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Research paper

Finite Element Analysis of R.C Beams Using Steel Scraps Under Cyclic Loading Using ETABS

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Abstract

In the modern trend peoples are looking for alternate material which is cost effective and high stability in while subject to dynamic loading. Considering this as one of the factor in our proposed we choose steel scrap as reinforced material which has high durability and strength. To find out the withstanding capacity of the dynamic loading model the structure using finite element software and analysis to predict the safety of the structure. From the analysis result we conclude for preventive measure of the structural failure and utilization of extra dampers has find out. To validating the result, analytical work is carried out and implemented by using ETAB software.

Keywords: *Finite Element Analysis, RC Beams, Steel Scraps, Cyclic Loading, ETABS*

1. Introduction

Hazardous layout and detailing within the joint place jeopardize the whole shape, even supposing other structural participants conform to the design requirements. When you consider that past three decades, substantial studies has been achieved on analyzing the conduct of joints beneath seismic situations thru experimental and analytical research. Various global codes of practices were undergoing periodic revisions to incorporate the studies findings into practice. In RC homes, quantities of columns which might be commonplace to beams at their intersections are referred to as beam-column joints. In view that their constituent materials have limited strengths, the joints have constrained pressure wearing capability.

While forces larger than those are carried out in the course of earthquakes, joints are severely broken. Repairing broken joints is tough, and so the harm should be avoided. As a result, beam-column joints should be designed to face up to earthquake outcomes. Underneath earthquake shaking, the beams adjoining a joint are subjected to moments inside the equal (clockwise or counterclockwise).

2. Methodology

Fig.1 shows the methodology of this study.

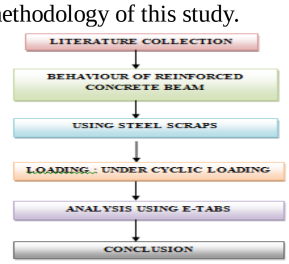

Fig.1: Methodology

Our experiment becomes performed to study the behavior of the SRC beams with various starting shapes underneath blended bending and shear at the region of the outlet. 13 specimens have been designed and fabricated. All of the specimens consisted of the equal amount and association of reinforcement and structural steel form. Specimens were properly instrumented to acquire the worldwide and detailed deformation in the course of the checking out.

3. Behaviour of Reinforced Concrete Beam

Beam-column joints in a strengthened concrete moment resisting body are important zones for transfer of loads efficaciously among the connecting elements (i.e. beams and columns) in the shape. Within the analysis of bolstered concrete moment resisting frames, the joints are generally assumed as inflexible hazardous design and detailing inside the joint region jeopardize the entire structure, although different structural individuals comply with the design requirements. On account that beyond three decades, massive research has been done on reading the conduct of joints under seismic conditions thru experimental and analytical studies. Diverse worldwide codes of practices have been present process periodic revisions to incorporate the studies findings into exercise. In RC buildings, portions of columns which might be commonplace to beams at their intersections are called beam-column joints. Considering that their constituent materials have limited strengths, the joints have restricted pressure wearing capacity.

4. Steel Scrap Reinforced Concrete (SSRC)

Steel scrap reinforced concrete (SSRC) defined as composite substances made with OPC, aggregates and strengthened with steel scrap randomly dispensed fibers or discrete discontinuous fibers. In SFRC, metallic fibers balance the forces with the aid of

transmitting tensile forces to the steel fibers which run alongside the cracks, as the result flexural durability and flexural energy increases to high-quality amount. SFRC used extensively in types of concrete shape i.e. reinforced concrete structure using metallic bars and non-bolstered structure.
Metal wire is produced via a sequence of hot and bloodless running methods. Round steel fibers are produced by slicing or reducing the cord, usually having diameters within the range of 0.01 to 0.03 inch.6 flat sheet fibers having regular pass sections within the variety 0.0060 to 0.016 inch7 in thickness and 0.0098 to 0.5 inch8 in width are produced through shearing sheets. fibers have also been made out of hot melt extract. long individual fibers, if no longer brought well by using sifting via a display, have given problem inside the past with the aid of clustering collectively, regularly making uniform distribution inside the matrix difficult.

5. Cyclic Loading

A number of the beam-column joint, outdoors joint behaves greater seriously than the interior joint throughout the occurrence of earthquake. Many researchers have executed studies on joints using exclusive strategies, substances and brought many repairing strategies to decorate the resisting capacity of joints. From literature, it's been observed that polypropylene and metal scraps have superior many proper houses of concrete. Hence, those fibrous substances may be added in these joints to decorate joint assets. Polypropylene is a plastic polymer and metallic scraps are crafted from top first-rate tough-drawn metal wire to make sure excessive tensile electricity and close tolerances.
The recorded records were plotted to draw hysteresis loop. The result had been compared in various plot like envelope curve, stiffness, strength burn up and ductility. It was observed that performance of fibre specimens in time period of all of the above parameters have been higher than the obvious specimen.

