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Study of Bond Properties of Concrete Utilizing Fly Ash, Marble and Granite Powder

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ABSTRACT: Nowadays in India, If we analyse the whole situation, we came to know that there is not a proper planning for the road development and construction in order to fulfil the criteria. As we know that infrastructure plays a tremendous role in the development of country and it has not developed in order to serve the people in the most efficient method it can. Population in India is increasing day by day and India is 2nd largest in population, because of this number of vehicles also increasing on road flexible and rigid pavement are not enough to giving the better results as formation of potholes and propagation of reflective crack occurs due to wheel load. The population for which roads are planned and designed are not providing adequate performance to withstand excessive load of traffic especially in metropolitan cites like Bangalore Delhi Mumbai etc.

In order to overcome this present situation there is a need to turn the focus on composite pavement from rigid and flexible pavements. The design life of composite pavement is more than flexible and rigid pavements. The overlay of bituminous concrete over cracked mortar or asphalt mix has placed a efficient and economical method to meet the problem of riding surfaces which get deteriorated due to high traffic load. Laying of bituminous mix layer over cracked surface is a much better solution but the reflective cracks propagation over the surface of overlaid layer from underlying cracked surface is a huge matter of concern. Various studies have been done to retard the propagation of reflective crack using additives like plastic waste, steel netting, geogrid, fibres and other alternatives. In this study we are using a glass fibres as an additive and compare the condition of roads with or without using glass fibres. Various types of tests are done to cement, aggregates, mortar, Marshall stability and other test in order to study the road reflective cracks.

Glass fibres provide inherent compatibility and excellent mechanical properties which allow it to be used in modification of bituminous mortar mix. The study was done to investigate the performance behavior of fibre modified bituminous mortar and its characteristic comparison with plain bituminous mix used as an overlay over cracked mortar surfaces. Samples of bituminous mortar mix were prepared with and without Glass Fibre and were tested for volumetric and mechanical properties and other properties such as fatigue life, skid resistance and rutting. The optimum dosage of glass fibre was found to be 0.3% with consideration of economy and performance which is the most crucial factor for designing with an optimum binder content of 5.5% in bituminous mortar layer. Apart from the comparative testing of plain and Glass Fibre modified bituminous mortar mix. The conclusions drawn from the study shows that the use of Glass Fibre as an additive in overlaying BC layer showed a tremendous improvement in the performance of mix. The stiffness of bituminous mix increased along with resistance to permanent deformation, indirect tensile strength also improved by 7.8%. The rut depth was also found to be 39% less at 45°C in Glass Fibre modified bituminous mortar as compared to plain bituminous mix. The skid resistance of modified pavement increased by 8.85 in dry and 11.76% wet condition. An increase of 40% was observed in the fatigue life of beam casted with Glass Fibre

KEYWORDS: Fly Ash, Marble and Granite Powder.

I. INTRODUCTION

Mortar, the world's single most commonly used construction material, has a heterogeneity consisting of combinations of easily accessible fundamental building elements including mortar, water, coarse aggregates, fine aggregates and, in certain instances, admixtures, natural fiber or other additions as required. If these components are combined together, they create a liquid mass which is readily formed. Over time, if adequately cured, the cement creates a hard matrix that links the other components together creating a stone-like, durable, mortar substance.

The reason why mortar is used enormously in the building industry rests in its flexible, dependable and sustainable character, thanks to its strength, stiffness, durability, moulding capacity, efficiency and economy.

For thousands of years, people have used mortar in various pioneering building achievements. The continuing boom in the real estate sector and other growth activities throughout the construction industry is causing a very fast increase in the demand for mortar worldwide. Worldwide about 12 billion tonnes of mortar are produced year, according to a study published in the United Nations Environment Programme. Such quantities demand a great deal of land and resources for manufacturing of aggregates and cement. In the past 20 years, for example, world-wide cement consumption has increased three-fold, from 1.37 trillion tonnes of cement in 1994 to 3.7 trillion tonnes in 2012, primarily because of fast development in Asia. In 2012, China used about 58 percent of its entire cement output, which is interesting.

Fine aggregates and gross aggregates usually occupy 60 to 75 percent of the mortar volume and consequently have a significant effect on the newly-mixed and hardened characteristics, mixed proportions and economy of the mortar. Therefore, at the site it is essential to have the appropriate kind and high quality aggregate since the total form the primary mortar matrix. Crushed stone and ribs are usually utilized as a coarse mortar aggregate, while river sand or fine aggregate is a fine mortar aggregate.

Naturally, river sand is composed of mineral and rock fragments that have been partitioned into tiny grains. The river's sand has the ability to replenish itself. Such local rock sources and conditions have an enormous impact in determining the composition of sand, but silica (silicon dioxide) is by far the most common weatherproof mineral because of its chemical resistance to corrosion and high hardness. The river canal construction business relies heavily on sand and floodplains as a raw resource, and these materials have a wide variety of uses.

In many parts of the globe, sand and gravel rivers, which provide the raw materials for mortar, are struggling to keep up with the growing demand. River sand and gravel, once plentiful, are running low. Natural sand and gravel stocks have overtaken water as the world's second-most-utilized natural resource, according to a UNEP research issued in March 2014. In contrast to their rehabilitation, they are today being demolished at a far faster rate.

