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STABILITY ANALYSIS OF CONCRETE COLUMN - STEEL BEAM JOINT UNDER SEISMIC LOADING

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Abstract - The cyclic behavior of connection containing steel beam concrete column is analyzed in this paper. Experimental analysis of beam column is done and the result is presented at the end. To avoid the severe damage in the joint region the hybrid section is considered. This will be help in future to save building from the damage due the vibration of the ground. This will enable the better safety to the occupants in the buildings. The safety of the building lies mainly in the joints where the damages occur severe due to the less vibration. This severe damage alters the load carrying capacity of the building in any manner. To make the building stronger than the conventional method this hybrid section is considered .This type is done in the other countries more commonly than in India. The results are compared and presented in this paper. The strength is increased by 30% when compared to the homogeneous material.

Key word: Concrete column – Steel beam; seismic loading; cyclic behavior.

1. INTRODUCTION

In the past few years of the world history the most damage of the building are occurred due the vibration of the ground. To make the building from the damage due to the vibration of the ground this paper is analyzed both in theoretical and in experimental methods to make the building safer way. This is a method in which the safety of the building is ensued to be little safer from the damage when compared to the conventional joint. This will ensure the safety against the damage due to vibration. To prevent this damage due the vibration. There should be some changes made in the design procedure or in the usage of the materials. The damage in the structure can be reduced so that the life of the building can increased. The major damage are occurred in the beam – column joint so that the maximum care should be taken in the joint so that to avoid the damage to safeguard the structure.

The steel will save the material cost and the concrete will have higher compressive strength so that the material cost will be lower when compared to the only usage of steel and only usage of concrete materials. This makes the member in an effective way so that the strength of the member is increased so that the load carrying of the member is increased. These composite constructions were studied in several countries to enhance the effect to the vibration. This is effectively used for the high rise building in which the damage occurs in larger amount to reduce the effect of the in smaller amount this method is adopted for construction in the foreign countries like America , Japan Taiwan the experiments are done to increase the strength of the building.

The pervious papers are done with the connection of the slab attached to the column beam. In these papers the joint were slab is not considered. The critical section in the structure is considered as beam –column joint. In the building the beam - column area is considered to be more critical section .The higher importance is to be given to the beam –column joint.

The joint should be effective to with stand the higher load. The beam –column joint are connected by welded joint. The steel beam resists the tensile force and the concrete column resists the compressive force. To make the beam column effective steel beam – concrete column are used. The steel beam is effective in reducing the seismic effect. The bending moment in the columns are due the eccentricity of axial force, the lateral force from the beam, the condition of the column.

The seismic vibration is considered according to the zone from IS CODE 13920, the detailing for seismic load for RC column IS 1893 -1984 codes are used. The seismic loads are in the form of vibration which is travel in the longitudinal and transverse direction. Due to the vibration of the ground motion, the structure gets shaked in the direction of the vibration or in the direction opposite to the vibration. This vibration cause the damage in the joint which gets deformed and the transfer of the load get affected so that the joint get damaged.

2 .COMPOSITE STRUCTRE

A structural member composed of two or more materials which act as single material during the application of the load is referred as composite construction. During the joining of the composite construction the properties of the

material do not change but the materials properties may alter during the application of load. This will enhance the durability of the material .The combination are made between steel-concrete, wood-concrete, steel-wood, and other types of combination are made. The mainly used combination in civil engineering is steel concrete combination. The other combination is rarely used when there is need for the other combination.

The composite structure is considered as the mixture of the two or more materials that in the strength of the material get increased. The increased in the strength results in the higher load carrying capacity of structure get increased. The most critical part in the building is the beam column joint in which the damage occurs most commonly due the lateral load. To overcome this damage the composite construction is preferred. The beam column joint is the most important and the critical area to be considered during the application of load. So it is considered to be an important part to make the beam column joint effective. Since the joint are effective the damage may occur due to seismic vibration. To avoid the damage due vibration, the beam column joint should be made effective.

2.1 HOMOGENEOUS MATERIAL

The homogeneous material are the same material in which the strength in one area is higher and the strength in the another area is low which result in the damage of the Structure. The most critical part in the building is the beam column joint in which the damage occurs most commonly due the lateral load. To overcome this damage the composite construction is preferred. The beam column joint is the most important and the critical area to be considered during the application of load.

The steel beam resists the tensile force and the concrete column resists the compressive force. To make the beam column effective steel beam – concrete column are used. The steel beam is effective in reducing the seismic energy. The bending moment in the columns are due the eccentricity of axial force, the lateral force from the beam, the condition of the column. This vibration cause the damage in the joint which gets deformed and the transfer of the load get affected so that the joint get damaged. So the homogeneous are to be avoided.

2.2 HETROGENEOUS MATERIAL

It is most effective type of construction to with stand both compressive strength and tensile strength .these combination are mostly used now a days in heavy load carrying structure to withstand the applied load. In the structure the concrete can with stand the compressive strength and the steel can with stand the tensile strength. The combination of the two materials enhances their physical properties but also increase the strength of the structure. In this concept the compressive strength of the concrete and the tensile strength of the steel are effectively used.

