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Performance of Cement Sand Mortars Using Diverse Grades of Sand

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ABSTRACT

Cement used was ordinary Portland cement. Two diverse grade of sand were selected from the construction material provider who is providing materials in the society. There sand have been named as W and X in data of their fineness modulus. In accepting with the data of fineness modulus of the sand are as following were 1.97 and 1.78 respectively. Mortars were preparing with the cement and sand ratio as 1:3.5 and 1:4.5 with providing constant flow (100+ 6) or with (100+9). All the tested were carried out in accordance with Indian standard code specifications of the mortars. Each of the mortar specimen are tested with the size of 7cm by 4.5 cm of cubes specimens in compression bearing using 3.5cm x 3.5cm x 15cm beam specimen and in tension also.

Key Words: Different grades of Sand, Indian standard code, Portland cement.

INTRODUCTION

The art of building with masonry materials has its roots in antiquity. The use of brick and stone goes to the earliest building effort of civilized man. The technique of moulding hollow clay units- clay tiles- was developed at the later stage and the production of concrete masonry came much later in the 19th century. Although lime mortar was used as the building agent for many hundred years, the development of Portland cement and its use in cement mortar and more recently, the development of organic cements has resulted in greatly improved methods of the construction with unit masonry.

Concepts regarding masonry construction have undergone radical changes over years. Whereas stone and brick were, at one stage, the primary structural materials, resulting in heavy buildings with thick bearing walls and great arched roofs, the modern trend favors lighter construction, using frame works and masonry closer walls or reinforced masonry walls. The result has been that the stone is now used almost entirely as a facing material, while brick is used for closer walls, bearing walls in some cases, and as a facing material. The trend to lighter buildings was enhanced by the development of hollow masonry concrete masonry. The production of concrete masonry during past fifty years has led to a great reduction of structural clay tiles.

Thus, we can say the masonry constructional technique is as old as the history of man. Different phases came, and their constructional techniques improved. In all types of masonry (i.e. brick masonry, stone masonry, concrete masonry) man used stone, bricks, concrete, cement, lime, sand etc. as building materials. For construction of any masonry binding materials are used which are known as mortars. So, the main function of mortars is to bind the bricks, stones or other building fragment to form a homogeneous mass capable of withstanding and transmitting the load safely. In different phase of masonry different types of mortars are used. For poor work mud mortar was used. Lime- surkhi mortar improved the mud mortar construction. Discovery and mass scale production of cement has replaced the lime mortar with addition of admixtures has affected the constructional techniques and more useful and durable structures can be made with the help of good quality of mortar. Thus, good mortars may be used for lining of hydro-structures, plastering of exterior faces with good finishes.

The type of mortar depends on the total load that structure has to bear, the weathering agencies, type of finish desired. For brick masonry, commonly used mortars are lime mortar, cement mortar, lime cement mortar, lime

surkhi mortar and mud mortar. Mud mortar is not used for engineering work. For stone masonry 1:3 cement sand mortar is used. To increase its workability 15% of cement is replaced by lime. Lime stones get stained by ordinary cement sand mortar. So, staining white Portland cement may be used. Generally, one part of clean non-staining cement part hydraulic lime and six part of clean sand are used for stone finishes. For concrete (hollow block) masonry, generally cement sand mortar is preferred.

The role of mortar in masonry work is as binding material. Bricks, stone pieces or other building material is bided together with the help of mortar which binds them. Mortar plays important role in providing even bed for masonry work. Mortar also gives good finish to the masonry. For hydro-structures mortar joints check the seepage of fluid, so it is more commonly used in canal lining and grouting. Mortars may be prepared wither by manually or mechanically. Manual preparation should be done on a clean, smooth surface of wood, concrete, metal or other suitable material which is practically non-absorbent and free from open joints. Mechanical preparation may be done by a machine equipped to produce a mixing action or combined grinding and mixing action.

METHODOLOGY OF EXPERIMENTAL WORK

Mortars

Mortars may be defined as a material composed of fine aggregate (say below 3/16" in size i.e. sand or surkhi) and cementing material which forms a hardened mass after admixing with a suitable proportion of water. It is used in beds and side jointing of brick work in order to bind the bricks together, to distribute the pressure throughout the brick work and filling the joints, to increase the heat and sound insulation. Sand is the aggregate commonly used for mortars, but old bricks, burnt ballast or stones ground in mortar are sometimes used as substitutes. It is doubtful if the shape of the individual grains, whether rounded or angular, has any significant role upon the quality or strength of the mortar.

