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The Effect Of Using Steel Fibers In Concrete Of CFT And SRC Composite Columns And Their Effect On Reducing Manufacturing Costs

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Abstract

The use of composite columns is increasing due to the combined cooperation of concrete and steel in many structural systems around the world. Composite columns not only have many advantages in construction but also significantly improve the mechanical properties of structural members compared to reinforced concrete and steel members alone. These include increased enclosure, increased shear strength and thus increase member efficiency. Also, the use of composite columns reduces the final cost of construction of the structure. In Article B, two specific types of CFT and SRC columns with steel fibers are discussed and with the help of ABAQUS finite element software, these columns are modeled and subjected to cyclic loading and their energy absorption and hysteresis diagrams are compared with each other and their advantages and disadvantages. It is specified and finally how these structures help to reduce the final cost is examined.

1. Introduction

The use of composite columns is increasing due to the proper cooperation of concrete and steel in many structural systems around the world. Composite columns not only have many advantages in construction but also significantly improve the mechanical properties of structural members compared to reinforced concrete and steel members alone. These include increased enclosure, increased shear strength and thus increased member efficiency. Composite columns are made with different sections, so they have structural diversity. Composite columns are divided into the following four groups in terms of location of concrete, steel and FRP3

1. Steel pipes filled with CFST concrete
2. FRP pipes filled with concrete with or without CFFT internal reinforcement
3.steel sections buried in concrete or reinforced concrete steel sections SRC
4. DSTC double layer steel columns

Chen and Lin [6] in their analytical research that uses different steel cross-section shapes and designs
Reinforcement reinforcement networking was performed, investigating the confinement factors for high-confined concrete parts and partially confined concrete, and also Mirza and Scrabek, using their research, showed that these parabolic areas can be simplified and A rectangular shape was observed in which case the concrete with high confinement is located along the life of the steel section up to half the width of the steel section wings and the concrete continues with a partial confinement of half the width of the steel section wings along the section life to the center line of longitudinal reinforcements. Unenclosed concrete remains as external parts.

Modeling:

Column modeling individually

In this research modeling and research, the Standard/Explicit Model module of ABAQUS 6.14.2 finite element software has been used. Load-displacement diagrams at the site of load application have been studied and analyzed.

2. Behavioral characteristics of models

The most important properties of steel are high ductility and durability, high yield strength and tensile strength and good thermal conductivity. In addition, the properties of stainless steels have anti-corrosion properties. For steels, there are several ways to measure properties. For example, tensile strength, flexibility and stiffness can be measured by tensile strength tests. Hardness is measured by impact testing and hardness is measured by measuring the penetration resistance of the hard sink. Tensile test is a test to determine the reaction of steel to the application of force. The answers are expressed by the relationship between stress and strain. By measuring the ratio of stress to strain, the elasticity of the material can also be measured. The ratio of stress to strain in the elastic range of metals is called the Young's modulus. The elastic modulus of steels is in the range of 190-210 gigapascals, which is about three times the elastic modulus of aluminum. In modeling, three types of steel are used for reinforcements, braces and dampers with the specifications mentioned in the following tables.

Table 1. Fiber concrete plastic damage specifications

Dilation Angel	Eccentricity	$f_{bo}\backslash f_{co}$	K	Viscosity Parameter
30.5	0.1	1.16	0.666	0.001

