Development of Plastering Mortar Based on Recycled Waste Glasses

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Abstract – The aim of this study is to find a way to reuse the huge amounts of glass wastes in construction industry, by making new products at a lower price and also reduce the glass wastes. In this research several types of plastering mortars have been studied from a physical and mechanical point of view when natural aggregates were replaced by waste glass. Fine aggregates were replaced by waste glass aggregate as 50%, 100% and by weight for mortar mix1:6. The mortar specimens were tested for 7, 14, 28 days of age and the results obtained were compared with those of control block of mortar. The specimen was tested on ANSYS to analysis the tensile stress and deformation.

Index Terms – Glass Wastes, Plastering Mortars, ANSYS, Deformation.

1. INTRODUCTION

1.1 GENERAL:

Plastering is a process of applying one or more coats of mortar to a concrete surface, brickwork, stone masonry or lathing. It must be durable such that it resists the penetration of moisture and should be able to weather uniformly. It should also be pleasing in appearance. These properties depend upon materials used, composition of mix, and degree of mechanical bond between the plaster and the backing surface and work manship.

1.2 SURFACE PREPARATION:

The joint shall be raked to a depth of 15 mm for brickwork and 20 mm for stonework. For new work, where subsequantant plastering is to be done, the raking of joints shall be done during the progress of the work, when the mortar is still green. Dust or mortar powder (loose mortar) shall be washed out. The whole surface shall be thoroughly cleaned and brushing and scrapping shall remove efflorescence, if any. The surface thoroughly washed with water, cleaned and kept wet for the day previous and up to the time started the work, and shall be kept very damp during the progress of the plastering.

1.2.1 Bonding:

Cement mortar has two types of bonds with its backing one being mechanical in which the mortar squeezes into the irregularities and gets interlocked when hardened and other due to the adhesive property of Portland cement on hardening. The degree of bond will therefore depend on the roughness of surface to be treated and the quality of cement and sand used in preparation of mortar.

1.2.2 Concrete surface:

All monolithic concrete walls should be roughened by hacking at close intervals with bush hammers or with a chisel and hammer and then washed thoroughly with water to remove all dirt and loose particles. Monolithic concrete can be roughened with a heavy wire brush or a special scouring tool if forms are removed early .Forms for concrete that is to receive plaster, should not be given excessive mould oil coating. As it is likely to remain on the concrete, interfering with the bond. Special care must betaken to remove the mould oil coating before plaster is applied .Curing compound if used should also be removed completely before commencing the plasterwork.

1.2.3 Brick and stone masonry:

There are excellent bases for direct application of cement plaster. The surface should be hard ,rough and clean. The joints should be racked. It may be desirable to roughen with a pick or a similar sharp tool if the surface of stone is too smooth.

Tools for plastering:

Following tools are used for plastering ,Gauging trowel, floats, floating rule, plumb bob, straight edge ,bushes, set square, sprit level, and scratcher, plumb rules etc.

1.3 MATERIALS

Sand cement mortar of specified mix shall be used.

1.3.1 Mortar:

Cement mixed with fine aggregate should produce smooth, plastic, cohesive, strong and workable mortar. Cement plaster shall unless otherwise specified, to be the following proportion and thicknesses. The mortar of specified mix shall be used.

1.3.2 Cement:

At present 33 grade and high grade cement such as43 grade and 53 grade are being used. These are essentially recommended for use in concrete. It is also used in masonry and plastering work.

1.3.3 Fine aggregate:

Sand must be clean, sharp, suitably graded ,and free from all deleterious and impure matter. Deleterious materials beyond a certain limit adversely affect the hardening , strength, durability or the appearance of the plaster or causes corrosion of metal lathing or other metal in contact with plaster.

1.3.4 Grading of Sand:

Most suitable particle size grading of sand plaster work for internal and external walls and ceiling is given below:

1.4 WATER:

Water used in plasterwork should be of quality suitable for drinking purpose. It should be free from chlorides and organic impurities.

1.4.1 Water proofing compound:

Generally, they are not required specially if correct type and quality of other materials of mortar are available. Where it is used, it should disperse uniformly and mixed properly in mortar.

1.4.2 Workability admixtures:

Plasticizers can be used in warm or hot weather condition as desired with field requirements.

Scaffolding:

It is always advisable to provide double scaffolding for plastering work. It is easier to fix and remove at various heights without damaging the masonry or plaster.

