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Cost Effectiveness In Design Of Structures With High Performance Concrete

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***Abstract*— Early stage decision-making for structural design critically influences the overall cost and environmental performance of buildings and infrastructure. However, the current approach often fails to consider the multi-perspectives of structural design, such as safety, environmental issues and cost in a comprehen- sive way. This paper presents the cost effectiveness in design of concrete sturutes with high performance concrete.**

I. 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.

However, when 'high performance' is linked to structural significant behavior high performance is usually synonymous with high strength. Thus high strength concrete is basically a form of high performance concrete which has compressive strength higher than the conventional concrete. High strength concrete is specified where reduced weight is important or where architectural considerations require smaller load carrying elements .The use of 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 cost.

S.C. Maiti, Raj K. Agarwal and Rajeeb Kumar (The Indian Concrete Journal 2006)(4) gave relationships between water-cement ratios or water cementitious materials ratios and 28-day compressive strength for concrete containing OPC or PPC or PSC or (OPC + fly ash) or (OPC + ggbs) and a superplasticiser based on data from different construction sites and gave a critical observation that these relationships are almost same as given in IS 10262 for two grades of OPC (43-grade and 53-grade). Regarding sand and water contents, suggestions to modify existing guidelines of IS 10262 have also been given for superplasticised concrete mixes.

Henry H.C. Wong and Albert K.H. Kwan (Department of Civil Engineering, The University of Hong Kong, Hong Kong) (5) introduces the concept of packing density as a fundamental principle for designing HPC mixes. The concept is based on the belief that the performance of a concrete mix can be optimized by maximising the packing densities of the aggregate particles and the cementitious materials and presents a preliminary HPC design method, called three-tier system design.

Papayianni, G. Tsohos, N. Oikonomou, P. Mavria(Department of Civil Engineering, Aristotle University of Thessaloniki, Thessaloniki, Greece) have established the influence of superplasticizer type and mix design parameters on the performance of them in concrete mixtures for cocrete of higher strength.

II. MATERIALS AND EXPERIMENTATION

Cement: In this experimental work, ordinary Portland cement (OPC) 43 grade conforming to IS: 8112 – 1989 was used.

Sand: Locally available river sand zone II with specific gravity 2.58, water absorption 1% and conforming to I.S. – 383-1970.

Coarse aggregate: Crushed granite stones of 20 mm down size, having a specific gravity of 2.61 conforming to IS 383-1970

Water: Potable water was used for the experiment.

III. EXPERIMENTAL RESULTS

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The variation of slump with superplasticizer content and the compressive strength variation
with the silica fume replacement wa s observed with the following graphs:

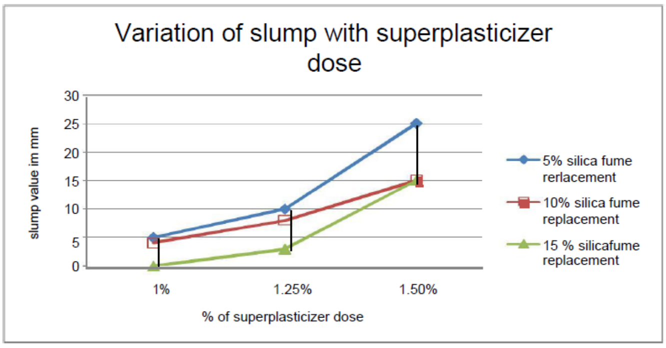

Fig 1.Variation of Slump with Super plasticizer dose

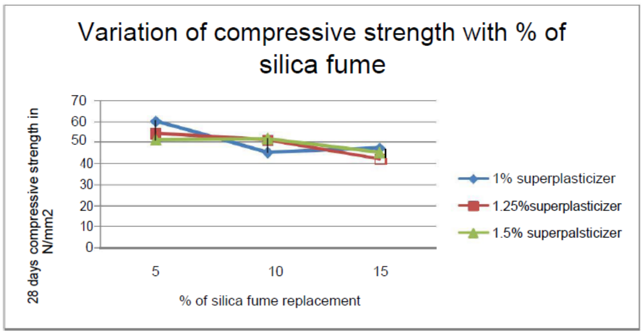

Fig 2. Variation of compressive strength with % replacement of silica fume

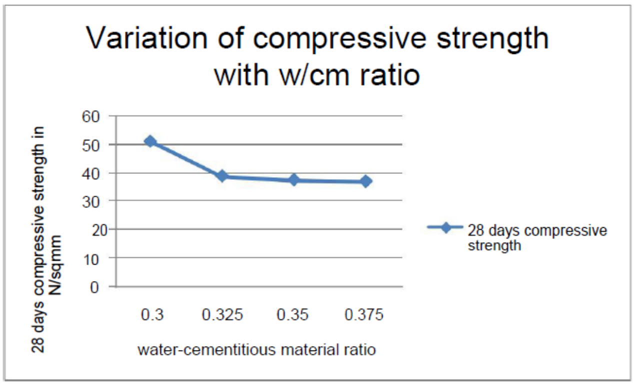

Fig. 3: Variation of compressive strength with W/CM ratio

Economic aspects with respect to the life-cycle costs of a structure

In addition to the production costs, the costs incurred during the life-cycle of a structure also have to be assessed in terms of cost-effectiveness. These include the repair and maintenance costs to keep the structure functional as well as the costs incurred by demolition at the end of the life-cycle of the structure. Together with the production costs they make up the sum total of the life-cycle costs. Fig. 4 shows the qualitative course of the lifecycle costs of a bridge. Investigations carried out in Austria reveal that the average replacement costs for the raw bearing structure of a bridge that had reached the end of its life-cycle with a effective span of up to 40 m were approx. 640 Rs./m² of bridge area [5]. The costs for repair of the bearing structure thus amount to 28 % of this value.

