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Concrete Beam With and Without Openings Using Sisal Fiber

[1]S.Sam Sundar , [2]Mrs.S.Mercy , [3]S.Shiva Priya
[1]Final Year Student of Civil Engineering
[2]Assistant Professor of Civil Department
[3]Final Year student of Civil Engineering
Francis Xavier Engineering College, Vannarpettai

Abstract:

The purpose of this experimental study is to know the behaviour of beam when openings such as pipe holes are made at the compression zone of the RC beam. The pipe hole are made as a passage for electrical wires, water pipeline etc., This can be generally adopted for multi-storey buildings. Usually while providing the openings in the beams, the distance at which the openings to be provided are not considered, at that point that failure loads increases. In this study, the required size and position of openings are considered to reduce the failure of the beam. This study deals with the behaviour and ultimate strength of sisal fiber reinforced concrete (SFRC) deep beams with and without openings in web subjected to two- point loading, four concrete deep beams of dimensions 1500mm×300mm×150mm thickness were tested to destruction by applying gradually increased load. Simply supported conditions were maintained for all the concrete deep beams. The percentage of sisal fiber was varied from 0 to 2.The influence of fiber content in the concrete deep beams has been studied by measuring the deflection of the deep beams and by observing the crack patterns.

Keywords — **Sisal Fibre, Strength, Openings, Compression zone, Deep beam.**

INTRODUCTION

In the construction of modern buildings, a network of pipes and ducts is necessary to accommodate essential services like water supply, sewage, air-conditioning, electricity, telephone, and computer network. Usually, these pipes and ducts are placed underneath the beam soffit and for aesthetic reasons are covered by a suspended ceiling, thus creating a dead space. Passing these ducts through transverse openings in the beams leads to a reduction in the dead space and results in a more compact design. For small buildings, the savings thus achieved may not be significant, but for multistorey buildings, any saving in storey height multiplied by the number of stories can represent a substantial saving in total height, length of air-conditioning and electrical ducts, plumbing risers, walls and partition surfaces, and overall load on the foundation. It is obvious that inclusion of openings in beams alters the simple beam behaviour to a more complex one. Due to abrupt changes in the sectional configuration, opening corners are subject to high stress concentration that may lead to cracking unacceptable from aesthetic and durability viewpoints. The reduced stiffness of the beam may also give rise to excessive deflection under service load and result in a considerable redistribution of internal forces and moments in a continuous beam.Circular and rectangular openings are the most common ones in practice. Circular openings are preferable. The size of the opening plays a major role in the strength of the building. So the size and position of the opening in the beam is considered in this study. To increase the strength of the beam fibres are added. As artificial fibres are costly and due to its scarcity, nowadays the use of natural fibres are increased. Natural fibres are available locally and are plentiful. The advantages of natural fibres are strength, competitive cost and environmental compatibility. Because its high content of ligin, sisal is much more advantageous than natural fibres. So sisal fibre is used to increase strength of the beam in this study.

LITERATURE SURVEY

From the study of literatures, Openings are provided in the beams for the passage of utility lines, pipes etc.. But it is cleared that by making openings the strength of the beam is reduced. To increase the beam strength various fibre such as glass fibre, steel fibre are added and the position and diameter of opening in the beam is varied. Nowadays artificial fibres are costly and due to its low availability we go for natural fibres. Sisal fibre is naturally available fibre and it is cost effective, it is added in varying proportions to improve the strength of the concrete. The strength of the beam is determined by compression, flexural and spilt tensile test. By adding sisal fibre it increases the flexural strength, impact strength and toughness to some extent. As sisal fibre reduces workability of concrete super plasticizers are added to increase the workability of concrete.

OBJECTIVE OF THIS STUDY

The main objective of this work is to study the following properties.

- Mechanical properties such as compressive strength, split tensile strength and flexural strength of reinforced concrete beams by introducing sisal fibre.
- To study the structural behaviour of beams in flexure when the holes are at different position.

MATERIALS USED

A. Cement

In this project, OPC 53 grade cement was used. The properties of cement is shown in table 1

Table 1 Properties of cement

S.No	Properties	Result
1.	Specific Gravity	3.14
2.	Fineness Modulus	2.998
3.	Standard Consistency	31.27
4.	Initial Setting Time	36 minutes
5.	Final Setting TIme	390 minutes

B. Fine Aggregate

Aggregate which is passed through 4.75 mm IS sieve and retained on 75 micron IS sieve is termed as fine aggregate. It fills the voids in coarse aggregate. Natural river sand conforming IS 383-1970 is used in this project.

