametric investigation of changing steel bracket length ratio, type of shear connectors, these are the two main aim of this paper.

Steel reinforced concrete structures, they have an excellent earthquake resistance with high capacities and deformability .The seismicity is also tested in the case of CES for the strength and stiffness behavior. This paper summarizes the test results and discusses how to evaluate the deflection and moment capacity of the joints.

The various beam column joint is making and the loading conditions are applied and the moment capacity and deflection value is noted etc. are the main purpose and aim of this paper.

2 ANALYTICAL STUDY

2.1 Material selection

The material used for the analysis of beam column joint is steel and reinforced concrete material. And the shear connectors, steel bracket, transverse bar etc. are used.

Table 1: Geometry parameters

Length of column	1700 mm
Yield strength	235
Grade of concrete	250 mpa
Tensile strength	486
Length of beam	3350

2.2 Loading condition

The loading analysis is carried out in two steps such as pushover analysis and cyclic load analysis. The pushover analysis is done for all models and the best of that models the cyclic loading analysis used.

2.3 Test setup

The test setup contains that beam column joint. The loading point is 3m away from column. And the loading is done 1/3 KN/S. After yielding the loading is ½-1/3 KN/S. The stiffner is used and the thickness is 21. Rebar spacing is 50 cm and length of steel bracket is 70 cm. studs are used of 20mm size. Reinforced stirrups are 5m size is used. The push over analysis is done for the above test set up

And the analysis is carried for the above test setup

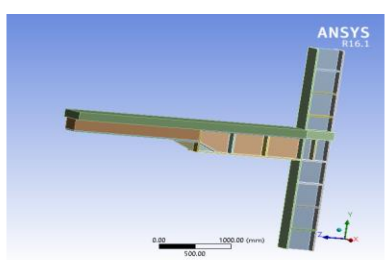

Fig 1: model for beam column joint

3 RESULT AND DISCUSSIONS

3.1 Parametric study

The parametric study is carried out by changing the steel bracket length, type of shear connectors and the pushover analysis is used and also best of themodel is tested in the cyclic analysis.

3.1.1 Steel bracket length

Table 2 : steel bracket length

description	Load (kN)	Deflection (mm)	Moment capacity
1700	129.48	151.92	433.75
1350	104.62	112.56	350.477
1000	89.42	151.01	258.45

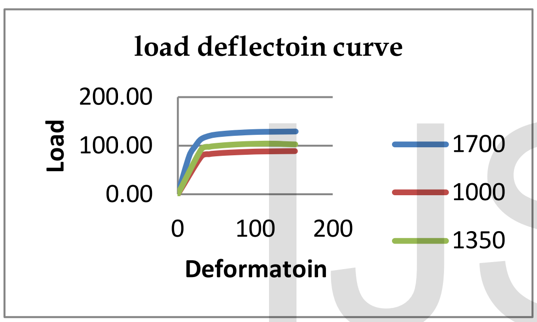

Fig 2 : Load vs deflection curve

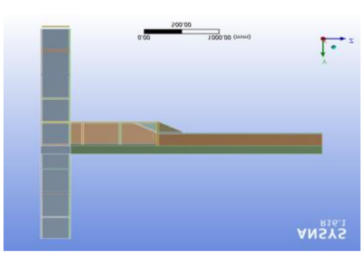

Fig 3: model of joint with steel bracket length 1350mm

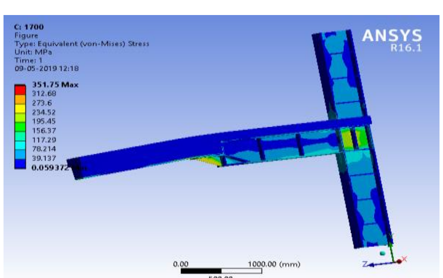

Fig 4: stress of joint with steel bracket length 1350mm

3.1.2 Type of shear connectors

Table 3 : stud changes with various sections

description	Load (kN)	Deflection (mm)	Moment capacity
Stud	129.53	151.91	433.92
SC I	129.63	151.92	434.26
SC Z	129.71	151.92	434.5285

The maximum value obtained by changing the type of shear connector as stud , stud is changes to with different section such as I,Z sections . and the best moment capacity is obtained at SC Z and also there is some minute changes for other sections. So that concluded that there is no effect in the case of stud change.

