

Cost & Time Control of the Project by Using Structural Synthetic Fiber Reinforcement

Sandesh S Pandit¹, Anuradha S Pansare²

¹M.E. Civil Student, Department of Civil Engineering, Pad. Dr. D. Y. Patil Institute of Engineering & Technology, Pimpri, Pune.

²Associate Professor, Department of Civil Engineering, Pad. Dr. D. Y. Patil Institute of Engineering & Technology, Pimpri, Pune.

Abstract: In this paper feasible use of alternative material to the steel reinforcement in building element such as column, beam is been done. The material used for partial replacement of steel reinforcement is Structural Synthetic Fibers. With the available papers it is learnt that use of structural synthetic fiber is much common and limited in tunnel lining works, Industrial flooring works, Concrete pipes, Road pavements etc. In this paper these fibers are considered for construction of building elements, with available values and studies done in previous stages by various authors. Here partial replacement of steel reinforcement is done with the Structural Synthetic Fibers keeping in view the design requirements of the particular element, the saved steel and concrete due to section reduction is combined and summed up to come over total savings. Comparison is done in previous requirement of steel and concrete to the new requirement of the same with adding cost of structural synthetic fiber in latter. Cost and time requirement is calculated in both the type of works and compared for the feasibility of the Synthetic Fibers in concrete in respect of cost and time control.

Keywords: Cost Control, Feasibility of SSF, Time control, Partial Replacement.

1. Introduction

At present scenario in construction industry it is very difficult to control the cost and time overrun of the construction project. Many Activities are involved at construction site up to its completion and start functioning. The governing feature in any structure is its skeletal i.e. beam, columns, slabs foundations. These consume fixed time once it is casted and we need to wait for its complete curing before starting work on it. The time can be saved only in its workmanship. For any structure same is reinforced cement concrete is only the option available. Also today at some extent cost overrun can be allowed to complete job before time but it seems and can be noticed cost is always a governing and driving force in a project, if alterations are provided to save time it first comes over how much cost is additional accumulating alteration of the same.

Here Structural Synthetic Fiber plays dual role to save considerable cost along with duration of the project. Structural synthetic fibers have shown many advantages in increasing toughness and resistance to tensile cracking. Tensile strength is not significantly increased with this so it limits full replacement of steel reinforcement in building elements unlike Industrial floors, and slabs on grade, but this increases compressive and flexural strength significantly so this fiber can be used for partial replacement.

Objective-The paper is aimed to find the feasibility of structural synthetic fibers in terms of saving time and cost of the project in its execution phase only as curing period is constant for concrete.

2. Literature Survey

1. Large-scale load testing was completed on both plain and fiber-reinforced concrete slabs-on-ground. The fiber-reinforced concrete used a new synthetic microfiber. Although the synthetic fibers did not alter the tensile cracking

load of the plain concrete slab, the flexural cracking load of the plain concrete slab was increased by 25 and 32% with synthetic fiber addition of 0.32 and 0.48% by volume, respectively, for the center loading configuration. Similarly, synthetic fibers at 0.48% volume fraction increased the flexural cracking load of plain concrete slab under edge loading by 28%. The ultimate load capacity of the plain concrete slab under center loading was increased by 20 and 34% with the addition of 0.32 and 0.48% synthetic fibers, respectively. Embedded strain gauges in the concrete slabs and deflection profile measurements indicated the fibers effectively distributed the load throughout the slab volume as cracking progressed, resulting in the increased concrete slab flexural and ultimate capacities (ACI 2006).

2. The Structural Synthetic Fibers offer a range of economic performance and safety related benefits to the Shotcrete industries worldwide. These fibers advantages include a reduction of cracking, enhancements to ductility, toughness and impact resistance and the elimination of the potential for reinforcement corrosion. In addition, the project is also able to realize significant economic benefits as a result of reduced labor, reduced cracking and an overall saving in reinforcement costs. (Clifford- 2009).

3. Data Collection

To carry out this study steel and concrete consumption data is obtained from one construction site which is now complete and have started serving its functions, steel and concrete data was obtained from site as per actual consumption recorded at site. The building is G+2 structure located at Chandrapur District of Maharashtra state and the project was named as Chanda Truck Terminal. Data collected is tabled as below,

Table 1: Concrete and steel consumption data.