C. Coarse Aggregate

Aggregate which passes through 20 mm IS sieve and retained on 4.75 mm IS sieve are known as coarse aggregate. Aggregates should be properly screened and if necessary washed before use. Coarse aggregates containing flat, elongated or flaky pieces should be rejected. The grading of coarse aggregates should be as per specifications of IS 383-1970. In this project, 20 mm size of coarse aggregate is used.

Table 2 Properties of Fine and Coarse Aggregate

S.NO	Properties		Fine Aggregate	Coarse Aggregate
1.	Specific Gravity		2.49	2.75
2.	Fitness Modulus		2.997	7.35
3.	Bulk Density(Kg/m^3)	Loose State	1544	1427
		Compacted State	1704	1707
4.	Water absorption (%)		1	0.5
5.	Moisture Content		NIL	NIL

D. Sisal fibre

The use of sisal, a natural fibre with enhanced mechanical performance, as reinforcement in a cement based matrix has shown to be a promising opportunity. The sisal fibre that have been brought from local markets and used in this study. Sisal fibre were cut into 30 mm length in order to be spread randomly in the concrete by using spreading method. The following are the properties of sisal fibre.

a. Density - 1.33 g/cm^3
b. Fibre diameter - 0.1-0.5 mm
c. Tensile strength - 31-221 N/mm^2
d. Specific gravity - 1.4
e. Elastic modulus - 7.83 GPa

Figure 1 Sisal Fibre

MIX DESIGN

Table 3 Mix Ratio

Ceme	Fine	Coarse	Wate	Super

nt	Aggregate	Aggregate	r	Plasticizer
1	1.515	2.86	0.46	0.2%

RESULT AND DISCUSSION

A .Compressive Strength

From fig 2, it was observed that the compressive strength was increased with the addition of 1.5% of sisal fibre. This was due to the reason that sisal fibres are added randomly, it arrests the micro cracks in the concrete. Then the further addition of fibre shows decrease in strength, this was due to the balling effect of fibre in concrete. Hence 1.5% addition of sisal fibre was considered as optimum.

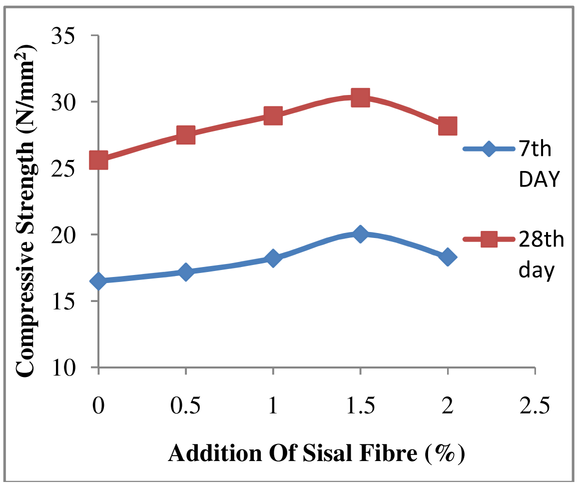

Fig 2 Variation of compressive strength at 7 and 28 days

B. Split Tensile Strength

Figure 3 shows the variation of split tensile strength of concrete at 28 days. The split tensile strength increased up to 1.5% addition of sisal fiber, this was due to the holding effects of the fibre, which prevents the splitting effect of concrete and there was a decrease in strength upon further addition of sisal fibre as adding more fibre results in balling effects. Hence 1.5% addition of sisal fibre to the weight of cement was considered as optimum.

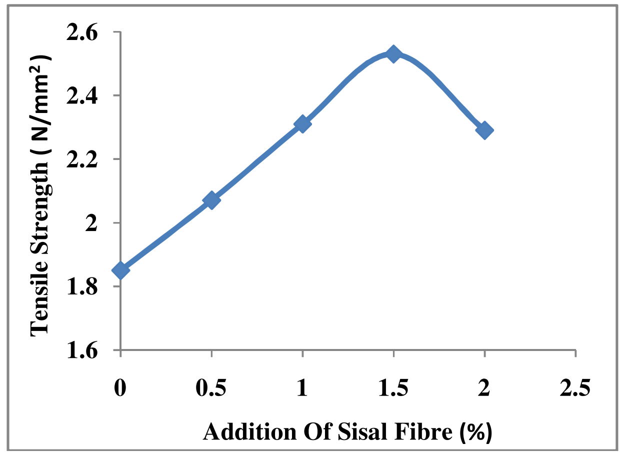

Fig 3 Variation of split tensile strength at 28 days

C. Flexural Strength

From the fig 2 and 3, it was seen that the maximum strength was attained at 1.5% addition of sisal fibre. Therefore, 1.5% addition of sisal fibre is considered as optimum and beam is casted for it. Following specimens are casted and tested.