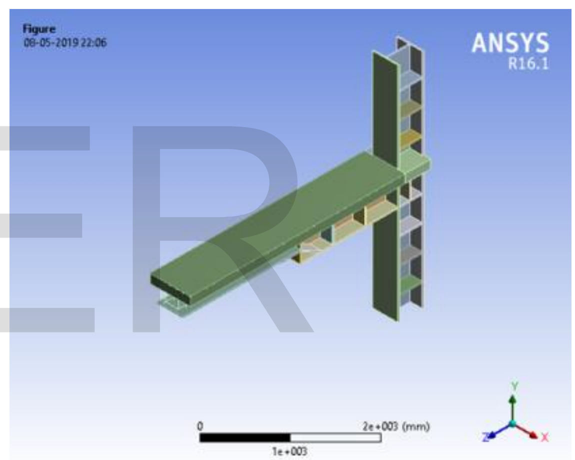

Fig 5 : model of beam column joint with stud

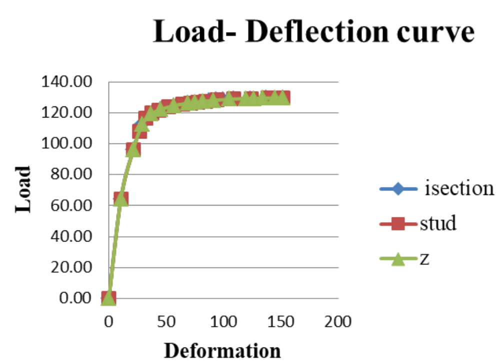

Fig 6 : load deflection curve

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3.1.2 Partially encased b/d ratio

The beam breadth and depth changes. Here breadth is increases and depth is constant and also there is no changes in their dimensions are also used as a model.

Table 4: partially encased b/d ratio

description	Load (kN)	Deflection (mm)	Moment capacity
B/D=1	258.49	149.57	865.43
B/D=2	262.49	145.53	879.43

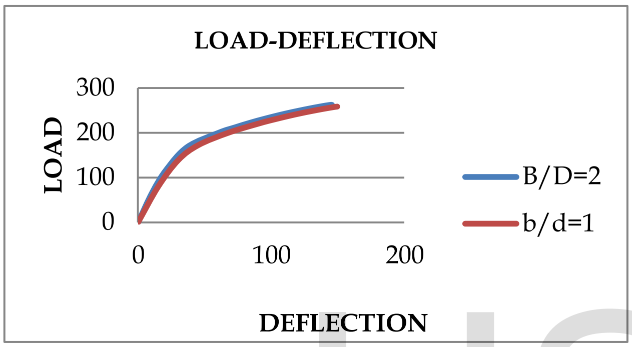

Fig 7: Load vs deflection curve

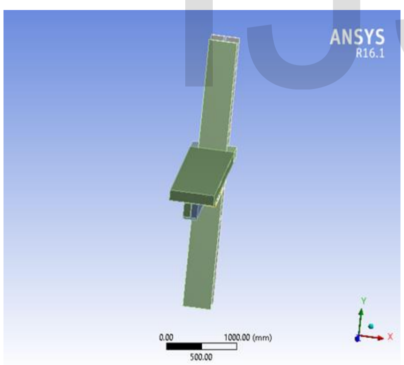

Fig 8 : model of beam column joint of b/d=1

3.1.4 I span with different ratio

Table 5: I span with different span

description	Load (kN)	Deflection (mm)	Moment capacity
I Span 1700	174.77	202.07	585.4795
I Span 1350	138.19	142.04	462.9365

