EXPERIMENTAL INVESTIGATION OF REINFORCED CONCRETE BEAM COLUMN JOINT USING BASALT FIBERS

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INTRODUCTION:

1.1 GENERAL

A beam column joint is the blend of concrete and steel that gives strength and rigidity to the member. This particular project deals with the analytical and experimental investigation of a beam column joint. In order to enhance the strength and ductility strength of concrete and to reduce the damage of structures, basalt fibre is added to the concrete. In this paper, the comparisons will be made between the conventional beam column joint and beam column joint with basalt fibre which results in high strength and to resist the joint failure when cyclic load is applied to the specimens. The specimen's cross section 200×150 mm with column height 1000mm. In this experimental analysis, the strength is augmented so that the performance can considering strength, stiffness and ductility factor. The addition of basalt fiber to concrete prevents the brittle failure of the joint. Volume fraction of fibres used in this study varies from 0 to 1.25%. The results were compared with various plots like hysteresis curve, stiffness and ductility. The observed

Performances of fibre specimens in term of all the above parameters are better than the conventional beam column joint.

1.2 HIGH PERFORMANCE CONCRETE

High performance concrete is a concrete mixture that possesses high durability and high strength when compared to conventional concrete. This concrete contains one or more cement-based materials such as fly ash, silica fume or ground granulated blast furnace slag and typically a super plasticizer. The term 'high performance' is rather posturing because the essential feature of this concrete is that it's ingredients and possessions for the expected use of the structures such as high strength and low permeability. Hence, the high performance concrete is not an extraordinary type of concrete. It involves similar material as that of conventional cement concrete. The use of some mineral and chemical admixtures like silica fumes and super plasticizer augments the strength, durability and workability intrinsic worth to very high extent. High performances concrete works out to be cost-effective, even though its initial cost is elevated than that of conventional concrete as the utilization of high performances concrete in construction improves the service life of the structures and the structures suffers less damage which would reduce overall costs.

1.3 BASALT FIBRE

Basalt fibre is a component made from the extreme-fine fibres of basalt, which is composed of the minerals plagioclase and olivine. It is similar to fiberglass, which consists of improved physical mechanical properties than fibre-glass, but being cheaper than carbon fibre. Basalt fibre is prepared from a solitary material, crushed basalt, from a carefully chosen quarry source. Basalt of high acidity (over 46% silica content) and low iron content is considered desirable for fibre production. Dissimilar to other materials, such as glass fibre, essentially no materials are added. The basalt is simply washed and then melted. The molten rock is then extruded through small nozzles to produce continuous filaments of basalt fiber. The fibers typically have a filament diameter of between 9 and 13 µm which is far enough above the respiratory limit of 5 µm to make basalt fibre a suitable replacement for asbestos.

Fig. 1.1 Basalt Fibres

1.4 BEAM COLUMN JOINT TYPES

1.4.1 BEAM COLUMN JOINTS

The functional requirement of a joint, which is the zone of intersection of beams and column, is the enable the adjoining members to developed and sustain their ultimate capacity. The demand on this finite size element is always severe especially under seismic loading. The joints should have adequate strength and stiffness to resist the internal forces induced by the framing members.

1.4.1.1 Interior joint

When four beams frame into the vertical faces of a column, the joint is called as interior joints.

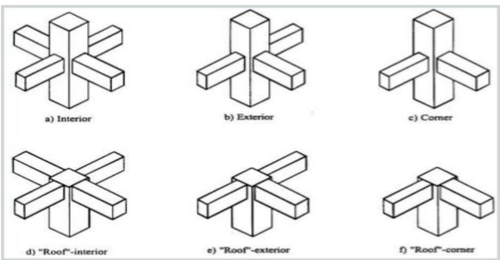

Fig. 1.2 Types of Joints

1.4.2.2 Exterior joints

When one beam frames into the vertical face of a column and two more beams frame into the column in the perpendicular direction it is called an exterior joint.

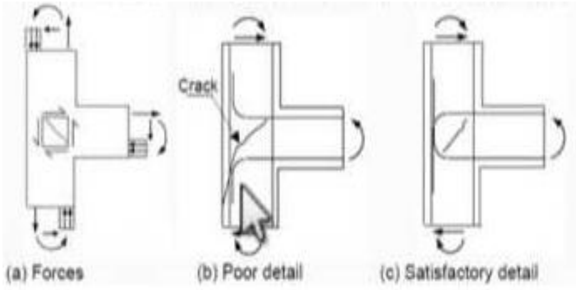

Fig. 1.3 Exterior Joint

1.4.2.3 Corner joint

A corner joint is one in which beams frame into two adjacent vertical faces of a column, then the joints is called as a corner joint.

The severity of forces and demands on the performance of these joints calls for greater understanding of their seismic behaviour. These forces develop complex mechanism involving bond and shear within the joint.

The pattern of forces acting on a joint depends upon the configuration of the joint and the type of loads acting on it. The effects of loads on the three types of joints are discussed with references to stresses and the associated crack pattern developed in them. The forces on an interior joint subjected to gravity loading can be depicted. The tension and compression from the beam ends and axial loads from the columns can be transmitted directly through the joints. In the case of lateral loading, the equilibrating forces from beam and columns develop diagonal tensile and compressive stresses within the joint.