The essential requirement for a good mortar aggregates are: -

a) Particle should be evenly graded from fine to coarse
b) Aggregates should be clean and free from all clays, earthy matters and soluble salts. These may give rise to efflorescence and dampness in the wall. So, care should be taken if either sea sand, ashes clinker or bricks contaminated with old plaster are used as aggregate. The use of a loamy or soft sand to increase workability and plasticity produces an inferior weak mortar, and should never be permitted.

The cementing material used in brick work or masonry may be either Portland cement or lime or the mixture of the two. The constituents of all mortars should be mixed thoroughly to ensure uniformity of composition.

Cement

Cement can be described as a material with adhesive and cohesive properties which make it capable of bonding fragments into a compact whole.

Fir 1 Cement

Sand

Sands consists of smaller grains of silica SiO_2. It is formed by the decomposition of sand stone under action of weather. The grains vary in size and may be rounded or angular According to sources, sand may be classified as pit sand, river sand, sea sand.

Fig 2 coarse grain sand

Water

Potable water is fit for masonry work and concrete work. Generally cement mixing water must be free from sugar, sulphate, chloride and other impurities. For this Project work tap water available in laboratory is used.

Admixture

Admixtures are additives which are mixed with cement to change properties of cement like setting time, workability, durability, strength etc. This results into the change of properties of mortars or concrete mix. With addition of admixture we can get special mortars or concrete according to our own need.

Types of Mortar

Mortar types are identified either by the proportions of cementations materials used per batch or by compressive strength of representative mortar cubes, tested after 7 and 28 days of curing time. When the proportions method is being used, the aggregate proportion in each case will not be less than two and one quarter or more than three times of the total volume of cement and lime in the batch.

Cement

Mortar type		Tasted at 7 days / Tasted at 28 days Compressive strength MPa(PSI) Average of six 50mm(2") cubes	
Laboratory prepared	P	11.0(1600)	17.5(2540)
	Q	7.5(1088)	12.5(1613)
Job prepared	P	0.3(45)	14.0(2030)
	Q	9.0(1300)	10.0(1450)

The ordinary Portland cement was taken for this work. The cement was available in th structure laboratory. It was tasted in laboratory as per I.S. 256-1967 at laboratory temperature with temperature correction. The properties of used cement is listed below:-

i) Normal consistency Pn = 36%
ii) Initial Setting time = 35 minutes

iii) Final setting time = 3 hours
iv) Fineness of cement = 18%
v) Specific gravity = 3.0
vi) Soundness (by Le-Chatelier apparatus) = 3.0mm

vii) Tensile strength (briquette)
- At 3 days 6.20kg/cm^2
- At 7 days 10.10kg/cm^2
- At 28 days 14.92kg/cm^2

viii) Compressive strength
- At 3 days 41.25kg/cm^2
- At 7 days 110.0kg/cm^2
- At 28 days 137.5kg/cm^2

Sand

For this project work four different types of sands were used which were obtained from contractor who was dealing with work of college library building construction. These sands were named on the basis of their fineness modulus as A, B, C, D. These sands were tested in accordance with I.S. Code 2386-63(Part I to VI), I.S. Code650-55(Indian standard sand) and test result were tabulated below:-

Sand A (Obtained from library construction site)

i) Loose unit weight = 1.45 t/m^3
ii) Compacted unit weight = 1.60 t/m^3
iii) Specific gravity = 2.625
iv) Bulking of sand = 12.365
v) Fineness modular = 1.97

Table 1: (A) Grading and fineness modulus of sand A (Weight of sand taken = 100 grams)

Indian standard sieve No.	Weight retained(gram)	Cumulative weight(gram)	percentage cumulative weight retained	Percentage passing
4.75mm	40	40	4.0	96.0
2.36mm	5	45	4.5	95.5
1.18mm	22	67	6.7	93.3
600micron	74	141	14.1	85.9
300micron	610	751	75.1	24.9
150micron	174	925	92.5	7.5
	Total :	**1699**	**196.7**	