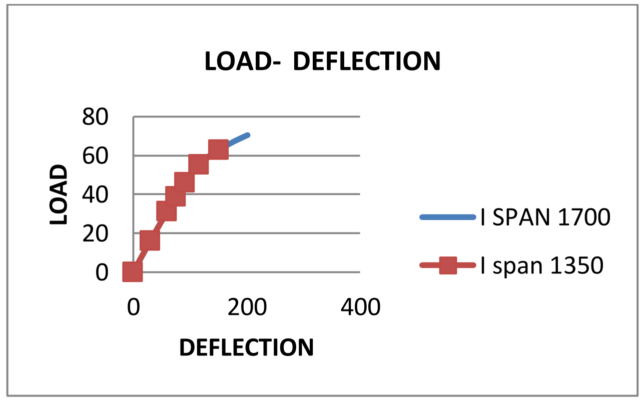

Fig 9 : Load vs deflection curve

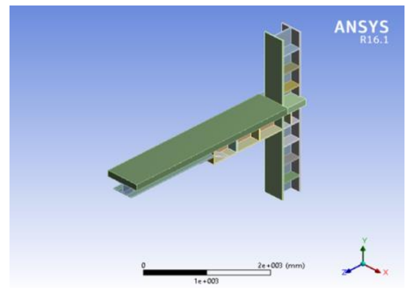

Fig 10 : model of I span of 1700

3.1.5 Effect of Rcc Slab Replaced With Steel I Beam

Description	Load	Deflection
B/D=1	132.49	118.3
B/D=2	172.48	151.1
B/D=0.5	163.9	63.78