Between 47 billion and 59 billion tonnes of material are mined worldwide each year, with sand and gravel accounting for 68 to 85 percent of the total. For 2012 alone, the global use of mortar aggregates is expected to be between 25,9 and 29,6 billion tonnes. This estimate includes aggregates used in asphalt, mortar, and other industrial uses, and it might be as high as 40 billion tonnes. It is possible to extract and use this large quantity of material without causing a significant environmental impact.

An activity known as "sand mining" includes the removal of sand from the coastline, which may include rivers, lakes, and other bodies of water. Dredging beneath rivers and large-scale separation of riverbed material results in changes in the canal's shape and structure, which in turn affects riverbed and beach erosion as well as channel bed slope and the morphology of channels. sand mining from seashores The river system suffers when sand is removed. It deepens the rivers and estuaries, as well as the river mouths and coastal entrances, which may also contribute to salty water entering the surrounding sea. It also poses a hazard to nearby bridges, riverbanks, and other structures.

River water quality is harmed by instream sand mining. Turbidity at the mining site is boosted by the suspension of both sediments and organic particles in the water. Oil spills and leaks from mining equipment and automobiles exacerbate the situation. Particle concentrations that are too high have a direct effect on the cost of water to consumers, as well as having negative effects on aquatic ecosystems and aquatic life. By removing sand from riverbeds, vast and deep holes form, lowering the level of groundwater in nearby wells and affecting the local groundwater supply considerably.

Stable sand and gravel beds rely on a specific combination of stream, sedimentation, canal geometry, and sediment accumulation. Stable substrates allow native creatures to thrive in streams. Permanent stream channels are not able to host most aquatic species.

Aquatic life is negatively affected by bed degradation and sedimentation because streaming deposits are disrupted and the organisms connected with them are lost. Fishing may suffer as a result of a decline in river habitats.

Biological nesting and breeding may be disrupted as a consequence of physical disturbances created by humans. As an example, sand mining in the national chamber refuge has harmed ghariys, who need on sandbanks to nest and bathe. They buried their eggs underneath the sand, where sand mining activities had harmed the eggs. It has gotten to the point that river ecosystems in a number of locations are at risk because of excessive sand mining's environmental impacts. As a result, several countries throughout the globe have banned the removal of sand from rivers and streams.

1.1. Objective of the Study

The main objective of this to study the potential of substituting fine sand in mortar for use of the natural stone fly ash or coal ash, marble and granite powder. Throughout this investigation the cement mortar is manufactured with a restricted substitute for natural sediment with limestone fly ash or coal ash, marble as well as granite powder at varying substitute rates of 10%, of 20%, of 30%, of 40% and of 50%, with different mortar qualities compared to a 100% natural sand-control mix. There are many objectives of this study:

- Compare overall durability of mortar mixtures containing granite fly ash or coal ash, marble as well as granite powder" as part of a natural sand replacement with a mortar control blend.
- Comparison of compaction strength, compaction strength as well as density of mortar mixtures that include sandstone ash, marble as well as granite powder" to partial substitution of natural sand with control mixed mortar.
- Comparison of water absorption, sorptivity as well as chlorine-ion permeability of mortar blends with sandstone fly ash or coal ash, granite and granite powder" as the partial substitution of natural sand and control mortar mix.
- To study various variations, x-ray diffraction (xrd) research was carried out in cement phases using fly-ash, marble and granite polish integrated "As a partial substitution in mortar mixes for sand.
- To analyse the various changes in mortar microstructures by adding fly ash or carbon ash, marble and granite powder "In mortar mixes as a partial substitute for the electron (sem) analysis microscope.
- To provide an appropriate replacement of natural sand with sandstone wood ash, marble and granite powder to ensure a suitable workability, hardness and durability.

II. LITERATURE REVIEW

Fly ash, coal ash, marble powder, and granite powder are some of the materials that will be studied in this study "in place of sandy or natural rivers in mortar and cement. There is a detailed review of the current published research and accessible articles on the use of fly ash, coal ash, marble, and granite powder "as a substitute for river sand, either in whole or in part. Research is conducted into new features, tougher qualities, and durability attributes. This review's primary topics are well-explained. Workability, compression strength, tensile divide strength, flexing strength, young elasticity modulus, chloride-ion penetration, water absorption, water permeability, drying shrinkage, and abrasion resistance have all been evaluated in the literature study.

2.1 The ability to do the job

At 25 percent, 50 percent, 75 percent, and 100 percent, fine stone crushed with river sand was studied by Shi-cong and Chi-sun. As the amount of river sand substituted with crushed finer stone rose, mortar workability deteriorated over time. For brickwork, the slump was 30mm, however for mortar it was 60mm, since the sand was 100% finely broken stone. Their findings show that fine crushed stone reduces achievability because of the shape of the material. There was a spike in the amount of water being consumed. In order to get the same level of workability as the control mortar, more water was required.