Mixing of ingredients of plaster:

It is preferable to mix the ingredients in a mixer. Dry mortar is mixed initially and thereafter water is added to the dry mix to get the required consistency. It is observed that excess mortar is often prepared and not utilised in time. The workers even break for lunch leaving the wet mixed mortar to dry out. Water is again added resulting in lower strength and more shrinkage problem .The quantity of the mortar made at a time should be such that it can be consumed within 30 minutes. Any mortar that falls to the ground in the process of application, it is thrown away and on no account re used. If excess mortar is prepared it dries up either due to evaporation of water or due to water absorption by sand and or due to water consumed by cement hydration.

Addition of water should be carefully monitored and should be added in such a quantity that it gives the required workability

Application of plaster:

The walls shall be prepared as above and rendered with a mortar of cement and fine sand in specified proportions. At suitable intervals, 15 cm x 15 cm mortar squares to full thickness of base coat shall be first laid to serve as a guide to ensure a plane, smooth layer of plaster over the entire surface of the wall .The mortar shall be dashed against the surface to be plastered with considerable forced, and shall be thoroughly worked into all joints and other surface depressions, to ensure a permanent bond. The plaster surface will be roughened and not beaten. Ceiling plaster shall be completed before commencement of the wall plastering. Plastering shall be started from the top and worked down, filling all putlog holes in advance of the plastering as the scaffolding is being taken down .All corners arise, angles and junctions shall be truly vertical or horizontal as the case may be, and shall be carefully finished.

Rounding or chamfering corners, arises, junctions, etc., where required, shall be carried out with proper templates to the required sizes .At the end of the day suspending plastering work shall be left cut clean to line both horizontally and vertically. Horizontal joints in plasterwork shall not occur on parapet tops and copings.

1.5 COATS FOR PLASTERING:

1.5.1 Scratch coat:

The thickness of this coat should approximately 10 mm to 12.5 mm and must be laid over the full length of the wall or the natural breaking points like doors and windows.

1.5.2 Base coat (In case of thick plaster):

The surface of scratch coat should be dampened evenly before base coat is applied. This coat is about 10 mm thick depending upon the overall thickness and then roughened with a wooden float to provide bond for the finishing coat. The second coat must be damp cured for at least seven days and then allowed to become dry.

1.5.3 Finishing coat:

Before this coat is applied, the base cat is dampened evenly. Joints should be avoided and the finishing coat should be applied in one operation with thickness not exceeding 6 mm.

1.5.4 External Plaster:

The external plaster is made in richer cement mortar proportion than the internal plaster. It is usually done in two layers. First layer is of 10 to 12.5 mm and final layer is of 6mm thickness. Waterproofing compound may be added in case the plaster is exposed to severe wet conditions .The finish can be of the type specified.

1.5.5 Internal Plaster:

The internal plaster is usually done in single layers of 12.5 mm.

1.6 FINISH:

The plaster shall be finished to a true and plumb surface and to the required degree of smoothness. The work shall be tested frequently as it precedes with a true straightedge not less than 2.5 m long and with plumb bobs. All horizontal surfaces shall be tested with a level and all jambs and corners with plumb bob as the work proceeds.

1.6.1 Plaster finishes:

There are four different types of finishes that can be obtained with cement plaster.

1.6.2 Smooth finish:

When a smooth finish is desired, the minimum amount of working should be applied to the wetted surface and the wooden float, rather than a steel trowel is to be used.

1.6.3 Roughcast finish:

This finish suitable for rural or coastal areas and the sever conditions of exposure. This is a finish, which is splashed on to the surface as a wet mix and left rough. The maximum sizes of sand, crushed stone or gravel vary from 12.5mm to 6.3 mm.

1.6.4 Pebbledash finish:

This is most durable of all finishes and is generally free from defects. This gives a rough texture and is obtained by means of small pebbles or crushed stone, graded from 12.5 mm to 6.3 mm being splashed on to a fresh coat of mortar and left exposed. This pebbles or stones are sometimes lightly pressed or tapped in to the mortar.

1.6.5 Textured finishes:

Textured finishes are now becoming very popular and may be obtained in a variety of ways in many different designs. Special effects can be obtained by scraping the surface of the rendering with a straight edge hacksaw blade or with the edge of a steel trowel.