Sr. No.	Description	Unit	Quantity Consumed
1	Steel in column		
a	Up to Plinth Beam	MT	2.48

b	Plinth beam to first floor	MT	2.72
c	First floor to terrace slab	MT	2.72
d	Column in parapet wall	MT	0.61
	Total	MT	8.53
2	Steel in Beam		
a	Plinth Beam	MT	4.25
b	Beam of ground floor slab	MT	4.24
c	Beam of terrace slab	MT	5.37
	Total	MT	13.86
3	Concrete in all Column	Cum	45.52
4	Concrete in all Beam	Cum	101.48

4. Methodology

To use structural synthetic fibers in concrete and to check its feasibility following methodology is used which included two phases.

Phase 1 Analysis of G+ 2 Structures.
 Phase 2 Costs and Time Comparison

5. Theoretical Content

Phase 1: One analysis was carried out in ETAB model, one is with plain reinforced concrete and other is concrete with addition of Structural Synthetic Fiber. Dosage considered were 3 Kgs/Sqm, theoretical increment in strength is 30 %. This factor was added in concrete strength and design was carried out for G+ 2 structures, Following results are obtained for the design, one specimen results are mentioned below,

Result 1:-Normal Concrete

Column- C1- M30
 Percent steel-
 Top- 0.804
 Bottom- 0.841
 Beam – B34- M30
 Percent steel
 Bottom middle- 0.0005588 – Ast

Result 2:-With addition of structural Synthetic Fibers

Column- C1- M30
 Percent steel-
 Top- 0.8<0.804
 Bottom- 0.804Ast< 0.841 Ast
 Beam – B34- M30
 Percent steel
 Bottom middle- 0.000515 Ast<0.0005588 Ast.

Phase 2: Cost and Time comparison, From the results obtained it can be clearly concluded that, steel requirement is considerably lowered for same cross section of beam and column. (Section reduction was not possible as load is not so high and cross-section was already too small to reduce which has to fulfill min c/s requirement). So the percent by which steel requirement is lowered as below.

Column Top – $((0.804-0.8)/0.804)*100 = 0.5 \%$
 Column Bottom- $((0.841-0.804)/0.841)*100 = 4.34 \%$
 Beam- $((0.0005588-0.000515)/0.0005588)*100 = 7.83\%$.

Requirement of steel reinforcement for column= 8.53 Tons

Let us consider average reduction in steel requirement in column is = $((0.5+4.34)/2) = 2.42 \%$

So total steel required when addition of Structural Synthetic Fibers,

Column = $(8.53-(8.53*2.42\%)) = 8.32$ MT

So, total reduction = 0.21 MT.

Beam = $(13.86-(13.86*7.83\%)) = 12.77$.

So, total reduction = 1.08 MT

Total Reduction in Beam and Column combined=
 $(1.08+0.21) = 1.29$ MT

Cost of steel reinforcement = 65000.00 Rs per MT
 (Including Material + Labor + Transport),

So, total reduction in steel cost => $1.29*65000.00 = 83850.00$ Rs.

Cost of Structural Synthetic Fibers=> 146.00 Rs per Kgs.

Dosage of Synthetic Fiber per cum considered- 3 Kgs

So increment in cost of concrete due to addition of these fibers=> $146.00 \times 3 = 438.00$ Rs per Cum.

Total Concrete consumed at site = $(45.52+101.48) = 147$ Cum.

Additional cost accumulated due to addition of Structural Synthetic Fiber= $147 \times 438 = 64386.00$

The cost accumulated due to addition of SSF (64386.00 Rs) in concrete is less than the total savings in steel reinforcement (83850.00 Rs).

Total Saving= $83850.00-64386.00 = 19464.00$.

In above section cost reduction is observed, but as SSF gives dual benefits towards cost and time saving, further described time savings by use of SSF.

Time required for concreting operation is same so no reduction was possible.

Time required for binding steel reinforcement

A. Column:-

1. Up to plinth beam-

Steel consumed – 2.48 MT= 2480 Kgs

Labour output for binding steel 350- 400 Kgs per day per 8 hours Shift, for 4 helper and 1 fitter.

Total time required for binding = $(2480/375) = 6.61 = 7$ Days.

Now time required to bind steel after reduction in steel

Reduced requirement = $(2480-2480*2.42\%) = 2420.00$ Kgs

Now total time required = $2475/375 = 6.45 = 6.5$ Days.