In order to be able to evaluate alternative construction designs with respect to their life-cycle costs for a cost-effectiveness comparison, use has to be made of the present value method [6]. By means of this method all costs to be incurred in the future are discounted to the current time of consideration. The present value thus specifies the amount which has to be invested at the time of consideration, and then has to produce interest in order to be able to settle all future costs.

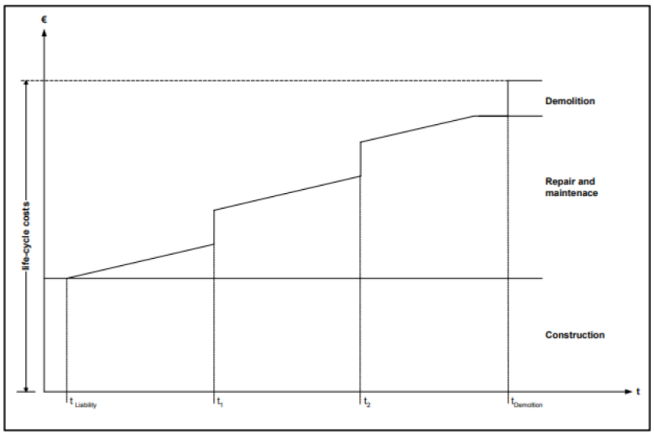

Fig. 4: Qualitative progress of life-cycle costs of a bridge

CONCLUSIONS

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.

Increasing social demand for sustainability in construction requires an appropriate engineering evaluation of HPC. By means of a design example the lower energy and raw materials consumption of HPC required for a column is compared with that of normal and highstrength concrete. This shows the relatively high degree of success in achieving the ecological goal of sustainability.

The economic benefits are shown by citing the example of the increase in floor space that can be achieved in a building, as a result of smaller compound units. There is also the factor of

the optimized durability of HPC, which generates altogether lower life-cycle costs than the existing standard concretes. In short, HPC can be characterized as the more sustainable building material.

The above-mentioned considerations make clear and also explain that the two criteria of cost-effectiveness and sustainability are increasingly important to the engineering evaluation of a structure because they give rise to further developments with respect to the shaping of the contractual arrangements between contractor and client. If, as shown, not only the net construction costs, but also the total life-cycle costs and yields are taken into consideration, then it becomes clear why, in practice, the utilization period is increasingly included in the period of validity of construction contracts.

REFERENCES

[1] Hegger, J, "High-strength concrete for a 186 m high office bui lding in Frankfurt, Germany." Engineering Structures, Vol. 18, No. 11, (1996): pp. 850- 854.

[2] Moreno, J,"High-Performance Concrete: Economic Considerations ." Concrete International, Vol. 20, No. 3, Mar.

[3] Bhanjaa, S, Sengupta, B, "Modified water–cement ratio law for silica fume concretes."Cement and Concrete Research. 33 (2003) p.447–450.

[4] Maiti, S C, Agarwal, Raj K, and Rajeeb Kumar,"Concrete mix proportioning."The Indian Conrete Journal , December 2006 ,p 23-26.

[5] Henry H.C. Wong and Albert K.H. Kwan "Packing Density: A Key Concept for Mix Design of High Performance Concrete".

[6] Papayianni,I, " Influence of superplasticizer type and mix design parameters on the performance of them in concrete mixtures.", Cement & Concrete Composites 27 (2005) p.217–222.

[7] James A. Farny and William C.Panarese , "High Strength Concrete" EngineeringBulletin , Portland Cement Association,(1994).

8 . Design Aids For Reinforced Concrete To IS: 456-1978 - SP:16-1980, Indian Standard Institution.

[8] Bundesamt für Bauwesen und Raumordnung (Hrsg.): Leitfaden Nachhaltiges Bauen. 2001

[9] Graubner, C.-A.; Hüske, K.: Nachhaltigkeit im Bauwesen. Verlag Ernst & Sohn 2003

[10] Böing, R.; Schmidt, M.: Rohstoff- und energiesparendes Konstruieren mit Beton. In: Beton Heft 7/1997

[11] Bornemann, R.; Schmidt, M.; Fehling, E.; Middendorf, B.: Ultra-Hochleistungsbeton HPC. In: Beton- und Stahlbetonbau, Heft 7/2001

[12] Wicke, M.; Kirsch, P.; Straninger, W.; Scharitzer, B.: Kostenmodell für den Funktionserhalt von Straßenbrücken. In: Bauingenieur Heft 2/2001

[13] Schelle, H.: Wirtschaftlichkeitsrechnungen für die Angebotswertung im Bauwesen. Werner-Verlag 1992

[14] Schmidt, M.; Fehling, E.; Teichmann, T.; Bunje, K.; Bornemann, R.: Ultra-Hochfester Beton: Perspektive für die Betonfertigteilindustrie. In: Betonwerk + Fertigteil-Technik Heft 3/2003

[15] Knoll, E.: Konzeption und Inhalt von Funktionsbauverträgen. In: Straße + Autobahn Heft 1/1999