1.7 CURING:

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for 7 days during which period it shall be suitably protected from all damages at the contractor's expenses by such means as the Engineer may approve. The dates of plaster shall be legibly marked on the various sections of the wall so that curing for the specified period thereafter can be watched.

1.8 DEFECTS IN PLASTERING:

1.8.1 Cracks:

Appear on the plastered surface in the form of hair cracks or wider cracks. Its due to old surface is not properly dressed, bad workman ship, and due to expansion and shrinkage in plaster coat during drying.

1.8.2 Efflorescence:

Some time soluble salts are present in plaster making materials or bricks. They appear on the plastered surface in whitish patches and produced ugly appearance. It may remove by brushing and washing the surface several times.

1.8.3 Blistering of plastered surface:

Small patches swell out beyond the plastered surface like boils.

1.8.4 Falling out of plaster:

Due to excessive thermal variation in plaster, Inadequate bonding between coats of plaster, and due to imperfect adhesion of the plaster to the background.

1.8.5 Discoloration:

The usual causes of discoloration in plaster are to variation in the cement and water content of mortar from place to place, uneven suction of the backing and un-uniform curing and inadequate mixing of the material resulting in lack of uniformity.

1.8.6 Crazing

Crazing is a network of lines or cracks in the fired glazed surface. It happens when a glaze is under tension. A craze pattern can develop immediately after removal from the kiln or years later.

1.8.7 Grinning

Grinning is the term given to the appearance of a plastered wall when the position of the mortar joints are clearly visible through the plaster. It is caused by the difference in suction between the masonry units and the mortar. Ranking out mortar joints also causes grinning and the practice should thus be limited to soft clay brickwork.

2. LITERATURE REVIEW

1.Cristina Pérez García, Mercedes del Río Merino, Sonia Romaniega Piñeiro- New plaster composite with mineral wool fibers from cdw recycling.study on this paper Over the last decade the intense activity of the building sector has generated large quantities of construction and demolition waste (CDW). In particular, in Europe around 890 million tons of CDW is generated every year; however, only 50% of them are recycled. In Spain, over the last years 40 millions of tons of construction and demolition waste have been generated. On the other hand, since the implementation of the Technical Building Code regulation the use of mineral wools as building insulation materials has become a widespread solution in both rehabilitation and new construction works, and because of that, this kind of insulation waste is increasing. This research analyzes the potential of a new composite (gypsum and fiber waste) including several mineral wools waste into a plaster matrix. For this purpose, an experimental plan, characterizing the physical and mechanical behavior as well as the Shore C hardness of the new composite, was elaborated fulfilling UNE Standards.

2.Gabriel García, Hector Valle, Luisa Maria Flores-Vélez , Martha Lomelí, Octavio Domínguez, Roberto Torres-Mechanical properties of composite mortar using flurogypsum and PVC particles, The present work describes the viability of a mortar binder based on two industrial by-products: poly(vinyl chloride) (PVC) particles from scrap and anhydrite ($CaSO_4$) from fluorgypsum. Mortar composites were made incorporating different amounts of PVC particles and cured at constant room temperature during various periods of time. From X-ray diffraction, it was possible to follow the hydration process and to estimate the effect of the PVC particles on anhydrite transformation to gypsum ($CaSO_4 \cdot 2H_2O$). Compressive strength from uniaxial testing was measured from stress strain curves carried out at room temperature. According to these results, the hydration rates of the composites depend on the concentration of PVC particles and there is an enhancement in their compressive strength as particle content increases, reaching values of 36 MPa after 28 days.

3.Claudiu Aciu , Daniela Lucia Manea , Elena Jumate ,Luminita Monica Molnar - Innovative plastering mortar based on recycled waste glass ,The aim of this study is to find a way to reuse the huge amounts of glass wastes in construction industry, by making new products at a lower price and also to reduce the glass wastes. In this research several types of ecological plastering mortars have been studied from a physical and mechanical point of view when natural aggregates were replaced by waste glass. The research also aims to study the impact which glass waste has on the hydration processes and the dimension of pores of the plastering mortars using innovative methods, such as optical microscopy and nuclear magnetic resonance. The objective of this study is to support the sustainable development policy, which requires mainly the development of eco-friendly constructions, based on two major goals: construction of buildings based on a sustainable design and constructions achieving energy performance.