ADVANTAGE

- Saving in weight of the structure.
- Steel component has the ability to absorb the energy due to seismic energy.
- Construction time is reduced.
- High ductility of steel lead to better seismic resistance of the composite section.
- Minimum disturbance to traffic in bridge construction.
- Ability to cover large column free area.
- The steel concrete construction has higher strength than the other composite materials.
- The thermal expansion of the steel and concrete are same.

3. ANALYTICAL ANALYSIS:

Finite Element Method is used to solve the complex problem using software called ANSYS. In this the elements are divided into a smaller section so that the stress in a point is calculated. By dividing the elements the properties of the elements does not get altered. The stress and strain in the element are expressed in terms of nodal displacement. The principle of virtual work is used to derive the equation of motion. The boundary condition and the loads are applied in the required to obtain the solution .The analytical analysis is done by using the software called ANSYS that helps to know the ultimate load carrying capacity of the model by which the capacity of the model is pre- determined. This will helps us to known the capacity of the member that can carry maximum and helps to know the value range by which the value can be known the failure mode can be analyzed so that the minute failure mode can be known easily.

The solving time required for the problem in ANSYS depends up on the complexity of the problem in the time is 60% less than by solving manually. Sketching- In the Sketching the models are drawn .If the models cannot be drawn in sketching it can be imported from other modeling software such as AUTOCADD. Modelling- After sketching it is extrude into the modeling, the dimension are checked. Meshing- The meshing is done automatically. Solution - In the solution the load ,boundary condition ,required result such as deformation, stress, strain are to be given . Then the problem is solved, the result will be obtained.

3.1 FINITE ELEMENT ANALYSIS

Finite Element Method is used to solve the complex problem using software called ANSYS. In this the elements are divided into a smaller section so that the stress in a

point is calculated. By dividing the elements the properties of the elements does not get altered. The stress and strain in the element are expressed in terms of nodal displacement. The principle of virtual work is used to derive the equation of motion. The boundary condition and the loads are applied in the required to obtain the solution Preprocessor - In this the models are created, the changes in the model are done. Solution-The load value, support condition, constrains can be given. In this step the finite element solution occurs. General post processor this is the last step in which the solutions are obtained. The changes in the solution can be
One by changing the values in the General post processor the analytical analysis is done by using the software called ANSYS that helps to know the ultimate load carrying capacity of the model by which the capacity of the model is pre- determined. This will helps us to known the capacity of the member that can carry maximum and helps to know the value range by which the value can be known the failure mode can be analyzed so that the minute failure mode can be known easily. In this the modeling is done in AUTOCADD and is imported to ansys and the structure is analyzed and the results are obtained. In the Sketching the models are drawn. If the models cannot be drawn in sketching it can be imported from other modeling software such as AUTOCADD

3.2 SPECIFICATION OF THE BEAM COLUMN JOINT.

- Size of the concrete = 200mm*300mm
- Size of the steel section = ISMB 150
- Diameter of the reinforcement = 12mm
- Diameter of the stripes = 8mm
- Strength of the I section = 420N/mm^2
- Grade of concrete = 40N/mm^2
- Grade of steel = 415N/mm^2
- Length of the column =800mm
- Length of the I section =600mm

The young's modules, possions ratio values are entered and the results are obtained and the results are obtained in the form of graph. The values are obtained .The beam is welded to the reinforcement of the column so that the beam is fixed to the column.