The influence of substituting fly ash or coal ash, marble or granite powder for natural sediment was investigated by Raman et al. (2011) in a high tensile strength rice quiet soot mortar." Two mortar series, c60 and c70, must be used to achieve the desired hardness of 60mpa to 70mpa. Natural sand was used to replace fly ash, coal ash, marble powder, and granite powder in each series to varying degrees (10%, 20%, 30%, and 40%, respectively). Ten percent of the cement had been replaced with rice hush soot for each combination. It was because of the presence of super plasticizers that all mortar combinations from both series were exceptionally workable and met the minimal target of 150mm. Incorporating fly ash or coal ash, marble, and granite powder reduced the workability of mortar mixes "The two C70 and C60 models use sand in place of it. They discovered that the decline in workability was caused by the presence of increased silt and fine content in fly ash or coal ash, marble and granite powder, and other materials "which increases the specific surface area and, as a consequence, the need for water.

Vijayalakshmi et al. (2013) evaluated the influence of replacing river sand with granite powder on the mortar's operability at replacement amounts ranging from 0% to 25%. They discovered that when the pace of mortar replacement rose, the operability of the material reduced. At 20% and 25% replacement rates, extremely low load bearing capability was discovered in mortar mixtures. They observed that this decrease was due to the differences in the elemental makeup, particle shape, and surface fabric of natural sand and granite powder. In order to increase the adsorption capacity and water consumption of fine aggregates and fine aggregates, typical sand was used, which had a particle size of 90% finer than 50 microns. Increased friction between aggregate particles and paste is caused by granite powder particle shape and surface roughness. As a result, the granite powder substitution has diminished the mortar's workability.

Singh et al. (2016) investigated the effect of granite replacing natural sand at substitution levels ranging from 0% to 40% on the cost of mortar workability. They found that employing granite waste instead of natural sand reduced the amount of cement needed to be replaced. There is a considerable increase in friction between the mortar particles due to the greater angular and harsh surface roughness of granite waste compared to river sand.

Crushed granite aggregates were used to substitute natural sand in the mortar at percentages of 10%, 30%, and 50%, according to Cordeiro et al. (2016). They developed a 50 mpa mortar with a total drop between 200mm and 220mm. A broken granite aggregate was used to substitute natural sand in the formulation, which increased the superplasticizer dosage. Mortar with 10% replacement had a superplasticizer dosage of 0.16 percent, whereas the dose for control mortar was 0.17 percent, 0.19%, and 0.19% respectively. They discovered that as the quantity of crushed granite aggregate increased, so did the water need for mortar, as seen by the growth in superplasticizer dosage.

The findings of all studies on mortar workability are summed up in Table 2.1.

Table 2.1: summary of workability results of different researches

Research Reported by	Test Method used	Replacement of Natural Sand with Quarry Dust (%)										
		0	5	10	15	20	25	30	40	50	75	100
Shi-Cong and Chi-Sun (2009)	Slump (mm)	60	–	–	–	–	55	–	–	45	–	30
Raman et. al. (2011)	C60 Series Slump (mm)	200	–	175	–	170	–	165	155			
	C70 Series Slump (mm)	220	–	200	–	190	–	190	180			
Singh et. al. (2016)	Compaction Factor	0.93	–	0.91	0.88	0.86	0.84	0.81	0.80			
Vijaya lakshmi et. al. (2013)	Slump (mm)	120	100	60	20	No Slump	No Slump					

To test the fresh properties of mortar made by replacing fine sand with three kinds of stone dust, quartz, granite, and calcium dust, respectively, at 0% to 20% for each stone dust. (Irassar and Bonavetti 1994) They discovered that as the quantity of stone dust grew, so did the amount of water required to maintain the flow. 5 percent stone dust

mortars need just a little amount more water than mortars with a lower percentage of stone dust.

There was a considerable increase in performance when more than 10% stone dust was used. There has been an increase in water use, according to the experts, since stone dust has greater surface area than natural sand, which requires more water.

Use of coir fibre resulted in increasing the stability by 22.6% and reduction in air void by 8%. The tensile strength ratio also increased by 14.8% making the pavement more sustainable and durable to Indian climatic conditions (Lakshmi, 2016). A study by Hugo Silva et al. (2008) in University of Minho shown that with the use of Acrylic fibre, the overlay thickness can be reduced by 70% helping in reduction of total cost of the project. It also helps in improving the resistance to fatigue cracking and enhancing the properties of mix. Addition of glass fibre in bituminous mix increased the stiffness and resistance to deformation along with improvement in fatigue characteristics (Shukla, 2013). According to (Ganesh et al. 2013), change in temperature caused more rut in plain bituminous mortar whereas the polymer modified bituminous mix shown more resistance to temperature indication less temperature susceptible.

Many researches used Finite Element Model to examine the behavior of reflection cracking. (Baek et al. 2010) studied the behavior of reflection cracking on HMA overlay with and without interlayer system through FEM and concluded that use of interlayer system gave excellent result in retarding the propagation of reflection crack. It was also observed that steel netting interlayer performed better than sand mix interlayer and provided six times longer durability to propagation of reflection cracking than that of plain HMA overlay.