Fineness modulus = 196.7 / 100 = 1.967 i.e. Fineness modulus = 1.97

Sand B (Obtained from library construction site)

i) Loose unit Weight = 1.45 t/m^3
ii) Compacted unit weight = 1.64 t/m^3
iii) Specific gravity = 2.58
iv) Bulking of Sand = 11.115
v) Fineness modulus = 1.78

Table 2: (B) Grading and fineness modulus of sand B (Weight of sand taken = 100 grams)

Indian standard sieve No.	Weight retained(gram)	Cumulative weight(gram)	percentage cumulative weight retained	Percentage passing
4.75mm	2	2	0.2	99.8
2.36mm	1	3	0.3	99.7
1.18mm	10	13	1.3	98.7
600micron	58	71	7.1	92.9
300micron	657	728	72.8	27.2
150micron	237	964	96.4	3.6
	Total :	**1781**	**178.1**	

Fineness modulus = 1781 / 100 = 1.781 i.e. Fineness modulus = 1.78

RESSULTS

7.07cm size cubes 5 cm size cubes briquettes were tested at 7 days and 28 days, 4 cubes of each specimen, 4 briquettes and 3 prisms were tasted at 7 days and rest 5 each cubes 5 briquettes and 3 prism were tested at 28 days the load carried by each specimen was added and divided by no specimen to obtain average load. Now corresponding strength are calculated as follow:-

1) Compressive strength = Average load / Cross Section area (Tasted on Compressing Testing Machine)
   a) For 7.07 cm cube A = $50cm^2$
      Compressive strength = Average load / $50cm^2$ (Cross Section area) ... (1)
   b) For 5cm cube A = $25\ cm^2$
      Compressive strength = Average load / $25cm^2$ (Cross Section area) ... (2)

2) Tensile strength = Average load / Cross Section area (Tasted on Tension Testing Machine)
   a) For 7.07 cm cube A = $6.45cm^2$
      Tensile strength = Average load / $6.45cm^2$ (Cross Section area)

3) Flexure Strength is given by F / Y = M / I
   a) F = M Y / I,
      = M / (I/Y)
      = M / Z = M / 10.67 kg / cm^3

For Bending Axis is XX
$I_{xx} = 1/12bd^3$
Z = I / Y, = I / (d/2)
(* $Y_{top} = Y_{bottom}$, Y = d/2)
Or
$Z = 1/12\ b\ (d^3 / (d/2))$
Or
$Z = 1/6\ x4x4^2\ cm^3$, $Z = 10.67cm^3$

For flexure test beam is placed on simple support at both ends and central load is applied by book arrangement. The exact load on which the beam fails is flexure load.

