COST EFFECTIVENESS OF HIGH PERFORMANCE CONCRETE

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Abstract:-

High Performance Concrete is a logical progression of cement concrete in which the elements are proportioned and chosen to contribute effectively to the various qualities of cement concrete in both the fresh and hardened phases. One of the characteristics of High Performance Concrete that gives considerable structural benefits is its increased strength. Concrete, steel reinforcement, and formwork are the three key components that contribute to the cost of a structural part. This research compares these primary components when higher-grade concrete is utilised in the design and concludes that high-strength concrete is the most cost-effective way to construct load-bearing parts and transport a vertical load to the building foundation through columns.

Key Words: High Strength Concrete, Scope, Methodology, ETABS.Top of Form

INTRODUCTION :-

Various studies have described the advantages of utilising High Performance Concrete, specifically the structural advantages of employing high strength concrete. These include a reduction in member size, a reduction in self-weight and superimposed Dead Load with accompanying savings due to smaller foundations, a reduction in form-work area and cost construction of high-rise buildings with accompanying savings in real estate costs in congested areas, longer spans and fewer beams for the same magnitude of loading, reduced axial shortening of compression supporting members, and a reduction in the number of supports and the supporting members themselves. Low creep and shrinkage, improved long-term service performance under static, dynamic, and fatigue stress, and low weight and cost of the majority of structures The use of various chemical and mineral admixtures to achieve high strength concrete is also a study topic, and several design mix methods and trial mix procedures have been offered for the creation of high strength concrete. The various parameters that govern the strength of concrete, such as the various constituent materials required, their properties, the proportions in which they are to be used, and the specifications for the production and curing technique to be used for the development of high strength concrete, are also a subject of continuous research for the development of high strength concrete, which is now being seen.

Objective of Study: To compare the cost of building a structure with high performance concrete to the cost of building a structure with normal concrete grades.

SCOPE:-The purpose of this study is to determine the cost efficacy of developing structures with High Performance Concrete by comparing the costs of concrete M20 and M40 using a laboratory-created concrete mix. The differences in the quantity of concrete and steel required for different beams and columns have been computed, examined, and compared with respect to their cost in the design of a multi-story reinforced building utilising both M20 and M40 in Staad Pro2018.

LITERATUREREVIEW:-

The concept of packing density is introduced by Henry H.C. Wong and Albert K.H. Kwan (Department of Civil Engineering, The University of Hong Kong, Hong Kong) (5) as a fundamental premise for building HPC mixes. The concept is founded on the belief that maximising the packing densities of aggregate particles and cement materials can improve the performance of a concrete mix, and it proposes a preliminary HPC design approach called three-tier system design.

Papayianni *, G. Tsohos, N. Oikonomou, and P. Mavria (Department of Civil Engineering, Aristotle University of Thessaloniki, 54 124 Thessaloniki, Greece)(6) investigated the effect of super plasticizer type and mix design parameters on super plasticizer performance in concrete mixtures for higher strength concrete.

1.METHODOLOGY

4 Details of concrete mix design for grade M20

M20 Mix Design Basic Requirements

M20's mix design

PPC cement is the type of cement used.

Aggregate nominal size: 20mm

75 mm slump is workable.

Cement content maximum: 450 kg per cum

Material Characteristics

1. Cement specific gravity 2.86
2. Specific gravity of coarse aggregate (under SSD conditions): 2.68
3. Fine aggregate Specific Gravity (SSD Conditions):2.63
4. Water absorption rate of coarse aggreagate: 0.68%
5. Fine aggregate water absorption: 1.12 percent
6. Moisture content of coarse and fine aggregates is nil. 1.08

Specific gravity of chemical admixture for mix proportioning according to IS Code 10262:2019

According to IS 10262:2019 Page no. 3 table no. 1 and 2

fck+1.65 x standard deviation

Fck= fck+1.65 x standard deviation

Fck= fck+1.65 x standard deviation F

Fck=20+1.65x4=26.60N/mm2

Fck=20+5.5=25.50 N/mm2

Fck=20+5.5=25.50 N/mm2

As per Is 10262 :2019, free w/c ratio required for target strength of 26.60 N/mm^2 is 0.58 (curve 2) which is higher than maximum value of 0.55 (As per IS 456),

As a result, the w/c ratio is 0.55.