4.Luminita Molnar -studies on plastering mortar prepared with recycled colored glass In the current context of sustainable development, waste management represents an increasingly acute problem due to its environmental impact. Recycling reduces the demand for raw materials. For every ton of recycled glass used more than a tone of raw materials is saved: 604.5 kg of sand, 197 kg of caustic soda, 197 kg of lime and 69 kg of additives. This paper aims to realize a study on the influence using waste glass as a replacement of aggregate in realizing plastering mortars. Thus, it were made six types of mortars using different proportions of colored glass as a replacement for aggregate: plastering mortars using green glass in proportion of 25% respective 50% from the total quantity required preparing recipe, plastering mortars using yellow glass in proportion of 25% respective 50% from the total quantity required preparing recipe and plastering mortars using burgundy glass in proportion of 25% respective 50% from the total quantity required preparing recipe. Due to incompatibility (alkali-silica reactions) between Portland cement and glass it was used aluminous cement. This paper aims a study on evolution of mechanical characteristics of prepared mortars and correlations of these with the obtained results made by the methods of last generation - NMR.

5.Kaveh Afshinnia, Prasada Rao Rangaraju-Influence of fineness of ground recycled glass on mitigation of alkali–silica reaction in mortars,The use of waste glass, both as a crushed glass aggregate and in a finely ground form, as a pozzolanic material in concrete has been extensively studied in the past. However, the combined use of finely ground glass powders with crushed glass aggregates has not been previously explored, as this presents a unique opportunity to not only maximize the use of waste glass in concrete but also potentially address the alkali–silica reaction issues, often associated with the use of crushed glass aggregates in concrete. This study focused on studying the influence of fineness of glass powder in mitigating alkali–silica reaction in mortar specimens containing crushed glass aggregate and a natural reactive aggregate. In these studies the glass powders were used both as a cement replacement material and as an aggregate replacement material. Two different fineness of glass powder were evaluated in this study, with an average particle size of 17 and 70 microns. Mortar bars prepared with glass powder as aggregate replacement material at 10%, 20% and 30% replacement levels were evaluated in the standard ASTM C1260 test method. Mortar bars prepared with glass powder as cement replacement material at 10% and 20% were evaluated in the standard ASTM C1567 test method. The results from these studies showed that the finer glass powder showed significantly improved ability to mitigate ASR, particularly when used as an aggregate replacement material, both in the case of crushed glass and natural reactive aggregates. This study shows that an aggregate comprised of 100% glass material can be produced without any deleterious consequences of alkali–silica reaction, provided sufficient quantity offine glass powder is used in the mixture.

6.AnaMafalda Matos, Joana Sousa-Coutinho -Durability of mortar using waste glass powder as cement replacement. It is well known that Portland cement production is an energy-intensive industry, being responsible for about 5% of the global anthropogenic carbon dioxide emissions worldwide. An important contribution to sustainability of concrete and cement industries consists of using pozzolanic additions, especially if obtained from waste such as waste glass. Crushed waste glass was ground (WGP) and used in mortar as a partial cement replacement (0%, 10% and 20%) material to ascertain applicability in concrete. An extensive experimental program was carried out including pozzolanic activity, setting time, soundness, specific gravity, chemical analyses, laser particle size distribution, X-ray diffraction and scanning electron microscopy (SEM) on WGP and resistance to alkali silica reaction (ASR), chloride ion penetration resistance, absorption by capillarity, accelerated carbonation and external sulphate resistance on mortar containing WGP. Glass particles well encapsulated into dense and mature gel observed by SEM, may help explaining enhanced durability results and thus confirming that waste glass powder can further contribute to sustainability in construction.

3. STUDY OF MATERIAL PROPERTIES

3.1 Cement:

Ordinary Portland cement conforming to IS: 269-1976 and IS: 7031-1968 was used in this study .The cement is of 43grade and the tests conducted on cement are tabulated.

Table No.3.1 Properties of cement

S.No	Property	Test Result
1.	Normal Consistency	29%
2.	Specific Gravity	3.13
3.	Initial setting time	92 minutes
4.	Final setting time	195 minutes
5.	Compressive strength at 3 days 7days 28 days	 27.40 N/mm^2 29.23 N/mm^2 41.62 N/mm^2

3.2 Water:

Ordinary portable tap water available in laboratory was used for mixing and curing of plaster.

Table. No: 3.2 Physical and chemical properties of water

S.No	Property	Value
1.	Ph	7.1
2.	Taste	Agreeable
3.	Appearance	Clear
4.	Turbidity (NT units)	1.75

3.3 Sand

It is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type.

