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COMPARITIVE ANALYSIS OF REVISED BIS CODE IS:10262-2009 WITH ITS PREVIOUS VERSION OF 1982 THROUGH MIX DESIGN

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Abstract— **This paper is an attempt to study the IS 10262 Bureau of Indian Standards (BIS). The Bureau of Indian Standards (BIS) has released the code on concrete mix proportion in the year of 1982 and revised version code in December 2009. Some changes have been made in the revised version and now it can be used for designing a variety of concrete mixes using chemical admixtures. The RMS have a high degree of workability in the revised version code. In this paper an effort has been made to examine the comparison between both IS 10262-1982 to IS 10262-2009.**

I. INTRODUCTION

Mix Design of Concrete is the process of deciding the proportions of the ingredients of concrete so as to be produced most economically, that would satisfy the desired properties of fresh and hardened concrete as well. In simpler words, the concrete should be well workable when fresh and the designed compressive strength as well as durability should be achieved at hardening.The engineering properties of concrete depend on the properties of its constituents, design mix standard, mixing, placing, compaction, curing, transportation and handling. Due to the use of natural materials in the preparation of concrete, the properties of the concrete mix vary widely. Therefore, determination of the quality and proportion of the constituents is an important aspect in the preparation of a concrete mix.

The wide use of concrete as the basic construction material may be due to its adaptability for a wide range of strength and workability. To achieve different strength requirements, it is the "Mix-design process" that makes the difference as the basic ingredients are same all the way.

Very likely to other methods of Concrete Mix Design, Guidelines recommended by Bureau of Indian Standards for concrete mix design is based on certain empirical relations established through vast number of experiments conducted upon materials used in Indian conditions. IS: 10262 is the specified code to serve the purpose. This code came to being in the year 1982. So IS: 10262-1982 had been evolved to guide the concreting technology being followed at that period. But at present due to demand in high strength concrete and for economic production, use of supplementary materials has become essential. With the advanced technology a number of additives have been identified and are being used extensively now-a –days. These additives are not only enhancing the quality of concreting but also make the process economic and eco-friendly too.

So keeping these in view the necessary modifications were felt essential and the revised version of the code as IS: 10262-2009-"Concrete Mix Design Guidelines" has met this in time. The revised version encourages use of supplementary cementitious materials and water reducing additives. Besides, being consistent with specifications of IS: 456-2000, necessary modifications have been made

Parameter	BIS Method Old [IS10262:1982]	BIS Method New [IS 10262:2009]

IS: 10262-1982 Vs IS: 10262-2009

Characteristic compressive strength at 28 days	YES	YES
Standard deviation of compressive strength	YES	YES
Degree of workability	COMPACTING FACTOR	SLUMP
Type and maximum size of aggregates	YES	YES
Nominal maximum size of coarse aggregates (NMSA)	YES	YES
Dry rodded unit weight of coarse aggregates	NO	YES
Fine aggregates (sand)	GRADING ZONE	FINENESS MODULUS (FM), ZONE WISE
Specific gravity of cement, coarse and fine aggregates	YES	YES
Water absorption and moisture content adjustment	YES	YES
Exposure condition	NO	YES
Superplasticiser, admixtures	NO	YES

Basic data used in the old and new BIS

A. The key modifications

Title of the Code The modified title of the code itself makes the designer feel little flexible. i.e. "IS 10262-1982-Recommended guidelines for concrete mix design" modified as "IS 10262-2009-Concrete Mix proportioning Guidelines.

B. Strength & Durability

The 1982 version considers strength as the governing criteria for durability and so also for the mix design process. But according to the revised one strength may be a factor for acceptance but may not assures durability.

C. Air Content

IS: 10262-1982 considers expected air content of 1% to 3% in the design process depending on the nominal maximum size of aggregates.

IS: 10262-2009 eliminates consideration of air content in the mix proportion calculation as it's not of much significance.