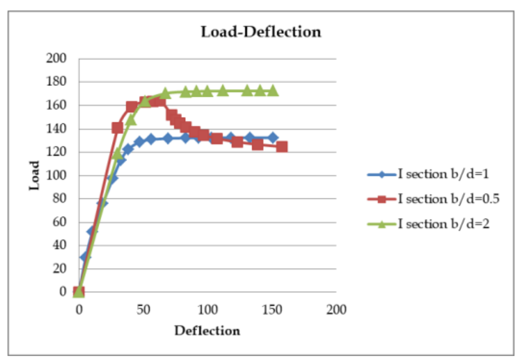

Fig 10: load deflection curve

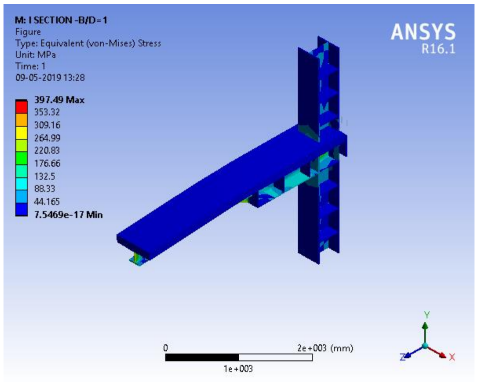

Fig 11: stress diagram partially encased b/d=1

3.1.6 FULLY ENCASED BEAM

Description	Load	Deflection
Fully encased	166.67	151.24

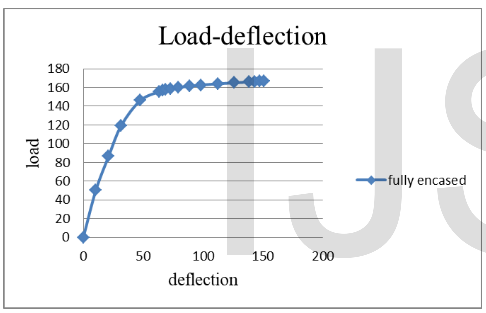

Fig 12: load deflection curve of fully encased beam

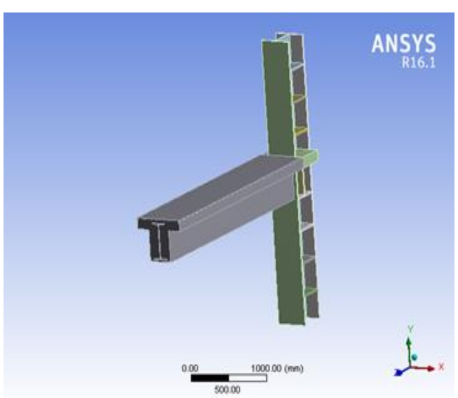

Fig 13 : model of fully encased beam

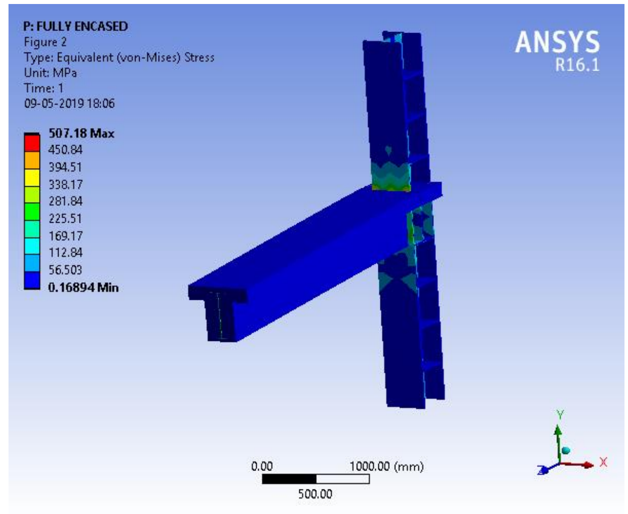

Fig 14: stress diagram fully encased

3.2 cyclic performances

Many models are created and push over analysis is done and the best of this model the cyclic performance is done. The reverse cyclic loading is done at the beam end of the beam column joint. The partially encased case the b/d ratio 2 is one of the best models and the cyclic performance is done for the Analysis.

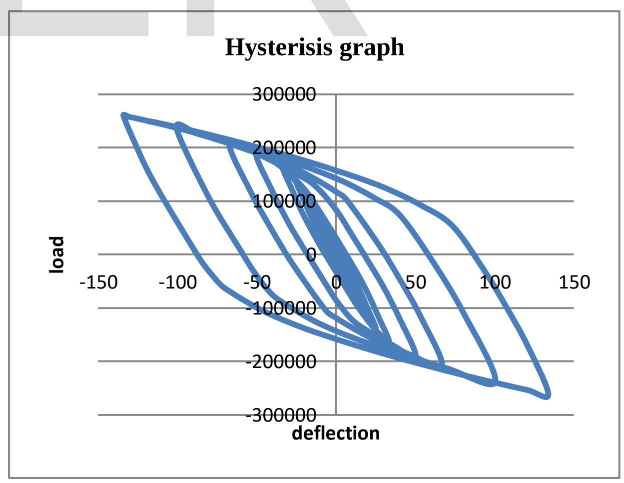

Fig 15: hysteresis graph

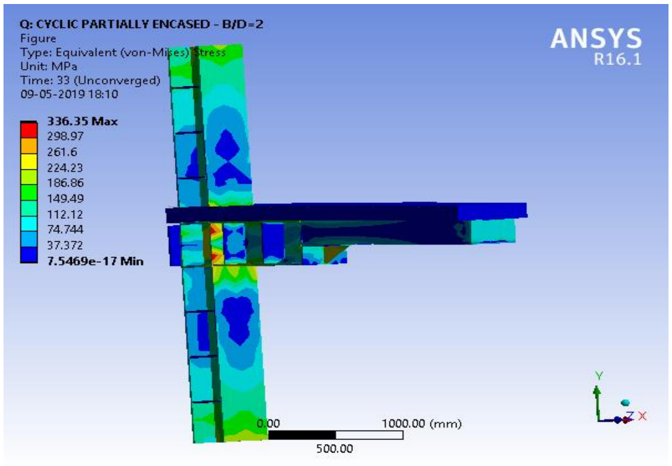

Fig 16: stress of partially encased b/d=2

Cyclic performance is done according to the AISC protocol, the force-displacement hysteretic loops for the specimens is above. The load carrying capacity is increases with increase of axial loading. The result is obtained as in 25mm deflection have 4% drift value.