Table 4 Specimen Details

Type	No of Specimens
Conventional beam	1
1.5% addition of sisal fibre reinforced beam	1
SFRC with opening at L/2	1
SFRC with openings at L/3 & D/2	1

a.Load Carrying Capacity of Beams

Table 5 shows the load carrying capacity of beam. SFRC has the maximum load carrying capacity of 210 KN. By adding fibre formation of cracks are decreased. The load carrying capacity of CC is 190 KN and for the beam with opening at a distance L/2 the load carrying capacity is 200 KN and for the beam with opening at L/3 and D/2 distance is 180 KN.

Table 5 Load Carrying Capacity

pening Position	Ultimate Load(KN)
CC without opening	190
SFRC without opening	210

SFRC with opening at L/2 distance	200
SFRC with opening at L/3 and D/2 distance	180

b.Crack Pattern

For Conventional beam the first crack is formed at 65 KN and for sisal fibre reinforced concrete beam the crack is formed at 75 KN, first crack for the beam with opening at L/2 distance is at 72 KN and for the beam with opening at L/3 and D/2 is at 63 KN.

c.Load Deflection Behaviour

Fig 4 shows the load vs deflection of SFRC and CC. From the graph it is seen that the beams with openings deflects more than SFRC. CC deflects at 190 KN. SFRC deflects at 210 KN. Deflection is reduced by adding sisal fibre.

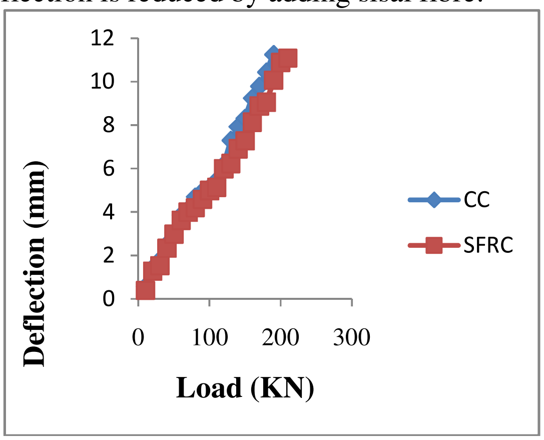

Fig 4 Load Deflection Curve

Fig 5 shows the load vs deflection of SFRC, Opening at L/2 and opening at L/3 & D/2. From the graph it is seen that the beams with openings deflects more than SFRC. Beams with openings at L/2 deflects at 200 KN and beams with openings at L/3 and D/2 deflects at 180 KN. Deflection is reduced by adding sisal fibre**.**

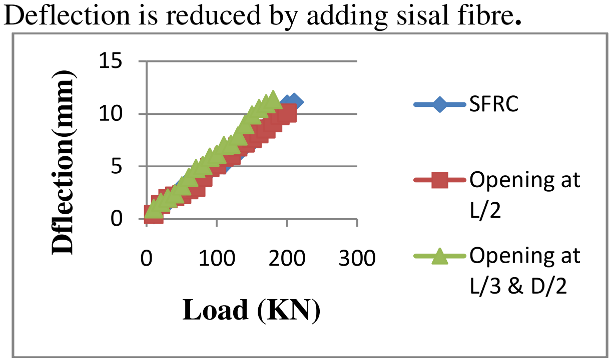

Fig 5 Load Deflection Curve

Fig 6 shows the load vs deflection of beams with openings at L/2 and CC. Beams with openings usually deflect more than the normal beams. But by adding sisal fibre, crack formation is delayed and the strength of the beam is increased than the normal beam.

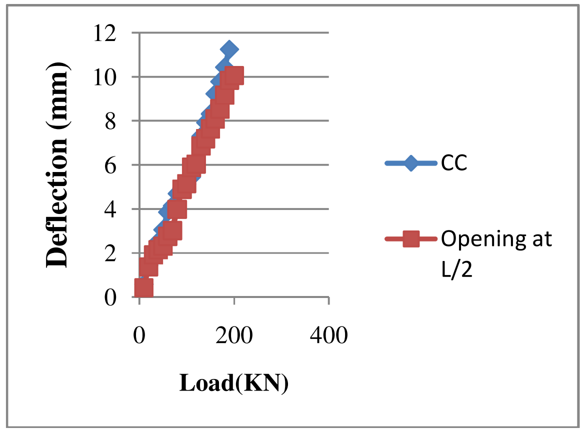

Fig 6 Load Deflection Curve

CONCLUSION

1. Beams with openings at L/2 position have more strength than the beams with openings at L/3 and D/2 distance.
2. Crack formations are arrested by adding sisal fibre.
3. By adding fibre beams with openings had good strength.

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