Mass Concrete and High Strength concrete

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Abstract— Mass concrete is a hot topic. Owners desire long service lives so engineers design concrete mixes for low permeability. These mixtures typically have high cementitious material contents, which results in high temperatures within the concrete. To avoid cracking and other temperature related damage to the concrete, contractors must control the maximum temperature and temperature difference between the interior and the surface of the concrete. This can pit the schedule against the service life. When all involved parties work together, appropriate changes can be made to achieve the desired service life with minimal impacts to the schedule. The key is an understanding of mass concrete.In this paper I present the procedure of Mass concrete that show the procedure of percentage wieght and fine aggregate od mass concrete. Concrete continues to be an important product for use in the construction of many different types of buildings, wall structures, floors and other items. However, with today' s complicated high rise structures, the need to strengthen the product has become of utmost importance. According to the American Concrete Institute (ACI), high strength concrete must meet very specific requirements of at least 6,000 psi To accomplish this, the concrete is generally manipulated within its basic cement and aggregate mixtures and mixed with compound additives like calcinated shale, fly ash granulated blast furnace slag, metakaolin or silica fume

Keywords- Mass concrete , Portland cement, Blended cement: , hydrated Portland .

I. INTRODUCTION

Mass concrete is defined as any volume of concrete with dimensions large enough to require that measures be taken to cope with generation of heat from hydration of the cement and attendant volume change to minimize cracking. The design of mass concrete structures is generally based principally on durability economy , and thermal action.

The concrete placed in massive structures like dams, bridge piers, etc. A large size of aggregate (up to 150 mm maximum size)and a low slump are adopted to reduce the quantity of cement in the mix to about 5 bags per cubic meter of mass concrete. Outline why high strength concrete is required. For while still maintaining their strength. It might be to build while still maintaining their strength. It might be to build extended structures like dams or bridges. Whatever the use it will have an impact on how the concrete will be mixed. Additional considerations include, but are not necessarily limited to, the item's permeability, the estimated amount of material shrinkage and the needed workability within the product. Beyond that, one also has to consider ornamental considerations, such as the mixture's ability to be stamped and whether or not it will be stained.

The rest of this paper is as follows: Section 2 describes the Materials and mix Proportion followed by in section 3 chemical admixture , while Mixing is in section 5 and curing in section 6 , in section Section 7 Method of making HSC and conclusion is in section 8 presented the aggregate of mass concrete,

II. MATERIALS AND MIX PROPORTIONING OF MASS CONCRET

As is the case with other concrete, mass concrete is composed of cement, aggregates and water, and frequently pozzolans and admixtures. The objective of mass concrete mix proportioning is the selection of combinations of materials that will produce concrete to meet the requirements of the structure with respect to economy, workability, dimensional stability and freedom from cracking, low temperature rise adequate strength, durability, and - in the case of hydraulic structures - low permeability, The following types of hydraulic cement are suitable for use in mass concrete construction:

- Portland cement: Types I, II, IV and V
- Blended cement: Types P, IP, S, IS, I(PM), and

Type I: Portland cement is commonly used in general construction. It is not recommended for by itself in mass concrete without other measure that help to control temperature problems because of its substantially higher heat of hydration

Type II: Portland cement is suitable for mass concrete construction because it has a moderate heat of hydration important to the control of cracking. Specifications for Type II Portland cement require that it contain no more than 8 percent tricalcium aluminate (C3A), the compound that contributes substantially to early heat development in the concrete.

Type IV: Portland cement, also referred to as "low heat" cement, may be used where it is desired to produce low heat development in massive structures.

Type IV specifications limit the C3A to 7 percent the C3S to 35 percent, and place a minimum on the C2S of 40 percent.

III. CHEMICAL ADMIXTURES

The chemical admixtures that are important to mass concrete are classified as follows:

(1) air-entraining

(2) water-reducing; and

(3) set-controlling

- Accelerating admixtures are not used in mass concrete because high early strength is not necessary in such work and because accelerators contribute to undesirable heat development in the concrete mass.
- Chemical admixtures can provide important benefits mass concrete in its plastic state by increasing workability and/or reducing water content, retarding initial setting, modifying the rate of and/or capacity bleeding, reducing segregation, and reducing rate of slump loss.
- Chemical admixtures can provide important benefits to mass concrete in its hardened state by lowering heat evolution during hardening increasing strength, lowering cement content increasing durability, decreasing permeability, and improving abrasion/erosion resistance.
- Air-entraining admixtures are materials which produce minute air bubbles in concrete during mixing - with resultant improved workability, reduced segregation, lessened bleeding, lowered, permeability, and increased resistance to damage, from freezing and thawing cycles.
- Water-reducing and set-controlling admixtures generally consist of one or more of these compounds:

  1- lignosulfonic acid

  2- hydroxylated carboxylic acid.