6. ETABS Software

Beam column joint is an essential element of a strengthened concrete second resisting body and should be designed and targeted properly, in particular whilst the body is subjected to earthquake loading. Failure of beam column joints in the course of earthquake is governed by means of bond and shear failure mechanism which might be brittle in nature. consequently, a cutting-edge global code offers excessive importance to provide ok anchorage to longitudinal bars and confinement of center concrete in resisting shear a beam column joint has been modeled to a scale of 1/5 throe the prototype and the model has been subjected to cyclic loading to discover its behavior in the course of earthquake. Nonlinear analysis is accomplished in ETABS software.

6.1. ETABS Ultimate

Includes all the capabilities of ETABS 2016 ,nonlinear with extra features inclusive of concrete slab layout with publish-tensioning, nonlinear layered shell elements, dynamic analysis making use of nonlinear body and wall hinges, linear and nonlinear direct integration time records analysis, buckling, and the modeling of creep and shrinkage behavior.

7. Analysis Results

Fig.2 shows the modelling of ETABS.

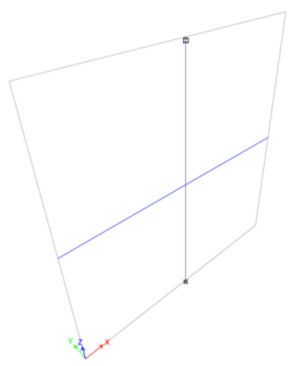

Fig.2: Modelling of ETABS

7.1. Structure Data

This area provides model geometry information, including items such as story levels, point coordinates, and element connectivity.

7.1.1. Storey Data

Table 1 show the storey data.

Table 1: Storey Data

Name	Height mm	Elevation mm	Master Story	Similar To	Splice Story
Story2	500	1000	Yes	None	No
Story1	500	500	No	Story2	No
Base	0	0	No	None	No

7.2. Loads

This area provides loading information as applied to the model.

7.2.1. Load Patterns

Table 2 shows the load patterns.

Table 2: Load Patterns

Name	Type	Self Weight Multiplier
Dead	Dead	1
Live	Live	0

7.2.2. Load Cases

Table 3 shows the Load Cases – Summary.

Table 3: Load Cases – Summary

Name	Type
Dead	Linear Static
Live	Linear Static

7.3. Analysis Results

This area provides the analysis results.

7.3.1. Structure Results

Table 4 shows the base reactions.

Table 4: Base reactions

Load Case/ Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m	Y m	Z m
Dead	0	0	110.6301	0	-65.315	0	0	0	0
Live	0	0	0	0	0	0	0	0	0

7.3.2. Storey Results

Table 5 shows the storey drifts

Table 5: Story drifts

Story	Load Case/Combo	Label	Item	Drift	X m	Y m	Z m
Story2	Dead	2	Max Drift X	0	0.5	0	1
Story2	Dead	2	Max Drift Y	0	0.5	0	1
Story2	Live	2	Max Drift X	0	0.5	0	1
Story2	Live	2	Max Drift Y	0	0.5	0	1
Story1	Dead	2	Max Drift X	0	0.5	0	0.5
Story1	Dead	2	Max Drift Y	0	0.5	0	0.5
Story1	Live	2	Max Drift X	0	0.5	0	0.5
Story1	Live	2	Max Drift Y	0	0.5	0	0.5

Table 6 shows the storey forces.

Table 6: Storey forces

Story	Load Case/Combo	Location	P kN	VX kN	VY kN	T kN-m	MX kN-m	MY kN-m
Story2	Dead	Top	-55.315	14.0872	0	0	0	25.6139
Story2	Dead	Bottom	-25.415	14.0872	0	0	0	17.7075
Story2	Live	Top	0	0	0	0	0	0
Story2	Live	Bottom	0	0	0	0	0	0
Story1	Dead	Top	25.415	14.0872	0	0	0	-17.7075
Story1	Dead	Bottom	55.315	14.0872	0	0	0	-25.6139
Story1	Live	Top	0	0	0	0	0	0
Story1	Live	Bottom	0	0	0	0	0	0

7.4. Model Results

Table 7 shows the modal periods and frequencies.