The another model of steel bracket length 1700 have also the maximum load carrying capacity and that model is also tested under the cyclic analysis. The model is tested under the aisc protocol, the maximum deflection is obtained as 132mm and the optimum angle is 0.75%. Which is the maximum deflection and corresponding load is noted

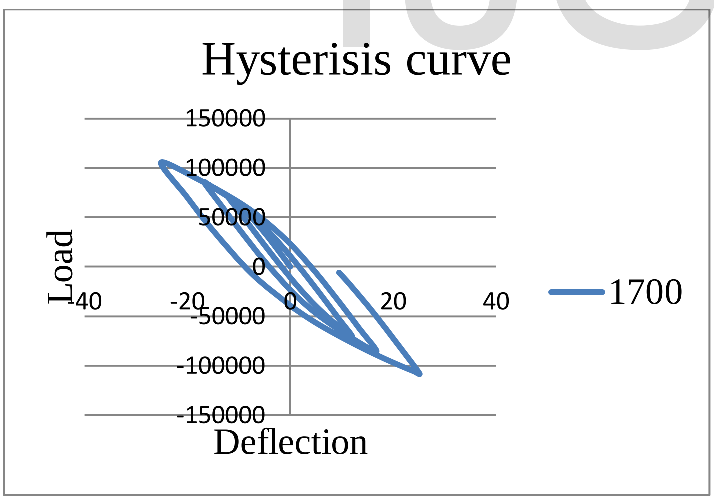

Fig 17: hysteresis graph

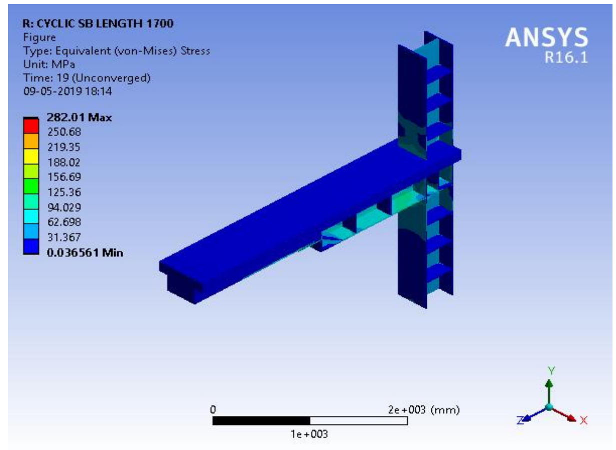

Fig 18: stress of steel bracket length 1700

CONCLUSION

From this work it is understood that beam column joint has good strength capacity and also the moment capacity of concrete steel composite beam column joint is obtained. The different parametric investigations are done and best of the result is obtained. The parametric investigations are such as the steel bracket length ratio, type of shear connectors etc. The push over analysis is done for the parameter with loading condition is lateral loading. The cyclic performance is also carried out and the result is obtained

From the results I concluded that in the case of steel bracket length ratio the maximum load and deflection is obtained as in ratio of 1700. And the moment capacity is 433.758. And the lateral loading is done by pushover analysis.

Also, the partially encased cases the b/d ratio is changes the best model is obtained that in the case of b/d= 2. And the load is maximum obtained. The moment capacity is obtained as 879.3415.

And best of that the cyclic analysis is done and it is done based on some specifications. I.e. AISC specification, the graph is obtained. And increase in the axial loading the load carrying capacity is also increases. The best value of cyclic loading is in 3rd cycle with 4% drift.

In the case of the steel bracket length the maximum deflection is occurs at 132mm, and the graph is plotted. The optimum angle is at 0.75% drift.

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