Table No : 3.3 Physical and chemical characteristics of the fine aggregate:

Aggregate	Sand	Glass
Specific weight (g/cm^3)	2.57	2.38
Loose unit weight (kg/cm^3)	1.691	1.545
Sieve 200	6.85 %	6.70%
H_2O absorption (%)	1.83	1.47
Compact unit weight(kg/m^3)	1.848	1.802

Surface percentage (%)	6.00	5.00

Table 3.4. Specific gravity of natural sand

Description	Trial-I	Trial -II
Weight of empty pycnometer(W_1)	0.657	0.657
Weight of pycnometer+coarse aggregate(W_2)	1.472	1.489
Weight of pycnometer +coarse aggregate+ water(W_3)	1.985	1.990
Weight of pycnometer+water(W_4)	1.527	1.527
Specific gravity (G)	2.28	2.36

Specific gravity (g) $=(w_2-w_1)/(w_4-w_1)-(w_3-w_2)$

Specific gravity (g) = (2.28+2.36+)/2

(G) = 2.32

Sieve analysis test:

The aggregate most of which pass through 4.75mm IS sieve are termed as fine aggregates. The fine aggregate may be of following types:

According to size, the fine aggregate may be described as coarse, medium and fine sand. The sand was sieved through 4.75mm sieve to remove any particle greater than 4.75mm and conforming to grating zone II. It was coarse sand light brown in color. Sieve analysis of fine aggregate are tested as per IS:383-1970 and result are shown in table.

Table :3.5 Sieve analysis test for natural sand\

Aperture size(mm)	Weight soil retained (kg)	Percentage of weight retained	Cumulative % retained	% of natural sand
4.75	0	0	100	0
2.36	0	0	100	0
1.18	0.092	9.2	90.8	9.2
0.600	0.307	30.7	69.3	39.9
0.300	0.044	4.4	95.6	44.3
0.150	0.040	4.0	96	48.3
Pan	0.026	2.6	97.4	50.9
Total	500.00		SUM	192.6

Calculation :

Fine modulus = total cumulative % / 100

= 192.6/100

= 1.926 %

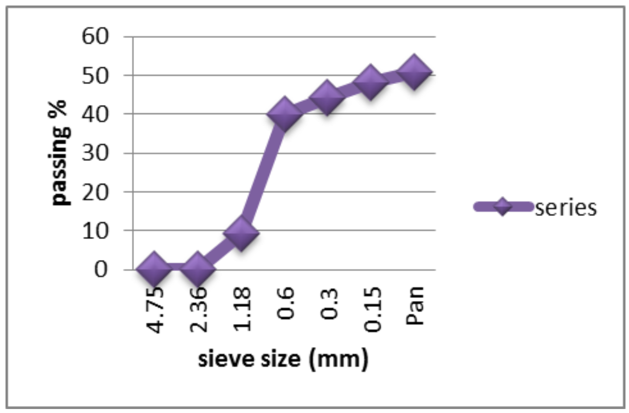


Fig 3.1 Graph for natural sand

3.4 Glass

Glass is a non-crystalline amorphous solid that is often transparent and has widespread practical, technological, and decorative usage in, for example, window panes, tableware, and optoelectronics. Scientifically, the term "glass" is often defined in a broader sense, encompassing every solid that possesses a non-crystalline (that is, amorphous) structure at the atomic scale and that exhibits a glass transition when heated towards the liquid state.

The most familiar, and historically the oldest, types of glass are "silicate glasses" based on the chemical compound silica (silicon dioxide, or quartz), the primary constituent of sand. The term glass, in popular usage, is often used to refer only to this type of material, which is familiar from use as window glass and in glass bottles. Of the many silica-based glasses that exist, ordinary glazing and container glass is formed from a specific type called soda-lime glass, composed of approximately 75% silicon dioxide (SiO_2), sodium oxide (Na_2O) from sodium carbonate (Na_2CO_3), calcium oxide, also called lime (Ca O), and several minor additives. A very clear and durable quartz glass can be made from pure silica, but the high melting point and very narrow glass transition of quartz make glassblowing and hot working difficult. In glasses like soda lime, the compounds added to quartz are used to lower the melting temperature and improve workability, at a cost in the toughness, thermal stability, and optical transmittance.