Reflection crack simulator was developed in Bangalore University to simulate the reflection cracking in bituminous slab using Geosynthetics by (Sathyamurthy et al., 1994) and concluded that the stress and cracks opening displacements reduces which majorly depends on the strength of Geosynthetics and thickness of bituminous mortar overlay.

III. PROPOSED WORK

3.1 Methods and Procedure

3.1.1 Materials Used

For the preparation and mixing of all mortar mixes the laboratory drum mixer was utilized. A drum mixer is an instrument used to blend cement, gross aggregates, fine aggregates and water in a rotating drum to create a homogeneous material. Both the coarse aggregates and the fine aggregates were dry. Therefore, before the mixing process, water corrections were made. The accuracy of all components, i.e., mortar, coarse aggregate, fine aggregate and water, was 1.0 gr. Drum mixer has been started and the first thing to do is to properly combine cough aggregates and fine aggregates. The cement was then poured to the drum mixer and spun to a homogeneous mass. Ultimately, water was added very cautiously in order to avoid water loss while mixing. The drum mixer has been spun, till we get a consistent hue and consistency mortar mass. During the whole procedure, care was taken to guarantee the correct mixing of all components. All mortar mixes were tested soon after the mixing finished.

3.1.2 Testing of components:

1. Testing of cement:

Ultratech Cement Limited's opc 43 was used in all mortar formulations. There are a number of ways to evaluate the physical qualities of cement, including fineness, solidity, the standard consistency, the starting and final setting time and the compaction strength and special gravity of the cement. Methods for determining the fineness of cement are detailed in bis 4031(part 1):1996. In compliance with the bis 4031(part 3):1988 procedure, le-chatlier equipment was used to evaluate soundness. Following 4031(parts 4 and 5), vicat devices check for standard consistency, as well as the start and finish times of setup. The bis 4031(part 6) approach from 1988 is used to measure the compaction cement's strength. Using normal sands, 70.6mm by 70.6mm by 70.6mm cubes of cement mortar have been created up to 650:1991. Compression testing machines (ctm) examined these cubic specimens up to a load rate of 516:1959.

A. Coarse grading aggregate:

In this experiment, a mixture of 20 mm and 10 mm nominal aggregates is employed. Coarse aggregates from the same location were used in both projects. The Indian Standard Specifications office evaluates the physical properties of the two coarse aggregates, including sieve analytical, specific gravity, water absorption, and bulk density. Using a set of sieves in line with BIS 2386(part 1):1988 and BIS 383:1970, seven components may be examined. The specific gravity, water absorption, and bulk density of coarse aggregates were examined in accordance with BIS 2386(part 3):1963. The water basket technique was used to calculate the specific gravity of both types of coarse aggregate.

Natural sand: natural sand:

The fine aggregate in the mortar was made from local natural sand. Natural sand properties such as sieve analysis, specific gravity, water absorption, and bulk density are taken into account while evaluating the Indian standard methods. According to BIS 2386(part 1):1988 and BIS 383: 1970, a series of sieves were used to filter natural sand to undertake seven analyses. Using ASTM D 383:1970 specifications, the surface area and fineness modulus of the sand were figured out. With the use of BIS 2386(part 3), the bulk density, water absorption, and specific gravity of naturally-occurring sand were all calculated. The specific gravity of natural sand was determined using pycnometers.

Fly ash or coal ash, limestone and granite powder in sandstone"

To gather sandstone, workers in the Punjabi city of Mansa utilised a crushing factory called "Marble and Granite Powder." The particle size distribution of sandstone ash, marble, and granite powder was compared to that of natural sand using a sieve analytical method provided for in BIS 2386(part 1):1963, according to the study. Standards for crushing sand according to ISO/IEC 383:1970 have been evaluated against those for other materials, including marble powder and granite dust. Marble and granite powder, as well as natural sand, sandstone fly ash, and coal ash, have been characterised. It was used to test the specific gravity, water absorption, and bulk density of fly ashes, coal ashes, marble powder, granite powder. The specific gravity test was carried out using the pycnometer technique. A method called X-ray diffraction (xrd) was used to identify the distinct minerals in sandstone powder, fly ash, or coal ash, and marble and granite powder. Particle form and surface roughness were the primary focuses of the scan using scanning electron microscopy. It was determined that flying ash from sandstone, marble and granite powder had a chemical makeup similar to that of sands.

B. Mortar component proportioning mixture:

BIS 383:1970 standards for aggregate with a nominal dimension of 20 mm were used to compute the aggregate percent in mortar. Tested and found to be error-free methods for calculating the appropriate amount of natural mortar. The proportion of 20 mm nominal size aggregate and natural sand utilised in the computation of coarse and fine aggregate amounts during the mixing design was calculated using this all-in aggregate grading.

The IS 10262:2009 standards were followed in the development of the mortar mix design. A M30 control mortar was used to achieve a drop of 100mm. It was determined that the exposure was moderate. The target strength was calculated using a preset value in line with IS 10262:2009. Estimated water contents were estimated, and an experience-based free W/C ratio was established in line with the required mortar strength in order to ensure proper workability. Estimated water volume. Using the estimated water content and free w/c ratio, cement was calculated. In accordance with all-in aggregate grading, the specific gravity and percentage of a volume of mortar aggregates was utilised to establish the amount of coarse and fine aggregates to employ. The estimated gross aggregate and fine aggregate amounts were computed using a saturated dry surface. Water modifications must be made taking into account the moisture content of coarse and fine particles.