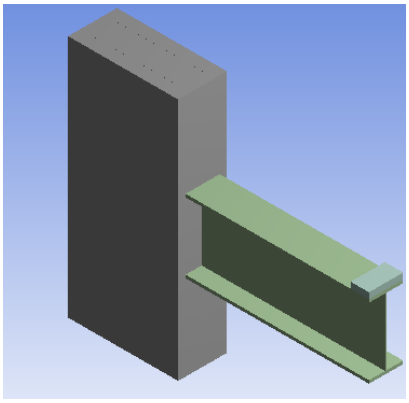

Fig 1 Beam – column joint

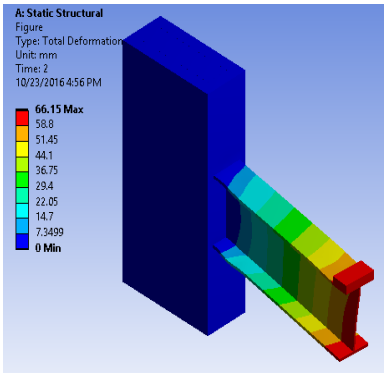

Fig 2 strain of beam column joint

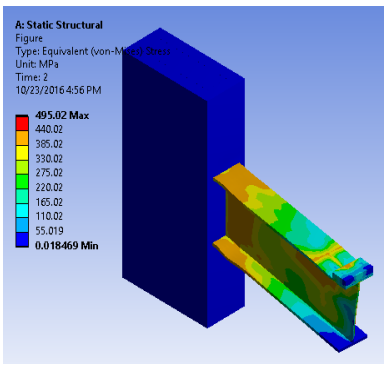

Fig 3stress of beam column joint

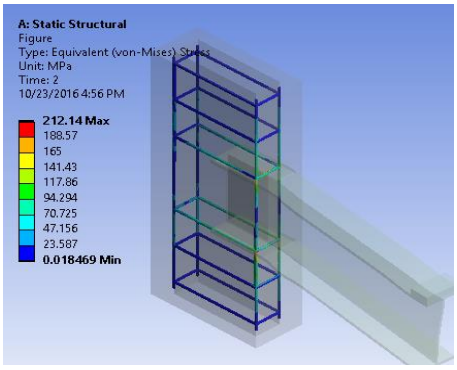

Fig 4 stress in reinforcement

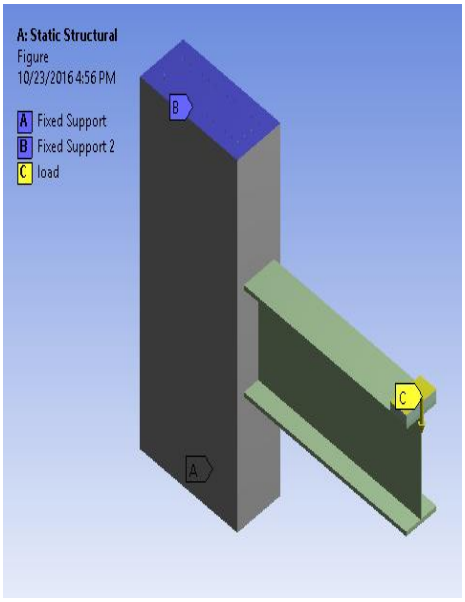

Fig 5 Loading details

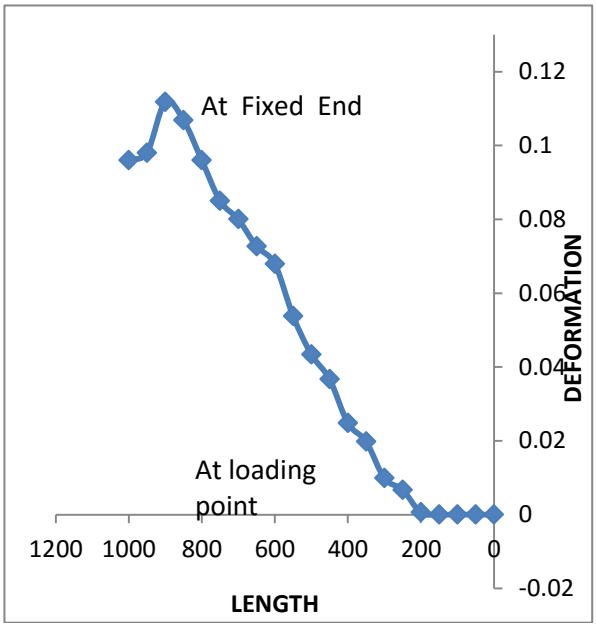

Chart 1 Deformation curve

The analytical work is done and the results are obtained. And the graph is drawn and the deflection maximum is 0.115mm

4. EXPERIMENTAL WORK

The experimental work is done by using load cell in which the load is applied by hydraulic jack. In this the deflection is measured by lvdt and the load is applied by the load cell in which the pressure is given by the hydraulic jack the vibration is given by the shake table attached to the loading frame.

4.1TEST SETUP

In this the column is made fixed at the both ends fixed and the column is made fixed so that it acts fixed end and is stable. During the application of the load on the beam the column get lifted due the load on the beam .In that time the displacement of the beam is measured using lvdt.

Fig 6 testing apparatus

The load is applied in the beam in which one end is fixed and the other end is free so that the load is applied. Since the beam is welded to the reinforcement to the column so that the load is transferred to the reinforcement so that it can with stand higher load results in the lesser damage of the structure and it can resist higher load so that the building will resist the higher load and it will make the building life increased. The load is applied on the beam so that deflection is measured using lvdt.

4.2 APPLICATION OF THE LOAD

The load is applied on the beam and the deflection is calculated

Fig 7 load applied

In this the load is applied and the crack pattern is found.

4.3 RESULT

Fig 8 initial crack

Fig 9 initial crack

Fig10 Final crack

5. CONCLUSION

In this paper the outcome is obtained and is increased about 30% when compared to the pervious paper .Thus the results are obtained and the maximum ultimate load is 266kN. The percentage of error between the analytical and experimental values is 10%.Thus the composite structure increase the load carrying capacity of the structure and prevents the structure from the damage.

6. FURTURE WORK

In this paper the future work can be done by varying the depth of penetration of the beam and also to prevent the damage of the outer end of the beam due to corrosion.

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