Table 2. Behavioral curves of concrete in the nonlinear compressive zone

Stress (MPa)	*Stress (MPa)*	Inelastic strain	Stress (MPa)	Inelastic strain	Stress (MPa)
6.293636	12.342636	0.003940	9.147820	0.006152	5.994836
7.347664	12.185450	0.004051	9.009165	0.026190	5.836360
8.301422	12.026420	0.004088	8.849530	0.006373	5.678930
9.087816	11.866984	0.004272	8.692798	0.006484	5.518661
9.821314	11.707856	0.024382	8.534394	0.006595	5.359877
10.457989	11.549380	0.004493	8.375261	0.006705	5.200445
10.999736	11.391050	0.004604	8.218075	0.006816	5.041790
11.443924	11.230355	0.004714	8.059045	0.006927	4.882155
11.826071	11.072160	0.004825	7.899609	0.007037	4.725423
12.138594	10.913505	0.004935	7.740481	0.007075	4.567019
12.398636	10.753870	0.005046	7.582005	0.007258	4.407886
12.596942	10.597138	0.005157	7.424575	0.007369	4.250700
12.746583	10.438734	0.005267	7.264306	0.007480	4.091670
12.853922	10.279601	0.005378	7.105522	0.007590	3.932234
12.923601	10.122415	0.005489	6.946749	0.007628	3.773106
12.964048	9.963385	0.005599	6.780895	0.007811	3.614630
12.976540	9.803949	0.005710	6.627200	0.007922	3.457200
12.816905	9.644821	0.005820	6.472430	0.008033	3.296931
12.660173	9.486345	0.005931	6.313400		
12.501769	9.326015	0.006042	6.153964		

3. CFT column modeling

The element used in concrete modeling in Abaqus software is the next three elements and 8 homogeneous C3D8R nodes. This element does not have special conditions and is not designed for concrete, but is used in all models whose material behavior is complex. Each of the desired models includes 2 parts.
Steel can 50 * 4 shelh/extrusion Concrete with dimensions of 496 * 496 of shel/extrusion type