These sorts of glasses can be made of quite different kinds of materials than silica: metallic alloys, ionic melts, aqueous solutions, molecular liquids, and polymers. For many applications, like glass bottles or eyewear, polymer glasses (acrylic glass, polycarbonate or polyethylene terephthalate) are a lighter alternative than traditional glass.

4. TEST METHODS

The testing are to be made on the prepared partial on the compressive testing machine and water absorption test.

4.1 Compression Test:

Apparatus

5cm cubes moulds (30cm^{2}face area), apparatus for gauging and mixing mortar, vibrator, compression testing maching etc.

Fig 4.1 Cube Mould

5. MIX DESIGN PROCEDURE

The water/cement ratio is the ratio of the volume of water used (in litres), to the weight of cement used(in kilograms) …

$$= \frac{\text{number of litres of water}}{\text{number of kilograms of cement}}$$

eg: If you use 3 kilograms of cement with 1½ litres of water …
= 1.5 litres of water = 1.5l ÷ 3kg = 0.5 3
kilograms of cement one litre of water weighs one kilogram … one cubic litre of water (1000 litres) weighs one ton (1000 kgs)

A water cement ratio of 0.5 means that for every kilogram of cement, you are using half a litre of water.

eg: You would mix 25 litres of water with a 50 kilogram bag of cement.

Procedure

Take 500gm of cement and 3000gm of standard sand in the proportion 1:6 by weight) in a pan. (The standard sand shall be of quartz, of light, gray or whitish variety and shall be free from silt. The sand grains shall be angular, the shape of grains approximating to the spherical form, elongated and flattened grains being present only in very small quantities. Standard sand shall pass through 2mm IS sieve and shall be retained on 90 microns IS sieve with the particle size distribution.

Mix the cement and sand in dry condition with a trowel for 1minitues and then add water. The quantity of water shall be (p/4+3)% of combined weight of cement and sand where, p is the % of water required to produce a paste of standard consistency determined earlier. Add water and mix it until the mixture is of uniform colour. The time of mixing shall not be < 3 minutes & not > 4 minutes. Immediately after mixing the mortar, place the mortar in the cube mould and prod with the help of the rod. The mortar shall be prodded 20 times in about 8 sec to ensure elimination of entrained air. If vibrator is used, the period of vibration shall be 2minitues at the specified speed of 12000+-400 vibrations /minutes.Then place the cube moulds in temperature of 27±2^{o} C and 90% relative humidity for 24 hours. After 24 hours remove the cubes from the mould and immediately submerge in clean water till testing. Take out the cubes from water just before testing. Testing should be done on their sides without any packing. The rate of loading should be 350 kg/cm^2/minute and uniform. Test should be conducted for 3 cubes and report the average value as the test result for both 7 day 14 days and 28 day compressive strength.

6. COMPRESSIVE STRENGTH

Specimen1-S1
(NORMAL PLASTERING)
Specimen2-S2
(PARTIALLY SAND REPLACED WITH GLASS)
Specimen3-S3
(FULLY SAND REPLACED WITH GLASS)

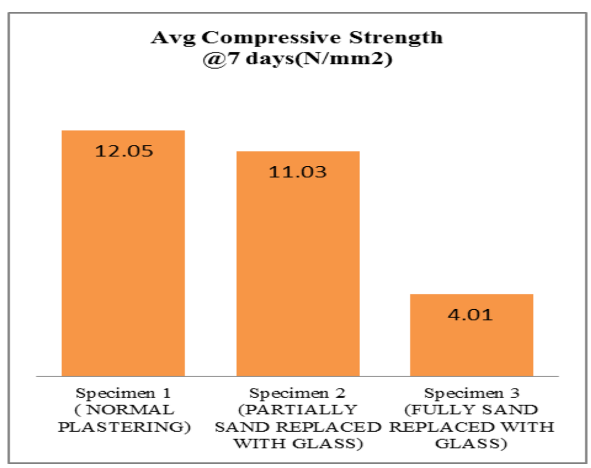


Fig 6.1 7 Days Compressive Strength

Material	Avg. Load on 7 days curing (KN)	Avg. Load on 14 days curing (KN)	Avg. Load on 28 days curing (KN)	Avg Compressive Strength @7 days (N/mm2)	Avg. Compressive Strength @14days (N/mm2)	Avg. Compressive Strength @28days (N/mm2)
S1	60	110	185	12.05	22.06	37.1
S2	55	90	150	11.03	18.06	30.1
S3	20	40	95	4.01	8.03	19.1