Hence 192/0.55 = 349 Kg/ Cumulus

(minimum necessary = 340 Kg/ Cumulus)

Water = 349 * 0.55 = 192 Kg/cum

Volume of cement = 349 / (2.86 * 1000) = 0.122 cum

Water volume = 192/(1*1000) = 0.192 cum

Entrapped air volume = 0.005 cum

Cumulative volume of coarse and fine aggregate = 1- (0.122+0.192+0.005)=0.681

cumulative volume of coarse and fine aggregate

coarse aggregate volume = 0.66 per unit volume

Fine aggregate volume = 0.34 per unit volume

Cumulative volume of coarse aggregate=0.681*0.66 =0.449

Coarse aggregate weight = 0.449*2.68*1000 = 1203.00 Kg/cum

Fine aggregate volume = 0.681 *0.34 = 0.232 sum

Fine aggregate weight = 0.232*2.63*1000 = 610.00 Kg/cum

M20 Cement(PPC) rate analysis: 349 kg * 450 per 50 kg bag = 3150/-

Cumulative fine aggregate = 0.232 * 2700 = 626

0.449 *2700per cum = 1212 coarse aggregate

Rate of M20 grade concrete=Rs.4988 per cum

Grade of concrete	Rate (Rs.per cum)
M20	4988
M25	5245
M30	5752
1) M35	5300
2) M40	5640

Introduction to ETABS

A reinforced concrete building frame, which was assumed to be a commercial building (located in Dhule), was analysed and designed using ETABS using concrete grades ranging from M20 to M40, and the beam and column concrete consumption, steel reinforcement required, and cost aspects for concrete consumption and steel reinforcement required were compared.

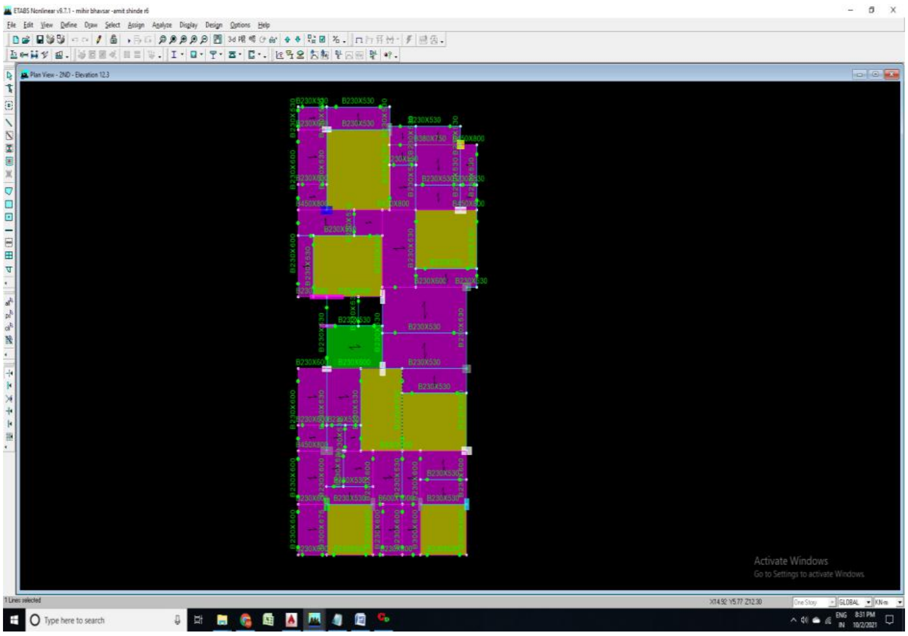

Figure 1 Key plan of slab beam of building (at second floor)