Table 7: Modal periods and frequencies

Case	Mode	Period sec	Frequency cyc/sec	Circular Frequency rad/sec	Eigenvalue rad^2/sec^2
Modal	1	0.104	9.639	60.5664	3668.2843
Modal	2	0.057	17.519	110.0732	12116.1194
Modal	3	0.045	22.165	139.268	19395.5738
Modal	4	0.03	33.068	207.7714	43168.9374
Modal	5	0.007	148.295	931.7649	868185.8942
Modal	6	0.006	179.796	1129.689	1276197

Table 8 shows the Modal Participating Mass Ratios (Part 1 of 2)

Table 8: Modal participating mass ratios (part 1 of 2)

Case	Mode	Period sec	UX	UY	UZ	Sum UX	Sum UY	Sum UZ
Modal	1	0.104	0	0	0	0	0	0
Modal	2	0.057	0	0.7611	0	0	0.7611	0
Modal	3	0.045	0.9999	0	0	0.9999	0.7611	0
Modal	4	0.03	0	0.2389	0	0.9999	1	0
Modal	5	0.007	0	0	0	0.9999	1	0
Modal	6	0.006	0.0001	0	0	1	1	0

Table 9 shows the modal participating mass ratios (part 2 of 2)

Table 9: Modal Participating Mass Ratios (Part 2 of 2)

Case	Mode	RX	RY	RZ	Sum RX	Sum RY	Sum RZ
Modal	1	0	0	1	0	0	1
Modal	2	0.7942	0	0	0.7942	0	1
Modal	3	0	0.9991	0	0.7942	0.9991	1
Modal	4	0.2058	0	0	1	0.9991	1
Modal	5	0	0	0	1	0.9991	1
Modal	6	0	0.0009	0	1	1	1

Table 10 shows the modal load participation ratios

Table 10: Modal load participation ratios

Case	Item Type	Item	Static %	Dynamic %
Modal	Acceleration	UX	100	100
Modal	Acceleration	UY	100	100
Modal	Acceleration	UZ	0	0

Table 11 shows the Modal Direction Factors

Table 11: Modal direction factors

Case	Mode	Period sec	UX	UY	UZ	RZ
Modal	1	0.104	0	0	0	1
Modal	2	0.057	0	1	0	0
Modal	3	0.045	1	0	0	0
Modal	4	0.03	0	1	0	0
Modal	5	0.007	0	0	0	0
Modal	6	0.006	1	0	0	0

Table 12 shows the Modal Direction Factors

Table 12: Modal direction factors

Case	Mode	Period sec	UX	UY	UZ	RZ
Modal	1	0.104	0	0	0	1
Modal	2	0.057	0	1	0	0
Modal	3	0.045	1	0	0	0
Modal	4	0.03	0	1	0	0
Modal	5	0.007	0	0	0	0
Modal	6	0.006	1	0	0	0

Fig.3 shows the material properties assigning window in ETABS

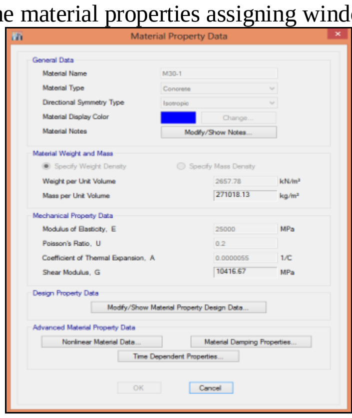

Fig.3: Material properties assigning window in ETABS

Fig.4 shows the deformed shape.

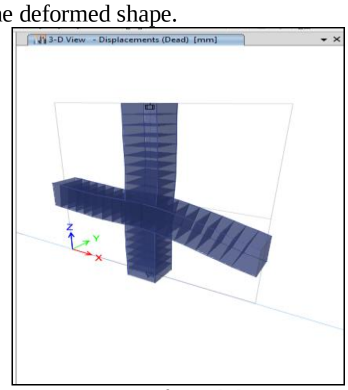

Fig.4: Deformed shape

Fig.5 shows the load applying window.

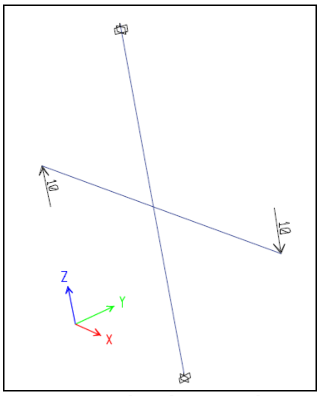

Fig.5: Load applying window

Fig.6 shows the shear force diagram.

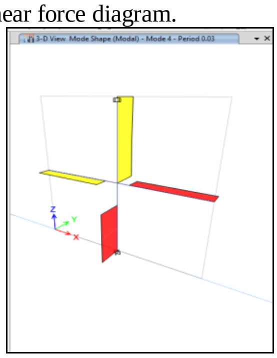

Fig.6: Shear force diagram

8. Conclusion

From the project works assessment on the study of the workability and mechanical strength properties of the concrete reinforced with industrialized waste fibers or the recycled fibers which subject to dynamic loading has pointed out the best result while analyzing with ETABS software. Here we use the wastage of steel scrap fiber reinforced concrete (SSRC) and their mechanical properties are found to be increase due to the addition of steel scrap in concrete. The cost - effectiveness also less in our project.

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