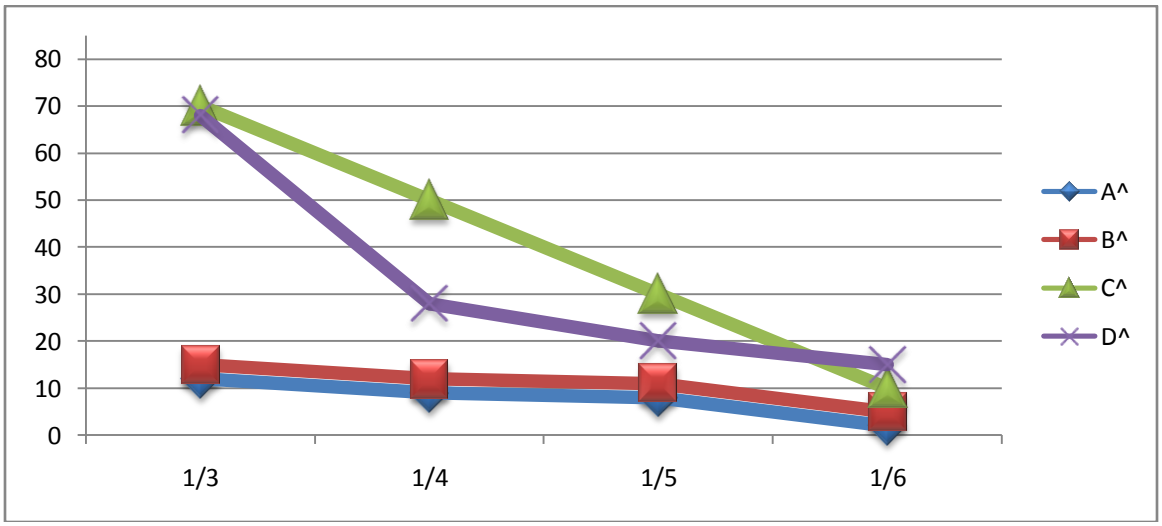
Table for test results

Sand type	F.M	Mortar type	C : S ratio	W/C ratio	Flow percentage	Compressive strength				Tensile strength		Flexure strength	
						7 days		28 days		7days	28 days	7 days	28 days
A	1.97	A_1	1:3.5	96	98	75	86	69	90.8	13.9	15.35	21.87	36.2
		A_2	1:4.5	99	100	30.5	36	27	40	13.5	11.31	11.74	21.8
		A_3	1:5.5	139	100	17	24	15	25.6	8.5	9.46	8.50	17.4
		A_4	1:6.5	179	100	14.5	20	12	16	6.30	6.5	6.25	14.0
B	1.78	B_1	1:3.5	99	102	70	84	60	92.8	12.9	13.6	21.3	33.4
		B_2	1:4.5	110	97	55	68	22	50.4	11.7	12.1	12.3	20.9
		B_3	1:5.5	155	100	25	32	12	20.8	8.1	8.46	9.56	14.3
		B_4	1:6.5	185	100	8.5	16	6	12	3.72	4.06	5.87	11.3

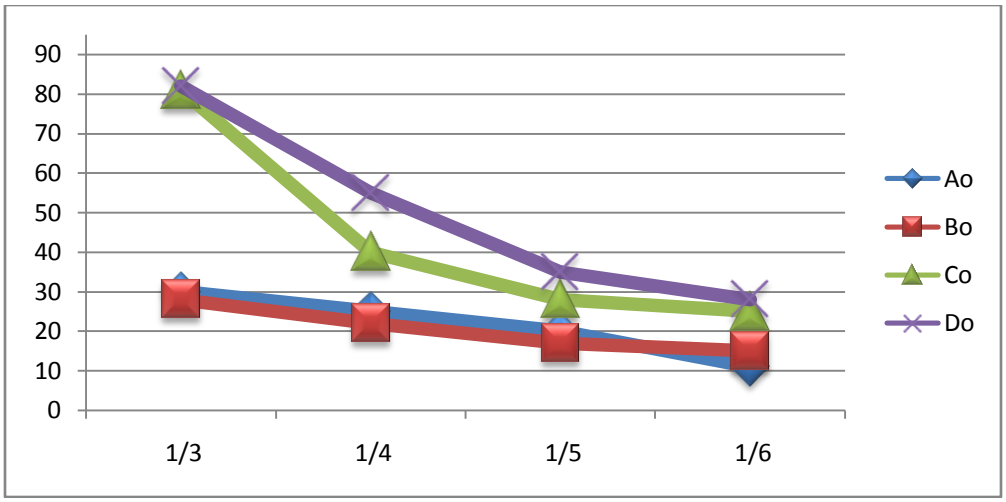
Table for the Description of Graphs

Curve	A_o	Stands for 7days strength for sand A (f.m. = 1.97)
Curve	$A_\wedge$	Stands for 28days strength for sand A (f.m. = 1.97)
Curve	B_o	Stands for7 days strength for sand B (f.m. = 1.78)
Curve	$B_\wedge$	Stands for 28days strength for sand B (f.m. = 1.78)

