A STUDY OF DESIGN OF STRUCTURES WITH HIGH PERFORMANCE CONCRETE

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Abstract: High Performance Concrete can be considered as a logical development of cement concrete in which the ingredients are proportioned and selected to contribute efficiently to the various properties of cement concrete in fresh as well as in hardened states. Higher strength is one of the features of High Performance Concrete which provides significant structural advantages. The three major components contributing to the cost of a structural member are concrete, steel reinforcement and formwork .This paper aims at comparing these major components when concrete of higher grade is used in the design and to establish that High strength concrete provides the most economical way for designing the load bearing members and to carry a vertical load to the building foundation through columns.
The mix design variables affecting the concrete strength which are the most critical in the strength development of concrete includes water-cementitious material ratio, total cementitious material, cement-admixture ratio, amount of super plasticizer dose .These factors are to be analyzed in order to obtain a mix for concrete of higher grade.

Key Words: High Performance Concrete, High Strength Concrete.

Introduction

Concrete has been since long a major material for providing a stable and reliable infrastructure. Concrete with compressive strengths of 20-40 N/sqmm has been traditionally used in construction projects. With the demand for more sophisticated structural forms along with deterioration , long term poor performance of conventional concrete led to accelerated research for development of concrete which would score on all the aspects that a new construction material is evaluated upon : strength, workability, durability, affordability and will thus enable the construction of sustainable and economic buildings with an extraordinary slim design besides providing a material that will have long term better performance and reduced maintenance. The development of high performance concrete in this regard has been a great breakthrough in concrete technology. ACI defines High Performance Concrete as "Concrete meeting special combinations of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing and curing practices". Important governing factors for High Performance Concretes are strength, long term durability, serviceability as determined by crack and deflection control, as well as response to long term environmental effects. High performance concretes (HPC) are concretes with properties or attributes which satisfy the various performance criteria. Generally, concretes with higher strengths and attributes superior to conventional concretes are called High performance concrete. Therefore High Performance Concrete can be considered as a logical development of cement concrete in which the ingredients are proportioned and selected to contribute efficiently to the various properties of cement concrete in fresh as well as in hardened states.

In order to achieve high strength for high performance, the various important factors that govern the strength of concrete are to be understood:

- The properties of the cement paste
- The properties of the aggregate
- The various chemical and mineral admixtures that are to be used
- The relative proportions of the constituent materials to be used .
- Paste –Aggregate interaction.
- Mixing, Compaction and Curing.
- Testing Procedures.

All these factors need to be optimized in order to obtain concrete with significantly high compressive strength for High performance concrete.

The use of High Performance Concrete with significantly higher compressive strength of concrete is on increasing trend in the construction industry and is being seen as an optimized

Solution considering the economics vis-à-vis strength and durability required for special structures. The scope of using High Performance Concrete in our constructional activities

lies large, viz Multi-storied buildings, bridges and structures on coastal areas and the like

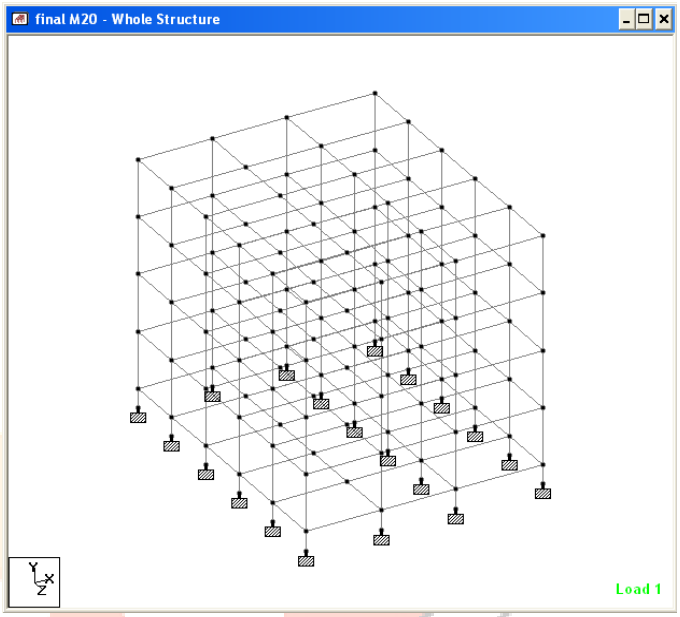
The primary reasons for selecting High Performance Concrete are to produce a more economical product, provide a feasible technical solution, or a combination of both. The use of HPC with its greater durability is likely to result in less maintenance and longer life and with the introduction of life-cycle costing, the long-term economic benefits are likely to more than offset the premium costs for initial construction. To affect this change from Conventional concrete to High Performance Concrete we will have to revive the designing of structures by encouraging use of High Performance Concrete by introducing the structural and economical advantages offered by High Performance Concrete.

LITERATURE REVIEW

The advantages of using High Performance Concrete particularly with the structural advantages of using high strength concrete have been described in various researches. These include a reduction in member size, reduction in the self-weight and super-imposed Dead Load with the accompanying saving due to smaller foundations, reduction in form-work area and cost construction of High–rise buildings with the 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 ,reduction in the number of supports and the supporting foundations due to the increase in spans ,reduction in the thickness of floor slabs and supporting beam sections which are a major component of the weight and cost of the majority of structures, superior long term service performance under static, dynamic and fatigue loading, low creep and shrinkage . Achieving high strength concrete by using various chemical and mineral admixtures is also a subject of research and different design mix methods and trial mix approaches have been proposed for the development of high strength concrete. The various parameters that govern the strength of concrete like the different constituent materials required, properties of constituent materials , proportions in which they are to be used and specifications for the production and curing technique to be used for the development of high strength concrete are also being a subject of continuous research for the development of high strength concrete which is now being seen as a logical development of concrete because of the numerous advantages that it is supposed to provide.