  3- Polymeric carbohydrates

  4-Naphthalene or melamine types of high-range water reducers

IV. AGGREGATES

Fine aggregate is that fraction "almost entirely passing the No. 4 (4.75 mm) sieve. It may be composed of natural grains, manufactured grains, composed of natural grains, manufactured grains obtained by crushing larger size rock particles, or a mixture of the two. Fine aggregate should consist of hard, dense, durable, uncoated particles .

o Fine aggregate should not contain harmful amounts of clay, silt, dust, mica, organic matter, or other impurities to such an extent that, either separately or together, they render it impossible to attain he required properties of concrete when employing normal proportions of the ingredients. Deleterious substances are usually limited to the percentages by weight given in Table 1

Table 1 The percentages by Wieght of Deleterious Substances

3.0	Clay tumps and friable
	Material finer than No.200
3.0	For concrete subject to abrasion
5.0	For all other concrete
	Coal and lignite
0.5	Where surface appearance of concrete is of importance
1.0	All other concrete

Table 2 Fine aggregate for mass concrete % of passing

	Sieve Designation
0	3/8in. (9.5 mm)
0.5	No. 4(4.75 mm)
5-15	No. 8(2.36 mm)
10-25	No. 16(1.18 mm)
10-30	No. 30(600 mm)
15-35	No. 50(300 mm)
12-20	No. 100(150 mm)
3-7	Pan Fraction

o Coarse aggregate is defined as gravel crushed gravel, or crushed rock, or a mixture of these nominally larger than the No. 4 (4.75 mm) and smaller than the 6 in. (150 mm) sizes for large structures

The maximum size of coarse aggregate should not exceed one-fourth of the leas dimension of the structure nor two-thirds of the least clear distance between reinforcing bars in horizontal mats or where there is more than one vertical reinforcing curtain next to a form.

Maximum allowable percentages of deleterious substances in coarse aggregate(by weight)

Material passing No.200 sieve (75mm)	**0.5**
Lightweight material	**2.0**
Clay lumps	**0.5**
Other deleterious substances	**1.0**

1- WATER

Water used for mixing concrete should be free of materials that significantly affect the hydration reactions of Portland cement, Water that is fit to drink may generally be regarded as acceptable for use in mixing concrete.

2- TEMPERATURE CONTROL

The high temperature of mass concrete due to the heat of hydration may lead to extensive and serious shrinkage cracks. The shrinkage cracks can be prevented by using low heat cement and by continuous curing of concrete. The mass concrete develops high early age strength but the later age strength is lower than that of continuously cured concrete at normal temperature. The volume changes of mass concrete during setting and hardening are small, but the concrete is susceptible to large creep at later age.

o The four elements of an effective temperature control program, any or all of which may be used for a particular mass concrete project, are:

(1)cementitious material content control, where the choice of type and amount of cementitious materials can lessen the heat-generating potential of the concrete

(2)precooling, where cooling of ingredients achieves lower concrete a temperature as placed in the structure

(3)post cooling, where removing heat from the concrete with embedded cooling coils limits the temperature rise in the structure:

(4)Construction management, where efforts are made to protect the structure from excessive temperature differentials by knowledgeable employment of concrete handling.

3-THERMAL STRESSES IN CONCRETE

A list to minimize thermal stresses:-

1. Aggregate with low coefficient of thermal expansion
2. Cement with low C3A
3. Insulating forms
4. Cast concrete at night I early morning
5. Use ice instead of water
6. Pre-cool aggregate and cement
7. Post cooling - embedded pipes
8. Provide joints (for expansion and movement
9. Less amount of cement
10. Use pozzolans
11. Use liquid nitrogen
12. Use thin layers
13. Use large size aggregates.

4-CREEP

Creep of concrete is partially-recoverable plastic deformation that occurs while concrete is under sustained stress. Creep appears to be mainly related to the modulus of elasticity of the concrete. Concretes having high values of modulus of elasticity generally have low values of creep deformation. The cement paste is primarily responsible for concrete creep.