Specimen: 7.00 cm size cubes

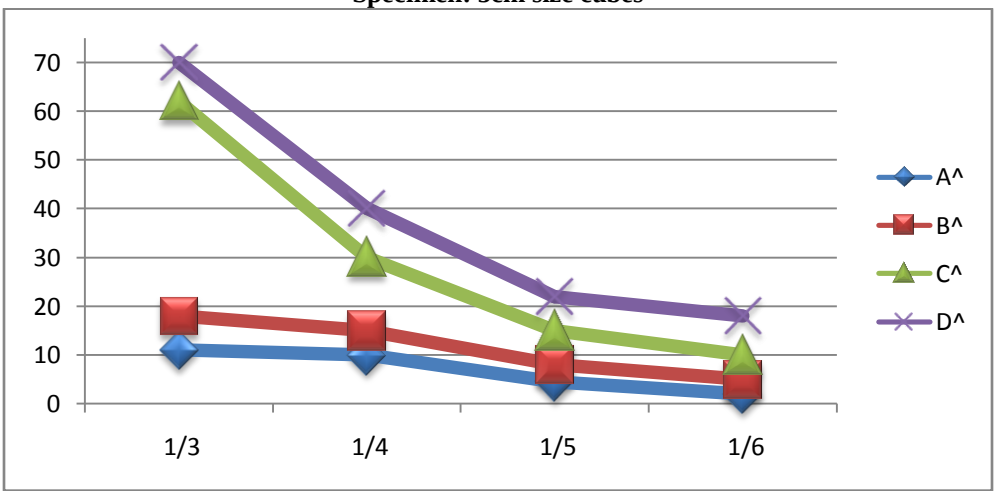


Graph A-7 days Cement:Sand ratio v/s Compressive Strength graphs

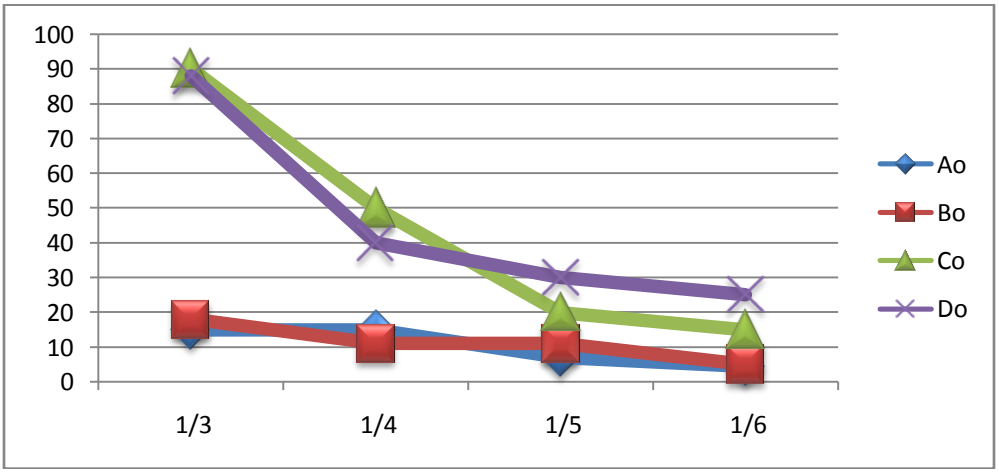


Graph A-28 days Cement:Sand ratio v/s Compressive Strength graphs

Specimen: 5cm size cubes



Graph B-7 days Cement:Sand ratio v/s Compressive Strength graphs



Graph B-28 days Cement:Sand ratio v/s Compressive Strength graphs

OBSERVATIONS

Investigations on "PERFORMANCE OF CEMENT SAND MORTAR'S USING DIVERSE GRADES OF SAND" were carried out and following observations are reported here as under.

1. The main properties of a fresh (green) mortar are workability and water retentivity. As per IS 236S-1963 (Part VI), flow should be (100+5) for workable mortar. Here it was found that for constant flow, water requirement increases with increase in cement sand ratio (from 1/3 to 1/4).
2. It was also observed that finer sand requires more water than coarser sand for constant workability.
3. The compression test was carried on compression testing machine of capacity 100t and 10t. Ist machine was used for testing of mortars having C/S ratio, 1/3 and 1/4, prepared with sand A (f.m.=1.97) and B (f.m.=1.78). For other mortars later machine was used. During test, it was observed later machine was used. During test, it was observed that failure pattern for rich mortars are in the form of vertical cracks, whereas for poor mortars chips were coming out from specimen faces. It was also observed that some specimens fall due to crushing showing very low strength.
4. From graphs it was observed that variations of strengths at 7days and 28 days is less for coarser sands whereas more for finer sands.

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