1.5 OBJECTIVE OF THE PROJECT

- To optimise the mix proportion with basalt fibre by casting cubes and cylinder.
- To design the beam column joint and to determine the durability properties of basalt fiber.
- To compare the behavior of conventional beam column joint and basalt fiber reinforced beam column joint.

1.6 NEED OF THE PROJECT

- Beam column joint forms the critical part in the member. It should be properly analyzed and designed.
- Fiber in concrete will arrest the formation of initial cracks.
- By adding basalt fiber strength will increase.

2. METHODOLOGIES

2.1 METHODOLOGY FLOW CHART

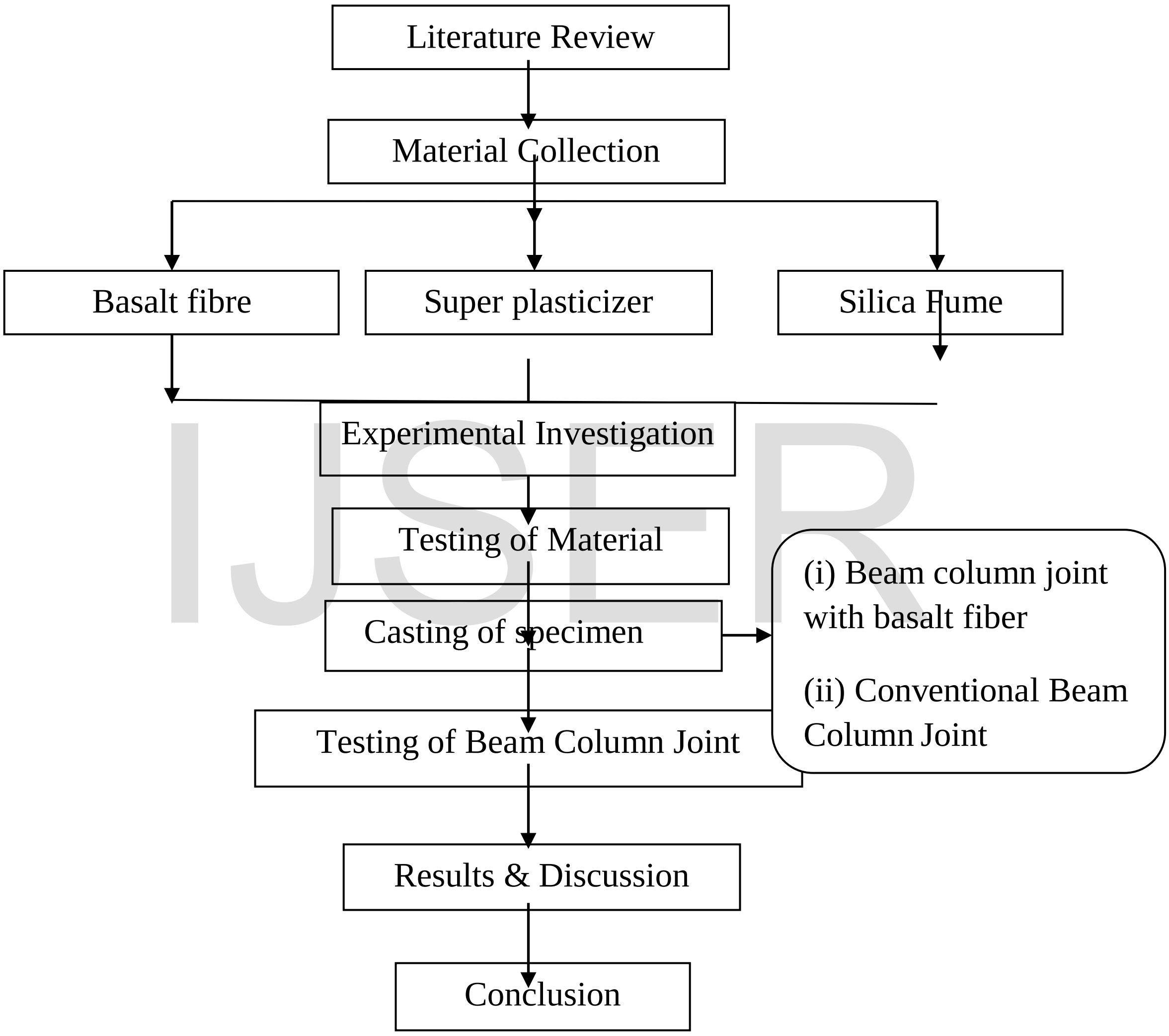

Fig. 2.1 Methodology Flow Chart

3. MATERIAL TESTING

3.1 GENERAL

Here, the details of materials and details of the test specimens are described. Further, this chapter gives an outline of the casting and testing of the casted samples.