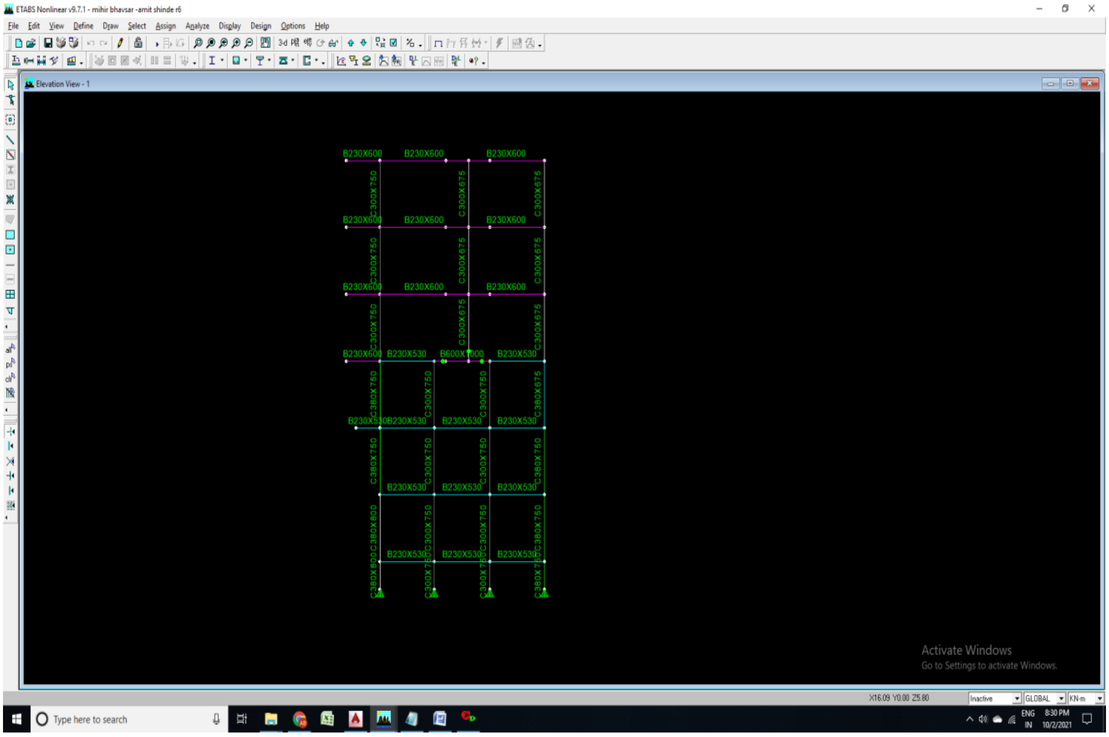

Figure 2 Front view of building (Elevation)