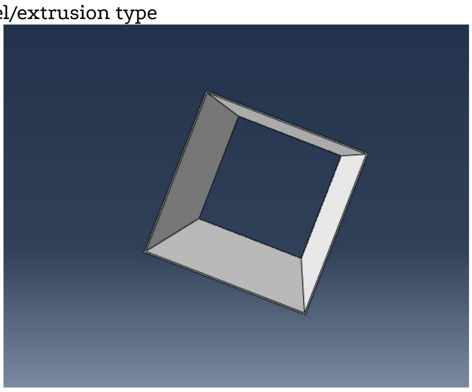

Figure 1. Cross section

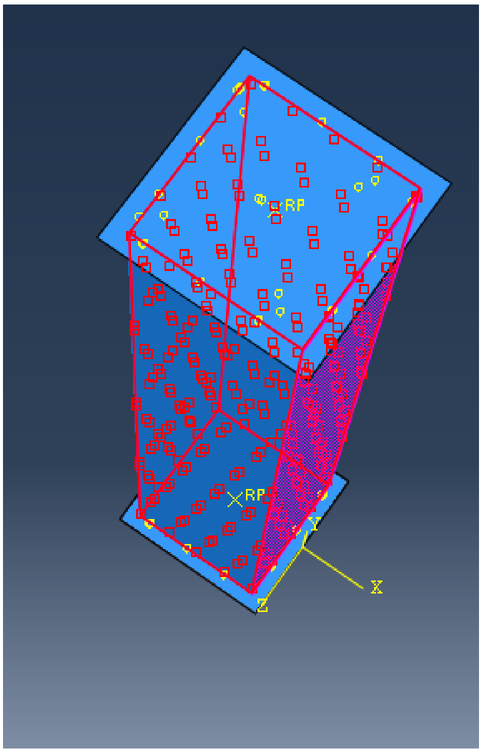

Figure 2. Boundary condition

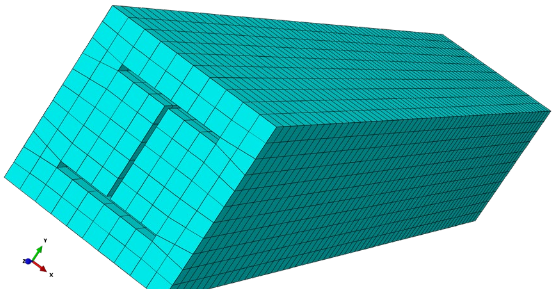

Figure 3. Src columns

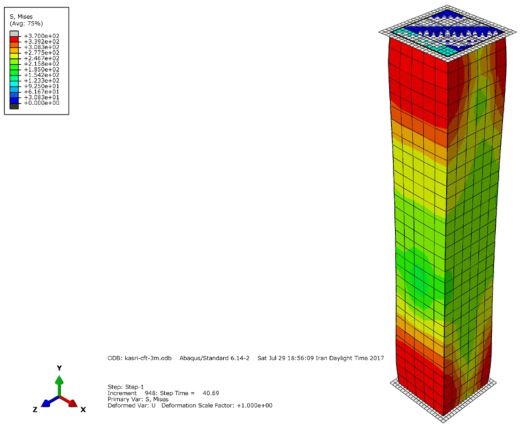

Figure 4. Von mises cft

As can be seen, von Mises stresses, which are one of the rupture criteria, are shown in these figures for the CFT column. The red dots indicate the points with the most stress. And the foot of the columns has more stress than the other points.

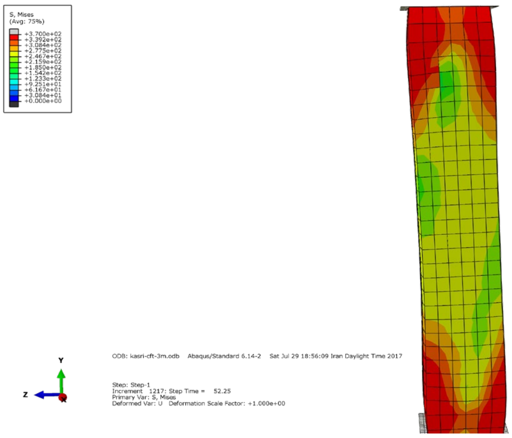

Figure 5. Von mises SRC

3.1. Advantages of steel-concrete composite column

3.1.1. The optimal location of the steel section

In CFT columns, due to the placement of the steel wall around the cross section just where the flexural and tensile stresses are most effective, it causes a significant increase in the stiffness and strength of the cross section. In SRC columns, their location is a factor in the rapid installation of the column.

3.1.2. High flexural strength at beam-to-column connection in SRC

Because the column and beam in this type of composite column are separated by reinforced concrete, the rotational stiffness increases due to the load transfer between the beam and concrete at the connection spring. Also, the tolerable flexural strength of the joint has a higher capacity than the original (unreinforced) steel joint.

3.1.3. Delay in local buckling

In composite sections, the steel column (compact, non-compressed) becomes more stiff due to contact with the hardened concrete, and buckling is delayed or does not occur. Therefore, buckling will be delayed as long as the contact between concrete and steel is reduced, such as cracking of concrete or separation of concrete and steel. However, in CFT columns, the concrete will remain in contact with the concrete wall as the concrete cracks to prevent over-expansion of the concrete wall. Therefore, the concrete core transmits lateral buckling modes to the outside, so thinner steel sections are used to ensure that the yield strength reaches the wall before buckling occurs.

3.1.4. High confinement in concrete

Steel sections increase the enclosure in the concrete core and consequently increase the strength and ductility in the concrete. Due to the cross-sectional shape and the created ring tension or belt tension, the circular sections of the CFT (CCFT) columns form more confinement than the rectangular sections of the CFT (RCFT) and SRC sections.

3.1.5. Save on construction costs

In CFT, the steel tube plays the role of a durable formwork for the concrete, which reduces human and material costs. CFT construction speed is much faster, especially in medium to high-rise buildings. The cost of the members themselves is much lower than that of a steel structure, with the cost of CFT almost equal to the cost of reinforced concrete members. Also, compared to steel flexural frame, in non-braced CFT frame, the saving of steel increases with increasing classes. Relatively simple connection details of the beam to the can column can be used. This reduces costs and simplifies design.

With high-strength concrete, CFTs are stronger per square foot than conventional reinforced concrete columns. Where high strength is desired, a smaller column size can be designed to increase the useful space of the building. A smaller, lighter skeleton rests on the foundation. Which will again reduce costs.

3.1.6. Fire Proof

In sections buried in concrete, concrete acts as a steel cross-section protector against fire.

4. Conclusion

It was observed that by using steel and concrete composite sections and also using fibers in them, the bearing capacity of the columns can be increased and the amount of damage can be reduced. Also, the use of this type of sections has reduced costs which can improve construction management.

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