Mortar mix proportions with sandstone fly ash or coal ash, marble and granite powder" were estimated based on the amounts of various materials in the control mortar. Natural sand was replaced with fly ash (coal ash, marble and granite powder) at 10%, 20%, 30%, 40%, and 50% in mortar mixes, which were numbered qd10, qd20, qd30, and qd40, respectively.

2. Sample preparation:

Steel moulds have been used to produce all specimens of mortar. Each mould was cleaned and greased before the mortar mixture was added. A reasonable amount of tightening was done before casting. Slurry can't escape since every crack and crevice have been sealed. In two layers, vibrating tables were used to crush the mortar sample. Mortar

specimens were maintained in the casting chamber for roughly 24 hours before being de-molded and placed in the curing tank. A list of the casts used in various tests is shown below:

For testing mortar's continuous strength, cubic specimens of 150mm to 150mm in diameter were cast.

Splitting strength: cylindrical specimens with a 150mm diameter and a 300mm height were cast to test the splitting force of tensile mortar.

70.6mm cubic samples per 70.6mm per 70.6mm have been cast for testing of water absorption in the mortar samples.

These cylindrical examples have been manufactured for mortar surprise testing: they are 100 millimetres in diameter and 50 millimetres in height

Testing the mortar's quick chloride-ion permeability required cylindrical specimens with a diameter of 100 mm and a height of 50 mm.

A. Procedures for testing:

Workableness:

When the mortar is properly mixed, transported, compacted, and finished, there is minimum loss of homogeneity. When it comes to gauging the workability of mortar, the slump test is unquestionably the gold standard. In compliance with the Indian standard criteria till 1199:1959, slump testing was used to determine the mortar's workability. Filled with four fairly equal layers, the mould was frustum-shaped and the cone-shaped filling had bottom and top diameters of 200 millimetres and heights of 300 millimetres. Each layer was subjected to 25 strokes of a conventional tempering rod.



Figure 1: slump test of mortar

The mould has been removed vertically, allowing the mortar to sink once the surface has been filled and elevated. Results of the workability test have been logged by the difference between the mould height and the highest subordinated mortar mass point in millimetres:

Compression's power:

Compression strength is the most important quality of hard mortar. According to the Indian standard, 516:1959, compressive strength tests were conducted in line with the technique. At seven days, 28 days, and 90 days, the standard cube samples of 150mm da150mm da150mm da1 were used to assess the strength of the mortar. Mortar compaction strength testing was carried out using a ctm with a capacity of 5000 kN. This machine was employed for the purpose. In order to ensure appropriate healing, the bentonite specimens were removed and placed in a curing tank after 24 hours after casting. The specimen was placed in the middle of the ctm's bearing plates at the stated age, and a constant loading rate of 140 kg/cm²/min was applied. Every specimen's maximum load was recorded before the weight was lifted once more till the specimen broke.



Figure 2: compactionstrength test on compression testing machine

The compactionstrength was calculated according to the following formula:

$$\Sigma = p/a$$

Where,

Σ = compactionstrength (n/mm²)

P = maximum load sustained by the cube (n) a = area of cross section of cube (mm²)

Results from the compactionstrength tests were given for each n/mm² mortar mix, with an average compactionstrength of 3 specimens at 7 days, 28 days and 90 days.

Mortar density:

In order to determine the dead weight of a building, the density of the mortar is a critical factor. Using a weighted balance of 10 kg with an accuracy of 1,0g and the day density of mortar, the following formula was calculated as follows:

$$P = s / s$$

Where,

$\emptyset$ = mortar density in kg/m³

M = 150mm mass per 150mm cube per kilogramme v = m³ cube volume

Splitting strength of tensile:

The tensile strength of the mortar must be assessed in order to prevent cracking in stress regions since mortar is strong in compression but weak in stress. An indirect method for determining mortar tensile strength is splitting tensile strength. An Indian standard technique of 5816:1999 was used to break the tensile strength test into two halves. Using typical cylindrical specimens with a 150 mm diameter and a 300 mm height, the tensile strength of mortar was divided into three groups and tested at ages of 7, 28, and 90 days. In order to ensure appropriate healing, the bentonite specimens were removed and placed in a curing tank after 24 hours after casting. Compression testing machine's 5000 kN compressive strength was tested (ctm)

Mortar. To test the splitting tensile strength, each specimen was put in the centre of the ctm plate with the appropriate packing bands above and below, as illustrated in Figure 3.4. Continuous and uniform loading was achieved at a rate of between 1,2 n/mm²/min and 2,4 n/mm²/min. The maximum load that each specimen could withstand was determined

by gradually increasing the weight until the specimen failed in the vertical plane. How the splitting force was determined is shown in this diagram:

Where,

$$\sigma_{st} = 2P/\pi dl$$

Σ_{st} = splitting tensile strength (n/mm²)

P = maximum load sustained by the cylinder (n) d = diameter of cylinder (mm)

L = length of cylinder (mm)

At 7 days, 28 days, and 90 days, the average tensile division of three samples for each conventional mortar of n/mm² was shown.