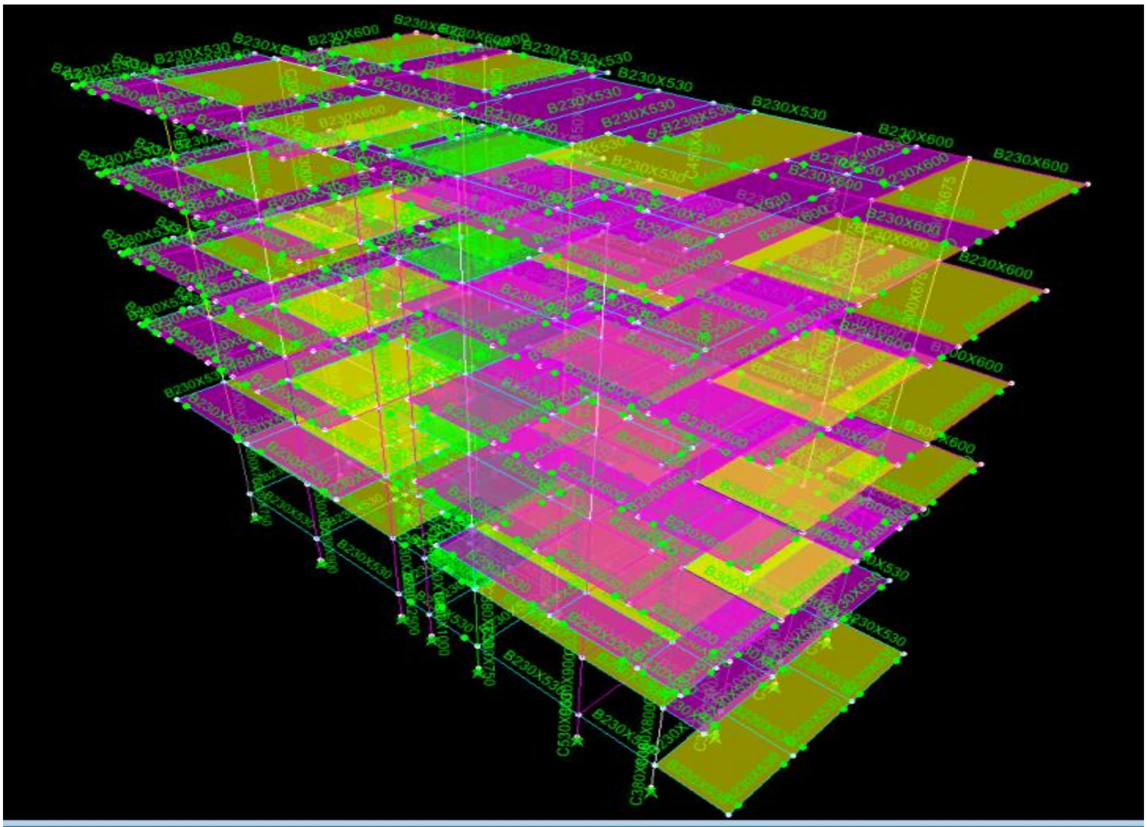

Figure 3 Generation of member properties

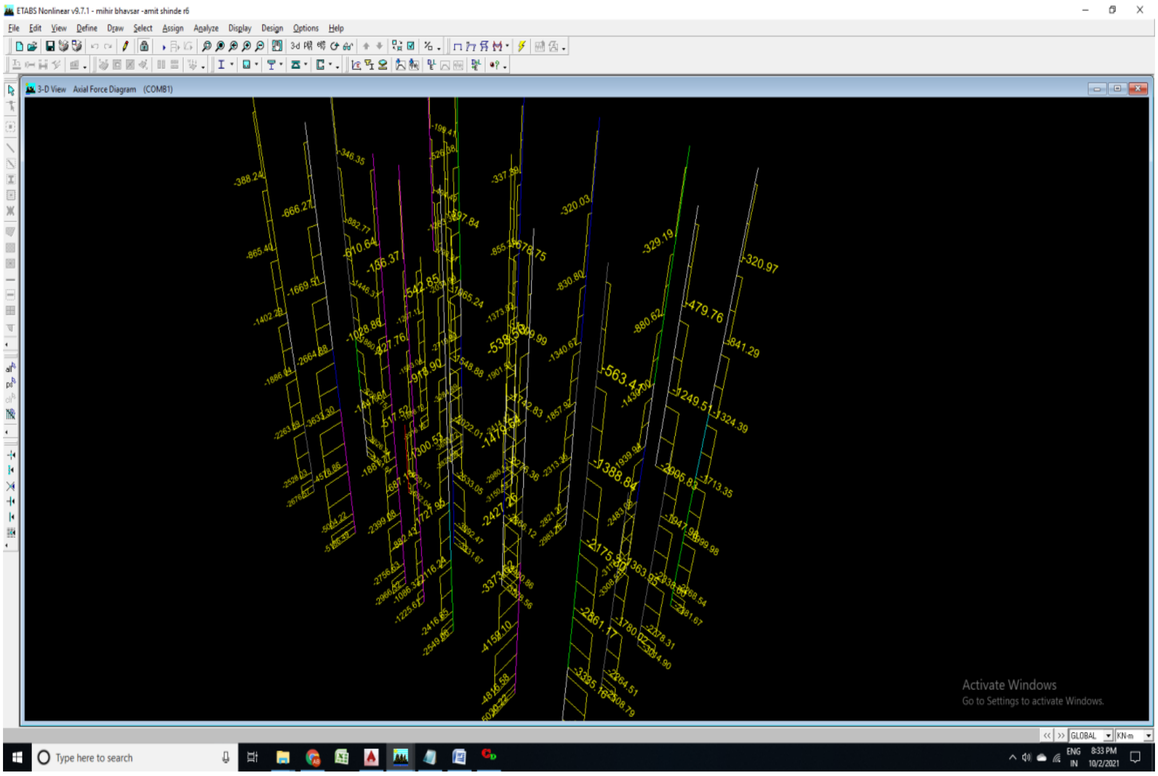

Figure 4 3-D view axial force diagram

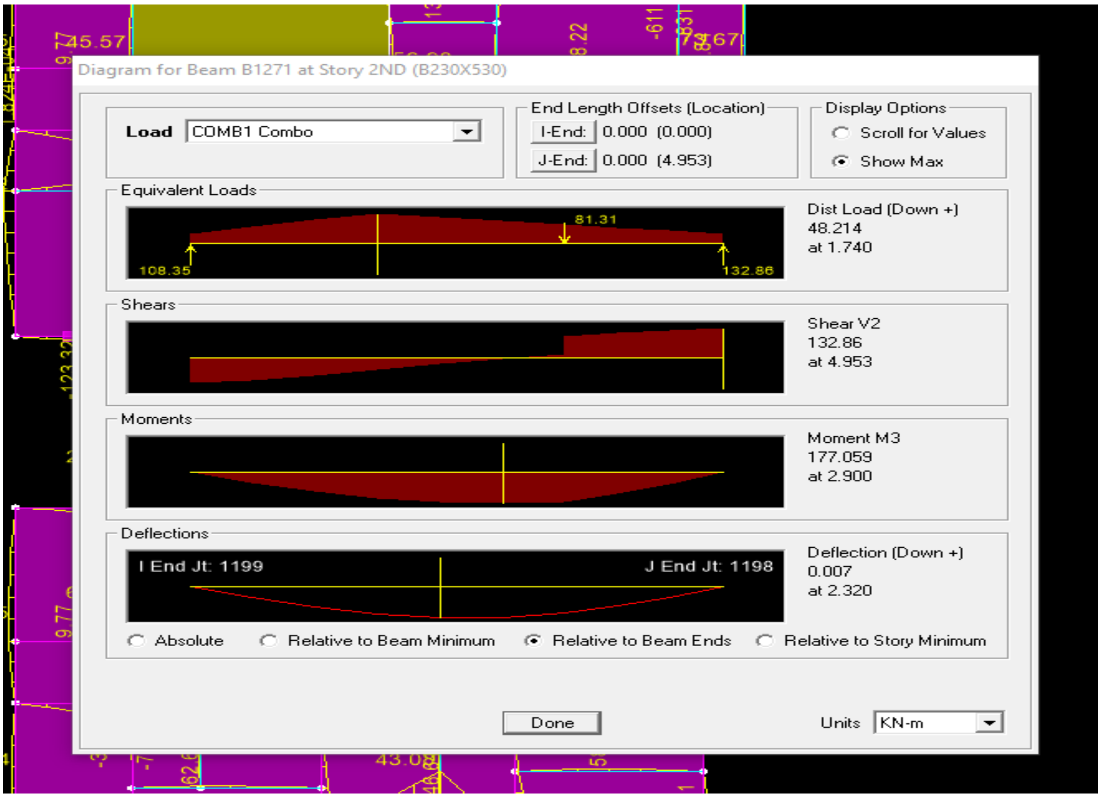

Figure 5 Design of beam member using RCDC

Discussion & Conclusion

A cubic metre of High Performance Concrete costs more than a cubic metre of regular concrete at the moment. To ensure that the concrete reaches the stipulated strength and performance, High Performance Concrete requires greater quantities of components such as cement and high-range water-reducers, which raises the cost of High Performance Concrete. However, using concrete with higher compressive strengths in columns and other load-bearing elements is an economically viable option. Furthermore, the use of High Performance Concrete, which has a higher concrete compressive strength than conventional concrete, has been found to provide structural benefits, such as more efficient floor plans due to smaller vertical members (columns), and also proves to be the most cost-effective option by reducing both the total volume of concrete and the total cost of construction.

CONCLUDING REMARKS

1. A flexural member made of high performance concrete (M40) can save up to 2.23 percent of its weight when compared to the same cross section made of normal grade (M20) concrete.

2. Compared to steel and concrete, the design of a flexural member with a lower cross section will cost nearly 15% more.

3. To save money, it's best to cast a flexural element with high-strength concrete only when the cross sections aren't changed (i.e. the same as for regular grade).

4. When it comes to axial members, utilising high strength concrete can save you up to 16.21%. (as compared to the same section with normal grade).

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