Table No: 6.1 Compressive strength

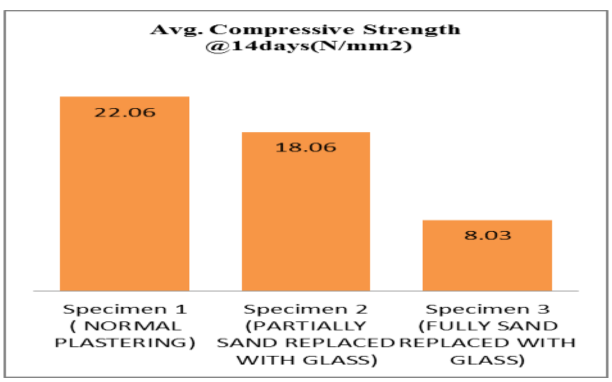


Fig 6.2 14 Days Compressive Strength

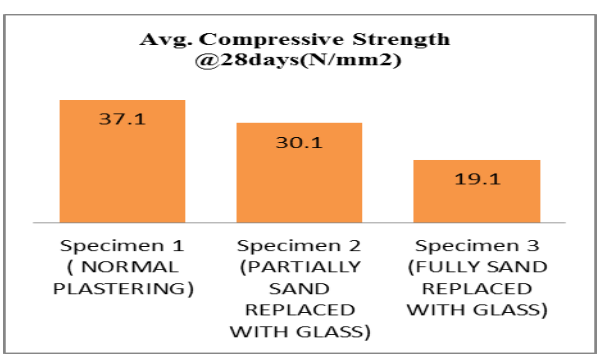


Fig 6.3 28 Days Compressive Strength

6.2 Water Absorption Test:

The average dry weight of plaster specimens after removing from farm was measured and the average weight of cube specimens after submerging in water for curing was measured at 1 days of age. The percentage of water absorption was measured for each specimen and it gave indirect measure of durability.

Table No: 6.2 Water Absorption of plaster

1	Specimen 1 (NORMAL PLASTERING)	3.6	3.9	300
2	Specimen 2 (PARTIALLY SAND REPLACED WITH GLASS)	3.8	4.125	325
3	Specimen 3 (FULLY SAND REPLACED WITH GLASS)	3.9	4.25	350

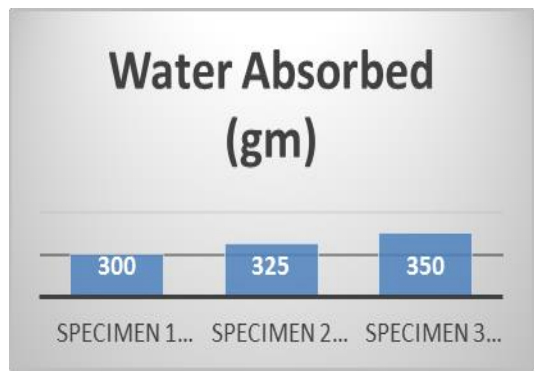


Fig 6.4 water absorption test

6.3 PULL-OUT TEST (ANSYS)

Introduction

ANSYS is a general purpose finite element computer program for the solution of structural, heat transfer engineering analysis. ANSYS solution to capabilities includes: static analysis, elastic, plastic, thermal, stress, stress stiffened, large deflections, bilinear elements, dynamic analysis, model, harmonic response, linear time history, non-linear time history, heat transfer analysis: conduction, convection, radiation, coupled to fluid flow, coupled to electric flow, structures, magnetics, etc. Analysis can be made in one, two, or three dimensions, including axisymmetric and harmonic element options. ANSYS also contains a complete graphics package and extensive pre and post processing capabilities.

ANSYS offers

- Tension capabilities
- Easy usage interface
- Structural development
- Import of externally designed specimens

Table No: 6.3 Examples of ANSYS analysis

Examples	Special options used
1.Laying ocean cable	Dynamic, stress stiffening, large deflection, hydrodynamic forces.
2.Automatic crash studies	Dynamic, large deflection, plasticity , gaps.
3.Evaluation of golf club swing .	Large rotations, stress stiffening
4.Railroad tank car	Dynamic, Fluid elements, pressure vessel fatigue evaluation.
5.Piping system evaluation	Static, seismic, gaps, large deflection.
6.Electric furnaces smelting	Heat transfer, thermal-electric elements.
7.Electronic circuit boards & microchips	Heat transfer, radiation, static, thermal stresses.
8.Offshore power plant	Multi-level sub structuring statics, modal, over 1.5 million dofs.
9.Artificial hip prosthesis	Statics, orthotropic materials.
10.Turbine Blade analysis	Stress-stiffened, modal analysis.