Figure 3: splitting tensile strength test of mortar

Water absorption:

The structure of the mortar is critical in determining how long it will last. The thickness of the mortar microstructure may be determined by its ability to absorb water. The ASTM C 642 – 13 technique was used to measure the absorption of water by the mortar at various ages.

According to conventional technique, water absorption testing requires specimens with a volume of 350 cm³, a weight of 800 g, and an absence of fractures, cracks, and broken borders. There are no further standards for the specimens' shape or size. In order to perform the water absorption test, a cubical specimen of 70.6mm calcium was used. 28 days after the first treatment. In line with ASTM C 642, 13, the dry oven mass and the saturated mortar mass were determined. Mortar's water absorption was determined using the following formula.:

Where,

$$\text{Immersion absorption (percent)} = [(b - a)/a]$$

B = dried oven mass of air specimen (g)

A = surface-dry specimen mass after air immersion (g)

After the initial 28-day treatment, the average percentage of water absorbed by three water samples was calculated after 7 days and 28 days.

Sorptive behaviour:

Mortar durability is influenced by the movement of liquids via interconnected pores. The rate of water absorption by a single-dimensional capillary action is known as the mortar sorptiveness. The astm c 1585 – 04 approach was used to gauge the beton's sorptiveness. A 28-day initial cure was followed by 7- and 28-day tests on water absorption rate on typical cylindrical specimens with 100 mm diameter and 50 mm height. An astm c 1585 procedure was used to create each specimen. An epoxy seal was applied to the specimen's edges, and an adhesive tape wrap was applied to the specimen's curved outer surface. The beginning mass of each specimen was recorded. Figure 3.5 depicts the experimental method's schematic design. Stopwatch and mass of specimen are begun once specimen is submerged in water.

It lasted 5, 10, 20, 30, 60, 120, 180, 240, and 360 minutes.. The object was hoisted at certain intervals, its surface was dried with a towel, and its weight was recorded.

Method I for determining sorptivity was to calculate the rate of absorption based on the change in mass, which was multiplied by a factor based on area and density. At 0.001 g/mm³ water density, the unit of I is defined as mm³/mm² or mm².

Where,

$$I = \frac{m}{a \cdot d} \quad I = \frac{m}{a \cdot d}$$

I = absorbance rate (mm³/mm² or mm)

Mt = specimen mass change at time t (g) a = exposed specimen area (mm²)

D = water density (g/mm³)

Now the absorption rate of water I was drawn in minutes, t^{0.5} versus square root of time and the curve was produced. The slope of the curve was determined using linear regression analysis. This curve pitch is considered sorptive using mm³/mm²/min^{0.5} or mm/min^{0.5} units. The results of the sorptiveness tests for each mixture of mm³/mm²/min^{0.5} were given as an average sorptivity of 2 specimens at seven days and 28 days following first cure.



Figure 4 sorptivity test of mortar samples

Rapid chloride-ion permeability test:

Mortar durability may be rapidly evaluated using chloride-ion permeability tests. To find out how long a batch of mortar would last, we tested its electrical conductivity. Rapid chloride-ion permeability testing was performed using the ASTM C 1202-97 method. A 28-day fast chloride-ion permeability test was conducted on standard 100mm diameter and 50mm height cylindrical specimens. The ASTM C 1202-97 approach was used to create each specimen. It was necessary to use a typical experimental setup with a 60-volt potential difference for each specimen in order to test the effects of the 3.3-percent NaCl solution and the 0.3-NaOH solution. The test setup is shown in figure 3.6. It took six hours to measure the amount of charge that had been transmitted in coulombs. After 28 days and two specimens, the results of the quick permeability test for chloride ions were reported.

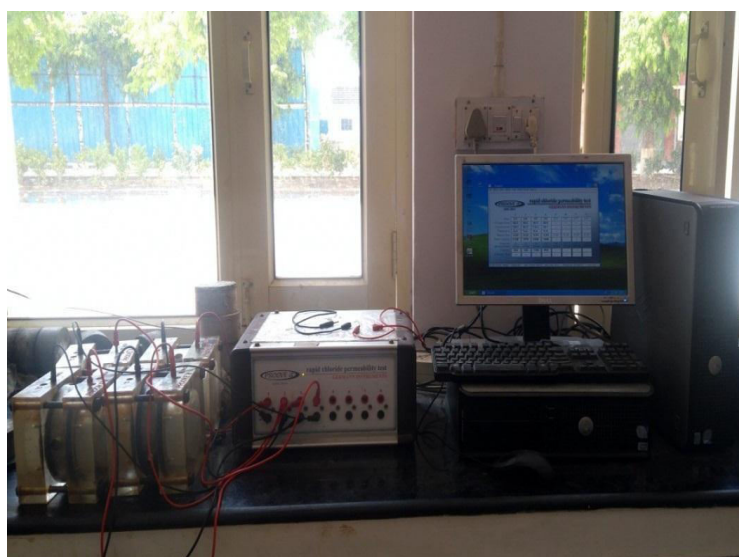


Figure 5: rapid chloride-ion permeability test

Table 2: chloride-ion permeability based on charge passed (ASTM 1202)

