INTERNATIONAL RESEARCH JOURNAL ON ADVANCED SCIENCE HUB
e-ISSN : 2582 - 4376
Open Access
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Available online at www.rspsciencehub.com

**Special Issue of First International Conference on Engineering, Science, and Technology (ICEST 2021)**

# Strength improvement of RC flat slab-column connection with SFRC composite-A Review

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## Abstract

*According in the world, the strength improves through using steel fibre reinforced concrete (SFRC), has been widely used in structures and also mostly useful in slab-column connections. The main reason steel fibre to be used; adding of additional loads, analysis part is in incorrect way, design process and others reasons. SFRC deals with every aspects of structures and its applications. Each specification has its own standards. In this paper, an attempt is made to make a comparison between design standards in Improving strength of rc flat slab-column connections using SFRC to explain the design and its strength parameters. The study of this paper is based on the American Concrete Institute (ACI), Concrete Society technical report 55 and Indian Society of Civil Engineers (ASCE-IS), The comparison results has been taken from (ASCE-IS), the report of 55 in Concrete Society technical gives the optimum value of the load.*

***Keywords: SFRC, Flat-slabs, Strength, flexural strength, punching shear.***

## 1. Introduction

The use of steel fibre reinforcement is replacement for conventional reinforcement in full or partial, it gradually increased popularity in present zone [1]. The SFRC are major used in the field of construction like tunnel and industrial areas. The volume fraction is upto differed from 0.28% to 0.78% were used. Ductility in plain concrete has no any behavior action on the rc structures, by adding SFRC it improves in a matrix way of concrete, when compared to plain concrete [2]. The post-cracking behaviour is generally, the implementation of internal cracks are reduced this process. Failure of rc structures will reduced by this post-cracking system. In rc flat slab the punching shear problem is reduced gradually and it become beneficial behavior by combination of SFRC [3]. A simple technique in construction filed the flat slab is a simple and easy construction. The slab is directly supported by column, when the beam not supported to the column. Shear forces and bending moment produce more in production of high concentration in column position, by using punching system then it be punching shear failure in column portion [4].

In the structural point of idea punching shear gives load less than compare to flexural strength, at the position of slab-column joints due to the shear stresses more in the concentration. Generally in construction of flat-slab we get problems in slab, by this punching shear we can regret the problem occurs in the slab. According to previous years construction if we see that, the bonding in steel plates or fibres at the tension zone or bolts are rectified in a probable way [5]. A sudden change as taken in construction industries that this SFRC gives high strength, high load capable factor compared to FRP(Fibre reinforced polymer). Strength of slab-column connection with SFRC sheets or plates gives good strength instead of using steel plates. This topic has made to look into research point and our investigation as started to understand all the extremely benefits of SFRC. In the first attempt. The design of column-slab gets failure by the flexure, in later it turned into punching shear [6]. The tension surface part increases strength by including SFRC in the slab-column construction. Here test has conducted to four rcc slabs of dimensions (1200×1200×100) and SFRC by different configurations [7]. The external reinforcement increases up to 90% and the flexural cracking reduces, this caused by increase the percentage of punching shear up to 25%. Using directional SFRC with a high modulus of elasticity in a high manner to internal to steel reinforcement [8].

## 2. Design procedure

Using SFRC reinforcement is strengthening the slabs against bending, resistant heigh shear forces resulted from growing bending strength. The shear strength of the beam section, whether it required or not to be calculated and recheck always while conforming that the strengthen of the column-flat slab [9].

### 2.1 ACI Standards (ACI 440-2R 2008)

Additional loads are removed on or before applying SFRC, the substrate will be strained. Consider this strain should have initial strain ($\varepsilon bi$) and excluded from the SFRC strain.

$\varepsilon bi = MDL(df - c)/Icr\ .\ Ec$ ....................(1)

Where,

$MDL$= dead load moment(N.m)

$df$=D-(2xd') (m)

$c$ = compressive depth (m),

$Icr$ =cracked section moment of inertia (m4 )

$Ec$ = young's modulus of concrete (GPa).