Choosing the software

The first thing to consider is how knowledge of structural mechanics might help you and your organization. To explore this, functional area are related to structural mechanics must be considered. Structural analysis may be used to determine the linear static stress and displacement in structures such as vehicle body shell and the engine under operational loads. Also, optimization may be required to produce body shells with a given displacement for the minimum material thickness.

To find out which of the available packages may be used, a list of requirements that the software should meet must be produced. More often than not, no single package will meet all the requirements, but several packages will meet some of the requirements.

Feature selection

The geometry of the structures that may need to be analyzed. This will show whether a package is needed that can solve problems in two or three dimensions.

Coupling requirements to other software

In some cases there may be a need to link structural results to heat transfer simulations or even to fluid flow software. There may be a requirement to send the results to a post-processor or to some other display software, so that software must have interfaces.

The size of the simulation problem

Here something about the number of nodes and elements that a typical mesh contains needs to be known, together with the number of degree of freedom that is to be calculated. This information helps to determine the storage requirements of the programs in terms of both primary and secondary storage.

Results required for analysis

Stresses,strains and displacements as a function of time.

6.3.1 PULL-OFF TEST

A pull off tester is indispensable for the diagnosis of building structure damages as well as for checking complete renovation work. The pull off tester is used to determine the surface strength of concrete and other materials testing it directly on the component allowing the use of any measuring point. Additionally, the Dyna pull off tester can be used for the measuring of the adhesive strength of applied coatings such as plastic coatings, concrete coats, and mortars and plasters. This mobile pull off tester allows testing on any point of a structure without having to install test devices prior to the casting of concrete.

Figure no : 6.3.1 A Analysis of stress load

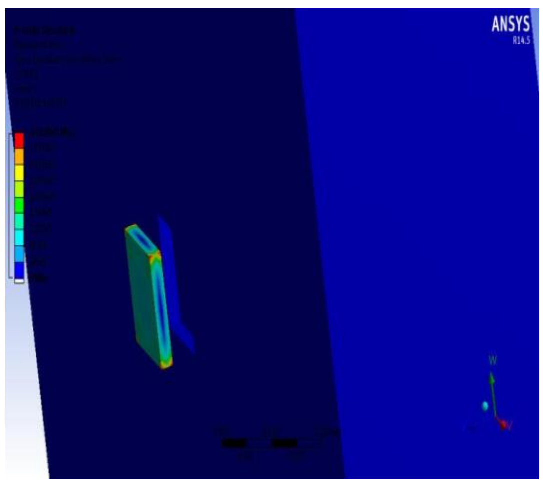
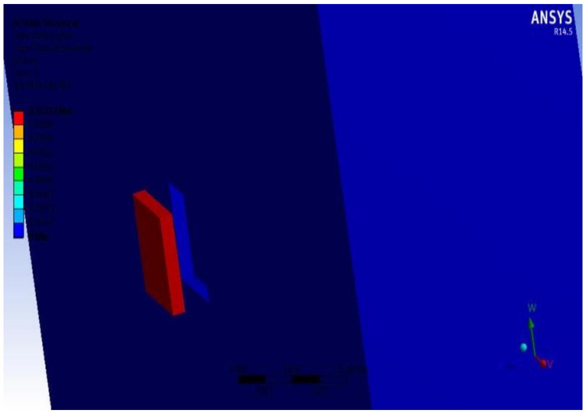


Figure no :6.3.1b Deformation of model



7. CONCLUSION

On addition of waste glass as fine aggregate, the rate of gain of strength is low at early age but it meets nearly required design strength at 28 day. At the level of 50% coloured fine glass replacement of sand meets maximum strength as compared to that of control mortar block and other percentage of replacement of sand. Addition of 100% glass aggregate decreases the strength of mortar.

As the size of waste glass particle decreases in cement mortar, the strength of cement mortar increases. From results, it is concluded that particle size less than 1.18 mm get higher strength than that of particle size ranges from 4.75 mm to 1.18 mm.

The optimum replacement level of waste glass as fine aggregate is 50%.

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