5- VOLUME CHANGE

Volume changes are caused by changes in moisture content of the concrete, changes in temperature, chemical reactions, and stresses from applied loads. Cracks are formed in restrained concrete as a result of formed in restrained concrete as a result of shrinkage or contraction and insufficient tensile strength or strain capacity. Cracking is a weakening factor that may affect the ability of the concrete to withstand its design loads.

6- THERMAL CRACKING

o Cement hydration produces a rise in internal temperature. The outer surface cools faster than the core of the section.

o By thermal expansion/contraction, the temperature differential induces thermal (tensile) stresses at the surface.

In mass concrete to prevent thermal cracking and improve long-term performance is needed. Research suggests that the cracking risk of mass concrete can be lowered by a variety of methods, including:

1- Reduction of the fresh concrete temperature

2- Use of a larger maximum size aggregate

3- Use of aggregate with a low coefficient of thermal expansion

4- Use of crushed aggregate instead of smooth, round aggregate.

5- Replacement of cement with fly ash, slag, or other suitable supplementary cementitious materials (SCMs)

6- Entrained air

7-Reduction of cement content and paste content.

FACTORS AFFECTING TEMP. RISE

1- Cement Fineness: Cement with a lower fineness with slow hydration, and reduce temperature rise.

2- Cement Content: Mass Concrete mixtures should contain as low of a cement content as possible to achieve the desired strength. This lowers the heat of hydration and lower the cement content, reducing temperature rise.

V. MIXING

Mixers for mass concrete must be capable of discharging low-slump concrete quickly and with consistent distribution of large aggregate throughout the batch. This is best accomplished with large tilting mixers in stationary central plants. The most common capacity of the mixer drum is 4 yd3 (3 m3) but good results have been achieved with mixers as small as 2 yd3 (1.5 m3) and as large as 12 yd3 (9 m3). Truck mixers are not suited to the mixing and discharging of low slump, large-aggregate concrete. Turbine type mixers may be used for mass concrete containing 3-in. (75-mm) aggregate.

VI. CURING

1-Mass concrete is best cured with water, which provides additional cooling benefit in warm weather In cold weather, little curing is needed beyond the moisture provided to prevent the concrete from drying during its initial protection from freezing However, the concrete should not be saturated when it is exposed to freezing. In above-freezing weather when moisture likely to be lost from the concrete surfaces, mass concrete should be water cured for a least 14 days or up to twice this time if pozzolan is used as one of the cementitious materials. Except when insulation is required in cold weather, surfaces of horizontal construction joints should be kept moist until the wetting will no longer provide beneficial cooling.

Curing should be stopped long enough to assure that the joint surface is free of water but still damp before new concrete is placed. The use of a liquid-membrane curing compound is not the best method of curing mass concrete but in some Instances it is the most practical. If used on construction joints, it must be completely removed by sandblasting or water blasting to prevent reduction or loss bond.

VII. Method of making HSC

There are special methods of making high strength concrete like (Seeding , Revibration , High speed slurry mixing , Use of admixtures , Inhibition of cracks , Sulphur impregnation , Use of cementitious aggregate):

Seeding: This involves adding a small percentage of finely ground, fully hydrated Portland cement to the fresh concrete mix. The mechanism by which this is supposed to aid strength development is difficult to explain. This method my not hold much promise.

Revibration: concrete undergoes plastic shrinkage Mixing water creates continuous capillary channels, bleeding, and water accumulates at some selected places. All these reduce the strength of concrete controlled revibration removes all these effects and increases the strength of concrete.

High slurry mixing: this process involves the advance preparation of cement-water mixture which is then blended with aggregate to produce concrete. Higher compressive strength obtain is attributed to more efficient hydration of cement particles and water achieved in the vigorous blending of cement paste.

Use of admixtures: Use of water reducing agents are known to produce increased compressive strengths.

Inhibition of cracks: Concrete fails by the formation and propagation of cracks, if the propagation of cracks inhibited, the strength will be higher.

Sulphur impregnation: satisfy high strength concrete have been produced by impregnation low strength porous concrete by Sulphur.

Use of cementitious aggregate: lt has been found that use of cementitious aggregate has yield high strength.