D. Water Cement Ratio

The old version suggested that selection of preliminary free w/c ratio may be adopted from established relationships presented in form of graph as generalized w/c ratio curves for different cement strengths. Accordingly six ready reference curves were there namely A to F for a wide range of cement strengths from 325kg/cm2 to 625kg/cm2. This selected w/c ratio is to be checked against limiting w/c ratio for durability.

The revised version encourages establishing the relationships for actually used material. Otherwise it suggests to consider it from the specified table (Table-5) of IS: 456 for desired exposure condition as preliminary w/c ratio that has to be further checked for limiting value ensuring durability.

E. Workability

IS: 10262-1982 considers compaction factor as the measure of workability. In revised one, slump is considered as the measure of workability. Measurement of workability as slump is more convenient, widely used at sites and is better acceptable.

F. Mineral Additives

The revised code provides guidelines for addition of supplementary cementitious additives. So additives like fly ash, silica fume, ground granulated blast furnace slag, rice husk ash etc. can be used in concrete mix provided the strength and durability requirement are met with.

So as per the revised code the concrete is no longer a four component system (cement, sand, coarse aggregates & water) as considered in the previous version, but it is much more.

G. . Water content

The quantity of water to be used plays a vital role in concrete mix design. Agreeing with the old guidelines, values of water content have been specified in terms of kg per cubic meter of concrete depending upon the nominal maximum size of aggregates which can be considered as starting selection point of water content.IS: 10262-2009 allows use of water reducers/ super plasticizers and also specifies the alteration in water content accordingly. Further water adjustment was specified in terms of variation of compaction factor in the older version whereas the same has been remolded in terms of slump variation (+3% for every 25mm slump over 50mm) in the revised one.

H. . Estimations of Coarse and Fine Aggregates

The 1982 publication specifies ratio of fine aggregates to all-in-aggregates from which coarse aggregates content can be derived.

In revised one the volume of coarse aggregates per unit volume of total aggregates for different zones of fine aggregates and different maximum nominal size of aggregates has been tabulated from which the fine aggregates content has to be derived. Further in the earlier guidelines necessary adjustments in sand content has been suggested depending on its grading zone, whereas the recent guidelines allow reduction in coarse aggregates content for better workability, provided other desired properties are satisfied.

I. Miscellaneous

Besides the other points to be bolded are

• The standard is applicable for ordinary and standard grades of concrete.

• Various requirements have been modified in line with the requirements of IS: 456-2000-Plain and reinforced concrete-Code of practice.

• Other illustrations like trial mixes, numerical example etc have been reviewed and modified.

• An example illustrating mix proportioning with supplementary cementitious additive (fly ash) has been included.

NUMERICAL EXAMPLE

Let's consider a mix design with following design parameters. Design Stipulations Grade designation M25 (moderate exposure) i.e. fck= 25 Mpa Maximum nominal size of aggregates 20mm. Sand conforming to Zone-II of IS: 383-1983 Degree of workability medium.

Test Data

i. Cement used: PPC IS:1489

ii. Specific gravity of Cement = 3.15 Fine Aggregates = 2.67 Coarse Aggregates = 2.78

iii. Water absorption of Fine Aggregates = 0.86% Coarse Aggregates
= 0.48%

iv. Free surface moisture of Fine Aggregates – nil Coarse Aggregates – nil

v. Grading of Aggregates (IS:383) Fine Aggregates-Zone-II Coarse Aggregates- nominal 20 mm size

Design as per IS: 10262-1982

Target mean strength ft = fck +k.S

= 25 + 1.65 x 4.0 =31.6 Mpa

Selection of w/c ratio 28 day compressive strength of cement comes to be 543kg/cm2 .

w/c ratio from curve E of figure.2 is 0.52.

Maximum w/c ratio from table 5 of IS: 456 is 0.5 Lets adopt w/c ratio = 0.5

Water & sand content For 20mm nominal maximum size of aggregates water content is 186kg/m3 of concrete.