#### 2.1.1 Stress – strain behaviour of SFRC reinforcement

SFRC section to be determined that strain level at the ultimate limit state point in this reinforcement because by using SFRC material it becomes in linear or elastic shape to failure. Compare of SFRC strain and concrete strain, ensure that steel reinforcement can be found in a compatibility process.

$\varepsilon fe = \varepsilon cu\ [\ (df - c)/c\ ] - \varepsilon bi \leq \varepsilon fd$.......(2)

Where,

$\varepsilon fe$ = SFRC effective strain

$\varepsilon cu$ = maximum compressive strain as in ACI standards

$df$ = D-( 2 X d')SFRC (m)

$c$ = compressive zone depth (m)

εfd = initial substrate strain at which deboning may occur

### 2.2 Maximum strength of singly reinforced concrete beam section

$Mu = \emptyset\ [\ As\ .\ fs\ (d - \beta 1\ .\ c\ 2\ ) + \psi f\ .\ Af\ .\ ffe\ (df - \beta 1\ .\ c\ 2\ )]$ ……….(III)

Where,

Mu=Maximum bending strength of the section (N.m)

∅=Shrinkage factor

As = Area of steel reinforcement ($m^2$ )

$Af$=Area of steel fibre section ($m^2$ )

ψf = 0.85

## 3. Results and Discussion

The strength improves in slab-column connections composite by SFRC strips. The identical compression height depending on the bending strength. The maximum height in the equations of the maximum flexural moment and maximum bending strength can be found. Load is acting on the roof slab, it distributed to the column and middle strips [10]

It gives ultimate applied service load and every service load is differ in the compression depth increases or decreases as shown in Table.1.

**Table.1. Compression depth in equivalent manner to flexural strength**

| Code Used | Identical Compression height (m) | Maximum bending Strength (kN.m) | Maximum acting service load ($kN/m^2$) |
|---|---|---|---|
| ACI | $\beta C$ = 0.016 | 507.6 | 37.59 |
| Concrete Society TR55 | $\lambda x$ = 0.017 | 416.23 | 32.64 |
| JSCE | $\beta x$ = 0.018 | 460.85 | 27.95 |

It shows that the ultimate applied service loads are different for each standard are given by service codes in Chart.1. It is observing that the most important factor that can be used for the calculation of the maximum serviceable loads is the failure condition as shown in Table.2.

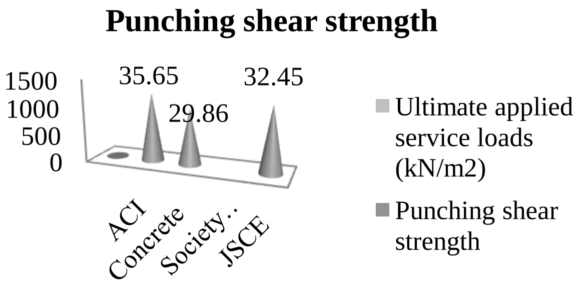


**Chart.1. Punching shear strength**

**Table.2. Maximum bending strength and the corresponding loads**

| Code | Maximum bending strength(kNm) | Maximum applied serviceable loads (kN/$m^2$) |
|---|---|---|
| ACI | 536.3 | 47.89 |
| Concrete Society TR55 | 583.06 | 57.90 |
| JSCE | 657.34 | 39.87 |

**Table.3. Value for unstrengthened and strengthened slab**

| Type of slab | $\xi$factor |
|---|---|
| Un-strengthened | $\xi$ = 0.321 |
| Gained strength | $\xi$ = 0.342 |

**Conclusions**

- The efficiency of rc mixing with steel fibre is gives good efficiency.
- The orientation and distribution gives cracks in structural element and also steel fibre participate effetely to resist and develop the flat-slab.
- Increasing the fibre volume and it as limitations fraction in the concrete mix.
- The casting direction effects the punching shear cone size and it is use in self-compacting concrete would avoid uneven dispersion of steel fibre.
- To obtain the maximize, the efficiency of steel fibre application in the thin slab, in a practical manner.
- The flexural reinforcement ratio only effected the stiffness of the specimen, therefore increasing of flexural reinforcement ratio did not really affect the punching shear behavior or capacity of flat slab.
- Two different outcomes are seen while increase concentration of steel fibre one is enhance and second one is deteriorate the punching shear capacity of flat-slabs.

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