Charge Passed (Coulombs)	Chloride-ion Permeability
> 4000	High
2000 – 4000	Moderate
1000- 2000	Low Very
100 – 1000	Low
< 100	Negligible

Any new product used to replace cement and fine aggregate may be analysed for changes in cement phases using X-ray diffraction (XRD), which is a technique for determining changes in cement phases' quality and quantity. New materials may be used as a partial replacement for cement or fine aggregate in the hydration of cement. After 28 and 90 days of compaction strength testing, little pieces of mortar from the cubes' cores were removed for X-ray diffraction analysis. The ground aggregate has been used to remove the cement paste, which has been crushed into a powder. A 60-micron sieve was used to measure the fine powder, and an X-ray diffraction test was performed using a 60-micron powder sample. CuK radiation ($\lambda = 1.54 \text{ nm}$) was used to record the diffractometer diffraction pattern in increments of 2 degrees (0.013 nm) from 10 to 80 degrees. 'x'pert highscore plus' software was used to analyse the peaks of X-ray diffraction patterns detected in cement paste after 28 and 90 days.

Electron scanning microscope (sem):

A partial substitute for hormigone, scanning electron microscopy (Sem) was used to investigate different microstructural changes in the mortar made with fly ash or coal ash, marble and granite powder." For electron microscope (sem) testing, small fragments of mortar from core cubes were collected after 28 and 90 days of compaction strength tests. Every 28-day and 90-day mortar mix is examined at different magnifications to determine its microstructure.

IV. RESULTS AND DISCUSSIONS

Mineralogical characteristics and microstructural analysis:

Scanning electron microscope(sem)analysis:

It was decided to use sandstone fly ash or coal ash, marble or granite powder as a partial substitute for natural sand in the mortar for the purposes of scanning electron microscopy (sem). The microstructure of each mortar mixture was examined by analysing benton samples obtained at 28 days and 90 days of age from all mortar mixes.

Using a magnification factor of 1000 and 5000, Figures 4.34 and 4.35 show the sem-morphology of several mortar combinations at 28 days of age.

Voids are reduced as the replacement rate of the natural sand with fly ash, coal ash, marble and granite powder rises. Mortar control has the highest voids between all mortar combinations. As fly ash, coal ash, marble, and granite powder replacement rates increase, they continue to decrease.

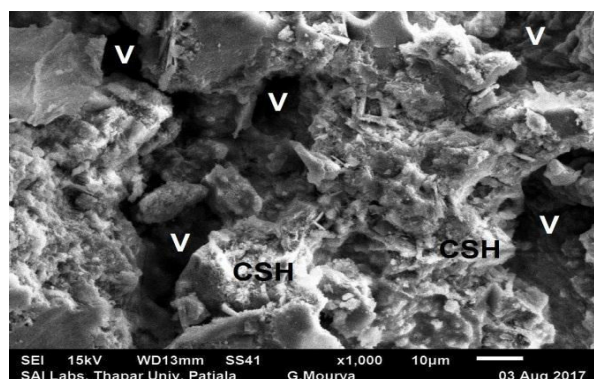
For example, the control mortar has a maximum empty space between all mortar combinations, and since natural sand is replaced with sandstone fly ash or coal ash,marble and granite powder," the gaps are further decreased. After 90 days, the mortar's microstructure is the same as it was after 28 days.

The filling action of tiny sandstone fly ash or coal ash, marble and granite powder, which tends to fill up holes in mortar and so increase the density of the microstructure, is responsible for the improvement in the microstructure of mortar.

The reduction in voids of mortar mixes adding sandstone fly ash or coal ash, marble and granite powder" was the primary reason of the control mix's better hardness and durability. Microstructure has a crucial role in the resilience and durability of mortar.

At 28 days and 90 days, Sem photos show that a mortar mix with 40 percent level of replenishment sand has minimum voids and consequently maximum density. The investigation also proved the cause for the increase in cement density with the sandstone fly or coal ash, marble and granite powder.

As a result, it can be inferred that the addition of sandstone flies ash, marble and granite powder" as a partial substitute of natural sand may be attributable largely to the dense microfilm of mortar mixes which include ash, marble and granite powder."