Time Saving- 0.5 Day.

2. Plinth Beam to First Floor-

Steel Consumed 2720 Kgs

Time required for binding steel = $2720/375 = 7.25$ Days

Reduction in steel- 73 Kgs.

New requirement= 2647

Time required for binding steel= $2647/375 = 7.05$

No significant reduction in time.

3. Column of parapet wall,

As this column does not consume much quantity of steel, no time reduction is expected.

B. Beam

1. Plinth Beam-

Steel Consumed – 4250 Kgs.

Time required for binding steel= $4250/375 = 11.33$ Say 11 Days.

Reduction- 7.83 % = 332 Kgs

New requirement = 3918 Kgs

Time required for binding steel = $3918/375 = 10.44$ Say 10 Days.

Time Saving- 1 Day.

2. Ground Floor Slab Beam-

Steel Consumed- 4240 Kgs

Time required for binding steel= $4240/375 = 11$ Days.

Reduction = 324 Kgs

New requirement = 3916 Kgs

Time required for binding steel = 10 Days.

Time Saving – 1 Day.

3. Terrace Slab Beam-

Steel Consumed – 5370 Kgs

Time required for binding steel= $5370/375 = 14$ Days.

Reduction = 421 Kgs

New Requirement = 4949 Kgs

Time required for binding steel = $4949/375 = 13$ Days

Time Saving – 1 Day.

Below graphs differentiates the cost & time requirement at various levels for each floor of column and beam.

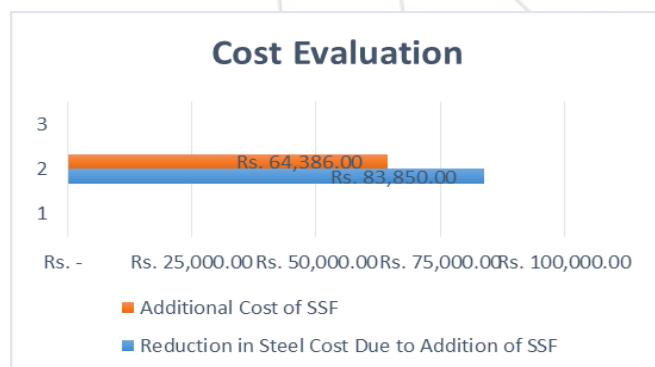


Figure 1: Graph of Cost Evaluation

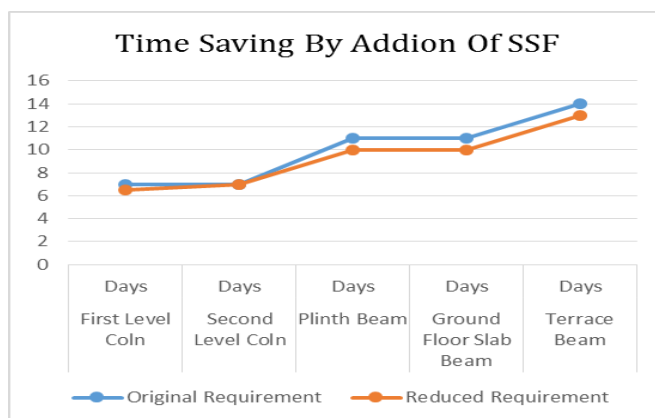


Figure 2: Graph of Time motion Study

6. Conclusion

From the detailed analysis it can be concluded that Structural Synthetic Fibers can be used for partial replacement of steel reinforcement. Significant cost and time saving is observed, in analysis the structure considered is G +2 and so figures obtained are low figures but when these fibers will be used in big project this will help in big time and cost reduction. However some researcher have reported to not to replace steel reinforcement with SSF. But experimental program shows replacement is possible. As these fibers are increasing flexural capacity of concrete which helps in making concrete more ductile and flexible after curing, which is mainly depended on primary steel reinforcement.

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Author Profile



Sandesh S Pandit, ME Civil (2nd Year), Padmashree Dr. D. Y. Patil Institute of Engineering & Technology, Pimpri Pune-18.



Associate Professor **Anuradha S Pansare**, ME Civil (CM), Padmashree Dr. D. Y. Patil Institute of Engineering & Technology, Pimpri Pune-18.