Fine Aggregates percentage of total aggregates by absolute volume = 35%

Adjustments

Change in condition	Percentage Water adjustment	Percentage Sand adjustment
w/c ratio (-0.1)	0	2.0
Workability (+0.1 CF)	+3.0	0
Sand zone (Zone-II)	0	0
Total	+3.00%	-2.00%

Adjusted water content=186kg x 1.03 = 191.6 kg

Adjusted sand content = (35-2) %= 33%

Cement content calculation

w/c ratio = 0.5

Cement quantity = 191.6/ 0.5 = 383 kg.

Determination of Aggregates content For 20mm nominal maximum size aggregates entrapped air as specified is 2%.

Total volume of ingredients excluding void per cubic meter of concrete designed = 0.98 m^3 .

Total volume of aggregates = 0.98 – [(383/3.15) +191.6]/1000 = 0.667m^3

Total mass of Fine Aggregates per m^3 of concrete = 0.667 x 2.67 x 0.33 x 1000 = 588 kg Total mass of Coarse Aggregates per m^3 of concrete

= 0.66 x 2.78 x (1-0.33) x 1000 = 1242 kg

Calculated proportions

Particulars	Qty. in kg/m^3 of concrete	Mix Proportions by mass
Water	191.6	0.5
Cement	383	1
Sand	588	1.54
Coarse Aggregates	1242	3.24
Total	2405	

Design as per IS: 10262-2009

Target mean strength ft= fck +k.S = 25 + 1.65 x 4.0 =31.6 Mpa

Selection of w/c ratio

Maximum w/c ratio from table 5 of IS: 456 is s 0.5

Let's adopt w/c ratio = 0.5

Water content For 20mm nominal maximum size of aggregates and slump range 25mm to 50mm, water content is 186kg/m3 (Table 2) of concrete.

Cement content calculation

w/c ratio = 0.5 Cement quantity = 186/ 0.5 = 372 kg.

Determination of Coarse & Fine Aggregates Content From table 3 of the standard, volume of Coarse Aggregates corresponding 20mm nominal maximum size aggregates and for Zone-II Fine Aggregates = 0.62%

- Volume of concrete = 1m^3
- Volume of cement = 372/3.15*1000 = 0.118m3
- Volume of water = 186/1000 = 0.186m^3
- Volume of all-in-aggregates =1-(0.118+0.186) m = 0.696m^3
- Mass of Coarse Aggregates =0.62 x 0.696 x 2.78 x 1000 =1200kg
- Mass of Fine Aggregates = (1-0.62) x 0.696 x 2.67 x 1000 =706kg

Particulars	Qty. in kg/m^3 of concrete	Mix Proportions by mass
Water	186	0.5
Cement	372	1
Coarse Aggregates	1200	3.22
Total	2464	

Compressive Strength

Compressive strength of concrete is tested on cube at different percentage of marble powder content in concrete. The strength of concrete has been tested on cube at 7 days,14 days curing and 28 days.7 days test has been conducted to check the gain in initial strength of concrete, 14 days test has been conducted to check the gain in median strength of concrete and 28 days test gives the data of final strength of concrete at 28 days curing. Compression testing machine is used for testing the compressive strength test on concrete. At the time of testing the cube is taken out of water and dried and then tested keeping the smooth faces in upper and lower part.

II. Conclusions

1. Calculated amount of Sand was found to be 4% more in IS 10262-2009.
2. There was no change in water content.
3. There was no change in Cement content.
4. Calculated amount of Sand was found to be 2% less in IS 10262-2009.

III. Discussion

1. During the 1980s the cements used were relatively of lower strengths. So the design following the old code results in more cement consumption.
2. Allowance for mineral additives as per revised code makes the mix economic and also properties like strength and durability are enhanced.
3. From the Numerical example it was observed that,

a. The Fine Aggregates content is appreciably higher, when designed as per the revised guidelines indicating the improved workability

b. Mix as per revised code yields better yield than that by older one, resulting a denser concrete. However numerical interpretations are to be verified experimentally.

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