3.2 MATERIALS

Following materials were used for the study is described in the following sections.

i. Ordinary Portland Cement (OPC)

ii. Aggregates

iii. Water

3.2.1 Cement

Cement is a binder, a substance used in construction that sets and hardens and can bind other materials together. The most important types of cement are used as a component in the production of mortar in masonry, and of concrete, which is a combination of cement and an aggregate to form a strong building material. Portland cement is the most common type of cement in general, used as a basic ingredient of concrete, mortar, stucco, and most non-speciality grout.

Table 3.1 Properties of OPC

Test	Result	As Per IS Standards
Consistency	32%	25%-30%
Initial setting time	42 min	Not less than 30 min.
Final setting time	275 min	Not more than 600 min
Specific gravity	3.15	2.5 – 3.1
Fineness	2.9	< 10

Fig.3.1 Cement initial and final setting time test

3.2.2 Fine Aggregate

Fine aggregate is the inert or chemically inactive material, most of which passes through a 4.75 mm and contains not more than 5 per cent coarser material. They may be classified as follows:

i. Natural sand: Fine aggregate resulting from the natural disintegration of rocks and which has been deposited by streams or glacial agencies.

ii. Crushed stone sand: Fine aggregate produced by crushing of hard stone.

iii. Crushed gravel sand: Fine aggregate produced by crushing of natural gravel.

The fine aggregates serve the purpose of filling all the open spaces in between the coarse particles. Thus, it reduces the porosity of the final mass and considerably increases its strength. However, at places, where natural sand is not available economically, finely crushed stone may be used as a fine aggregate.

Fig.3.2 Fineness modulus test for fine and coarse aggregate

Fig.3.3 Specific gravity test for fine aggregate

Table.3.2 Properties of Fine Aggregate

Test	Value	As Per IS Standards
Fineness Modulus	2.90	2.2-3.2
Specific Gravity	2.65	2.6-2.8

3.2.3 Coarse Aggregate

Construction aggregate, or simply "aggregate", is a broad sort of coarse particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geo-synthetic aggregates. Aggregates are the most mined material in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Maximum coarse aggregate size used is 20 mm and the minimum coarse aggregate size used is 12 mm.

Fig.3.4 Specific gravity test for coarse aggregate

Table.3.3 Properties of Coarse Aggregate

Test	Value	As Per IS Standards
Specific Gravity	2.75	2.6-2.85
Fineness modulus	7.5	6.5-8

4. MIX DESIGN

Grade Designation	-	M_{60}
Type of cement	-	OPC 53 Grade
Maximum nominal size of aggregate	-	20 mm
Workability	-	60mm
Exposure condition	-	Severe
Specific gravity of cement	-	3.15
Specific gravity of fine aggregate	-	2.65
Specific gravity of coarse aggregate	-	2.75
Water absorption of fine aggregate	-	0.5%
Water absorption of coarse aggregate	-	1.0%

Step 1 – Target mean Strength for Mix Proportion

$f'_{ck} = f_{ck} + 1.65\ s$

$s = 5.5$

$f'_{ck} = 60 + 1.65 \times 5.5$

$f'_{ck} = 69.07 N/mm^2$

Step 2 – Selection of Water – Cement Ratios

Maximum water – cement ratio = 0.50

Thus, water – cement ratio = 0.45

Step 3 – Selection of Water Content

Maximum Water content = 225 litres (For 100mm Slump)

Step 4 – Calculation of Cement content

Water – Cement ratio = 0.45

Cement content $= \frac{225}{0.45} = 500\ kg/m^3$

Thus, Let us take cement content = 500 kg/m^3

Step 5 – Proportion of volume of Coarse Aggregate and Fine Aggregate

Volume of Coarse Aggregate = 0.62×1600 = 1100 kg/m^3 . Estimated of density of fresh concrete for 10 mm maximum size of aggregate and for non air entrained concrete = 2285 kg/m^3

Weight of Fine Aggregate = 2285 - (225+500+992) =768 kg/m^3

Step 6 – Mix Calculation

a. Volume of Concrete = 1m^3
b. Volume of Cement = $\frac{500}{3.15 \times 1000}$ = 0.158 m^3
c. Volume of Water = $\frac{225}{1000}$ = 0.225 m^3
d. Mass of Coarse Aggregate = 992/2.75 ×1000 = 0.360 m^3
e. Air = 0.02
f. Mass of Fine Aggregate = 0.780 m^3

Step 7 – Mix Proportion

i. Cement = 500 kg/m^3
ii. Water = 225 litres
iii. Fine Aggregate = 780kg/m^3
iv. Coarse Aggregate = 1100kg/m^3
v. Water–cement ratio = 0.45

Step 8 – Mix Ratio

Table 3.4 Concrete Mix Proportion (M60)

Cement	Fine Aggregate	Coarse Aggregate
1	1.56	2.2

5. CONCLUSION

- To optimize the mix proportion of conventional concrete by casting cubes and cylinder.
- To optimise the mix proportion of basalt fibre by casting cubes and cylinder.
- To design the conventional beam column joint and to determine the strength and durability.
- To design the beam column joint and to determine the durability properties of basalt fiber.
- To compare the behavior of conventional beam column joint and basalt fiber reinforced beam column joint.

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