VIII. Selection of materials and their properties in HSC(1)

All materials for use in high-strength concrete must be carefully selected using all available techniques to insure uniform success. Items to be considered in selecting materials. include cement characteristics, aggregate size, aggregate strength, particle shape and texture, and the effects of set-controlling admixtures, water reducers, silica fume, and pozzolans. Trial mixtures are essential to in-sure that required concrete strengths will be obtained and that all constituent materials are compatible. Mix proportions for high-strength concrete generally have been based on achieving a required compressive strength at a specified age. Depending on the appropriate application, a specified age other than 28 days has been used. Factors included in selecting concrete mix proportions have included availability of materials, desired workability, and effects of temperature rise. All materials must be optimized in concrete mix proportioning to achieve maximum strength. High-strength concrete mixes have usually used high cement contents, low water-cement ratios, normal weight aggregate, and chemical and pozzolanic admixtures. Required strength, specified age, material characteristics, and type of application have strongly influenced mix design. High-strength concrete mix proportioning has been found to be a more critical process than the proportioning of lower-strength concrete mixes.

Laboratory trial batches have been required in order to generate necessary data on mix design. In many cases, laboratory mixes have been followed by field pro-duct ion trial batches Batching, mixing, transporting, placing, and control procedures for high-strength concrete are not essentially different from procedures used for lower-strength concretes. However, special attention is required to insure a high-strength uniform material. Special consideration should be given to minimizing the length of time between concrete batching and final placement in the forms. Delay in concrete placement can result in a subsequent loss of long-term strength or difficulties in concrete placement Special attention should also be paid to the testing of high-strength concrete cylinders since any deficiency will result in an apparent lower strength than that actually achieved by the concrete. Items deserving specific attention include manufacture, curing, and capping of control specimens for compressive strength measurements characteristics of testing machines; type of mold used to produce specimens; and age of testing. In many instances, strength measurements at early ages have been made even though the compressive strength has not been specified until 56 or 90 days Some research data have indicated that the modulus of elasticity of high-strength concrete is lower than would have been predicted from data on lower-strength concretes However, values of Poisson's ratio appear to be in the expected range, based on lower-strength concretes The modulus of rupture for high-strength concretes is higher than would have been anticipated. However, the tensile splitting strength values appear to be consistent with lower-strength concretes. Unit weight, specific heat diffusivity, thermal conductivity, and coefficient of thermal expansion have been found to fall generally within the usual range for lower-strength concretes. High-strength concrete has shown a higher rate of strength gain at early ages as compared to lower-strength concrete, but at later ages the difference is not significant Information on creep and shrinkage of high-strength concrete. has indicated that the shrinkage is similar to that for lower-strength concrete. However, specific creep is much less for high-strength concretes than for lower-strength concretes.

In the area of structural design, it has been found that axially loaded columns with high-strength concrete can be designed in the same way as lower-strength columns. It has also been Identified that high-strength concrete columns exhibit less shortening under load than lower-strength. columns because of the higher modulus of elasticity and lower creep coefficients. For beams, use of the conventional equivalent rectangular stress block appears to give satisfactory results for under-reinforced concrete members. The compressive strain limit of 0.003 appears to be acceptable. However, changes have been recommended for present code values for minimum tensile steel ratio, modulus of rupture, modulus of elasticity shear strength, and development length. Changes are also needed in the area of calculating long-term beam deflections. The economic advantages of using high-strength concrete in the columns of high-rise buildings have been clearly demonstrated by applications in many cities. The ability to reduce the amount of reinforcing steel in columns without sacrificing strength and to keep, the columns to an acceptable size has been an economic benefit to owners of high-rise buildings. Consequently concrete with compressive strengths in excess of 6000 psi (41 MPa) has been used in the columns of high-rise Buildings in cities throughout North America. Studies have also indicated advantages in the use of high-strength Concrete in long-span concrete bridges. However, this application has yet to be fully implemented. There have also been applications where high-compressive-strength concrete has been needed to satisfy special local requirements These have included dams, prestressed concrete poles, grandstand roofs, marine foundations parking garages, bridge deck overlays, heavy duty industrial floors, and industrial manufacturing applications. Although high-strength concrete is often considered a relatively new material, it is becoming accepted in more parts of North America as shown by the many examples of its usage.

IX. Conclusion

In this paper I present a Mass Concrete and High Strength concrete as a two topic for concrete and the result show that the mass Concrete is used in massive structures like dams , piers to deal with the high heat from the hydration of the cement and to deal with the thermal stresses , creep and volume change in concrete …........

While the High Strength concrete show that it could be used to reduce the size of column and the ability to reduce the amount of reinforcement steel has been an economic benefit to owner of high- rise building …....

REFERENCES

1- ACI committee 207.1R-96. (1)

2- (Concrete technology M L GHAMBER. (22-

3-Retrived from http: //courses. Washington. Edu/cm425/ther maL pdf.

4- www.concreteconstruction.net

5-Composition and properties of concrete DAVIS KELLY