SCOPE OF THE PRESENT WORK:

The objective of the present work is to study the cost effectiveness of designing structures with High Performance Concrete by giving a cost comparison between concrete M20 and M60 using a concrete mix achieved in the laboratory .The effect of silica fume dosage and the dose of super plasticizer on the strength of concrete have been evaluated using an experimental programmed aimed at achieving a High strength concrete mix. Design of a multi storied reinforced building has been done using both M20 and M60 using Staad Pro2004 and the differences in the quantity of concrete and steel required for different beams and columns have been calculated and analyzed and compared with respect to their cost. Design curves for M60 and M60 have also been generated using MATLAB and given in the report for use in design using the grades of concrete as they are not given in the design aid presently available.



CREATING THE MODEL:

The model of the Reinforced concrete building frame was created using the graphical model generation mode, or graphical user interface (GUI).

Load Data for the building:

1. Dead Load

(a) Finishes=2.5 KN/sqm Floor Finishes=1.0 KN/sqm

(b) Slab=25 D KN/sqm where D is the depth of the slab

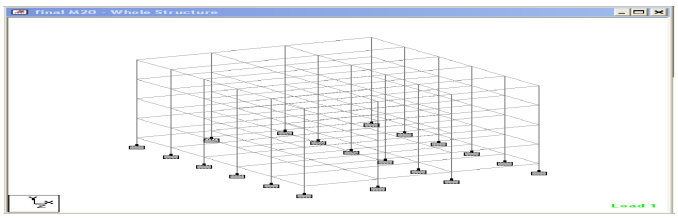
(c) Walls=External 250 mm thick =20*.25=5 KN/m/ m height Internal Walls=150 mm thick=20*.15=3KN/m/m height

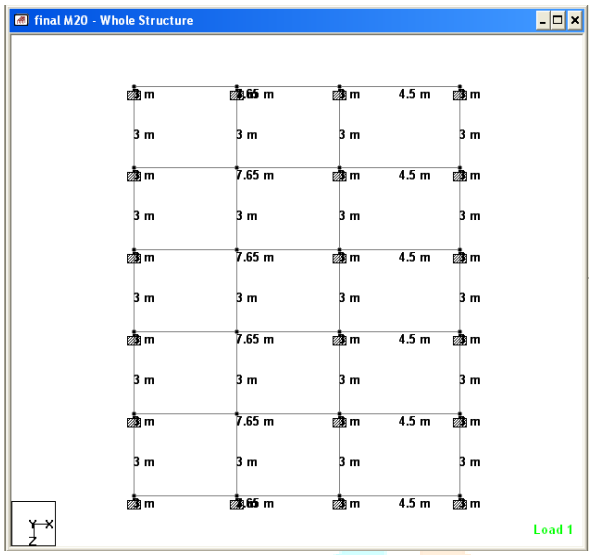
2. Live Load (a) Roof=1.5 KN/sqm

(b) Library=10KN/sqm

Concrete member

The materials for the structure were specified as concrete with their various constants as per standard IS code of practice.





The frame was analyzed under a repeat load of 1.5 Dead Load + 1.2 Live Load

Design results:

Two beams , Beam no 109 and Beam no.132 and column no.177 were analysed .Beam no.109 forms the beam B2 at exterior roof level at the second floor. Beam no 132 forms the beam B1 at the exterior roof level of the second floor whereas the Column no.177 forms the column of second floor were analyzed and the reinforcement required were obtained.

At the present time, a cubic metre of High Performance Concrete is found to be more than a cubic metre of conventional concrete. High Performance Concrete requires additional quantities of materials such as cement, silica fume, high-range water-reducers to ensure that the concrete meets the specified strength and performance which increase the cost of High Performance Concrete. But overall the use of concrete with higher compressive strengths offer economically viable solution in columns and other load bearing members Also the use of High Performance Concrete with concrete compressive strength higher than conventional concrete is found to offer structural advantages viz, more efficient floor plans through smaller vertical members (columns) and also proves to be the most economical alternative by reducing both the total volume of concrete and the amount of steel required for a load bearing member besides providing resistance to long term detonation, lower maintenance etc.

Conclusion :

High Performance Concrete with higher compressive strength provides the most economical way for designing the load bearing members and to carry a vertical load to the building foundation through columns by a reduction in the quantity of steel required and also concrete which contribute mainly to the cost of the structural member. The mix design variables affecting the concrete strength which are the most critical in the strength development of concrete including water-cementitious material ratio, total cementitious material, cement-admixture ratio amount of super plasticizer dose are to be analyzed and optimum values of the critical mix design variables are to be taken for obtaining the mix design for the required High Performance Concrete

The use of High Performance high strength concrete offers numerous advantages in the sustainable and economical design of structures and gives a direct savings in the concrete volume saved ,savings in real estate costs in congested areas, reduction in form-work area and. The use of High Performance Concrete with its greater durability is likely to result in less maintenance and longer life and with the introduction of life-cycle costing, the long-term economic benefits are likely to more than offset the premium costs for initial construction. To affect this change from Conventional concrete to High Performance Concrete we will have to revive the designing of structures by encouraging use of High Performance Concrete

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