Cm: control mix

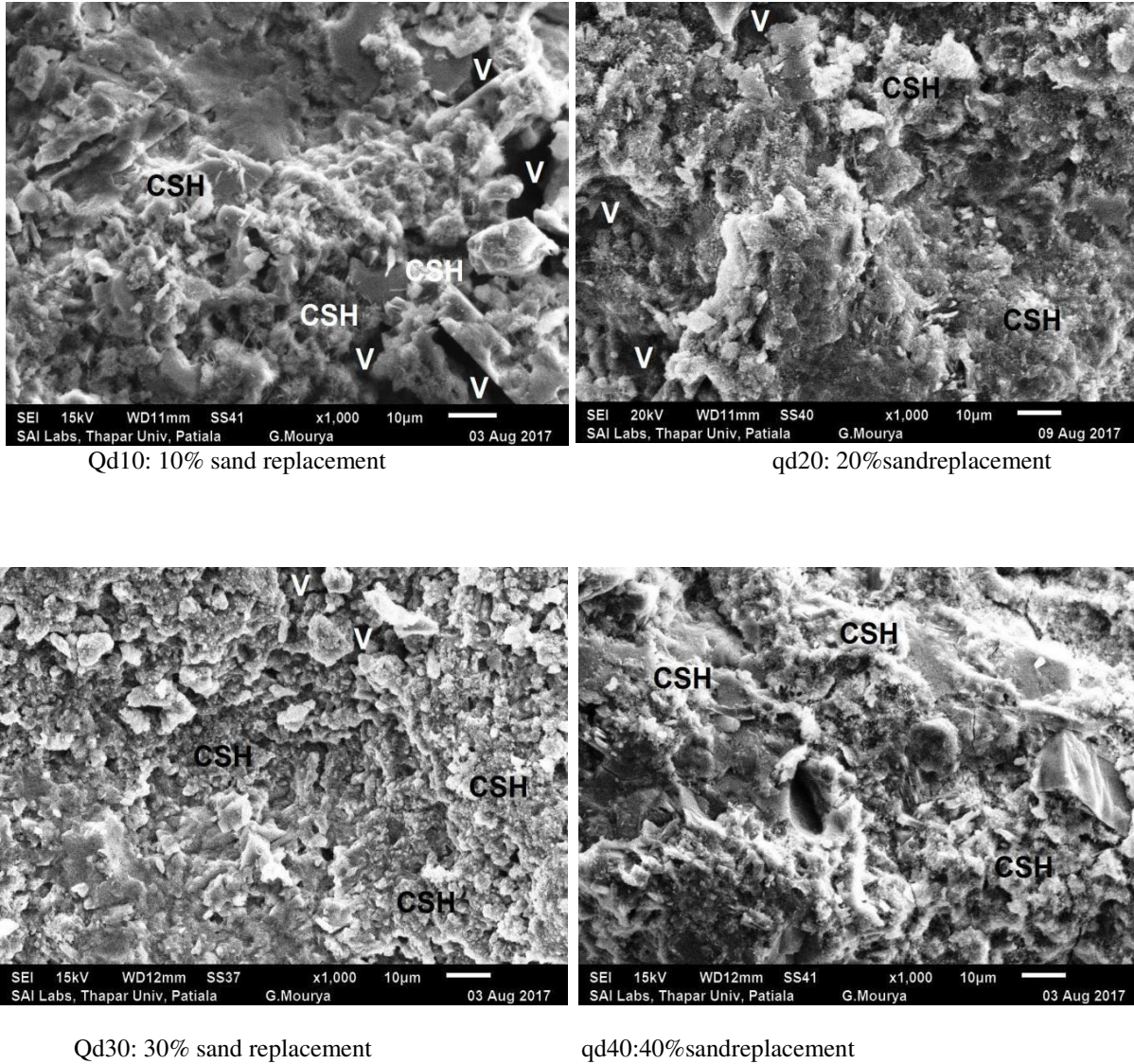
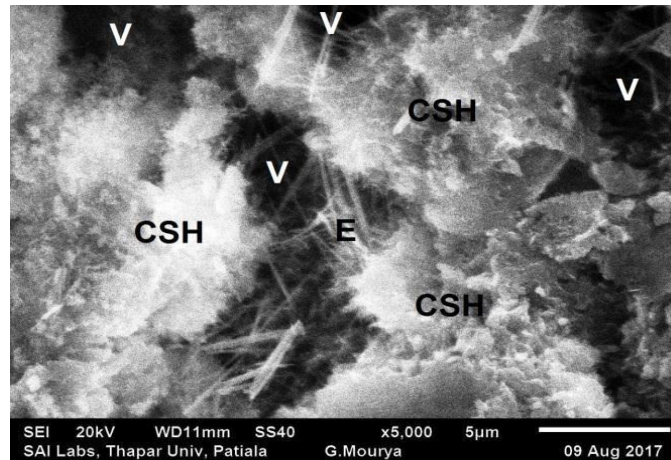
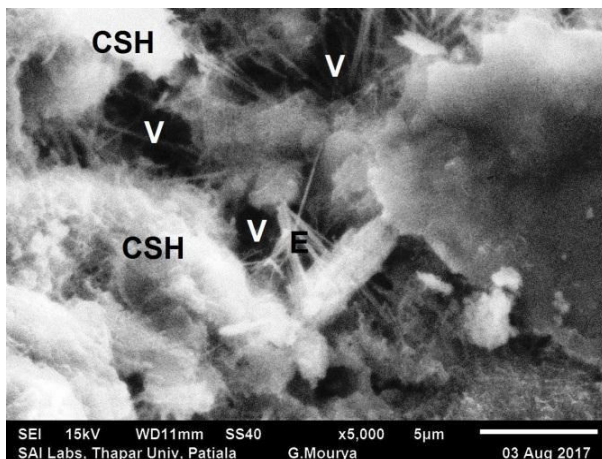


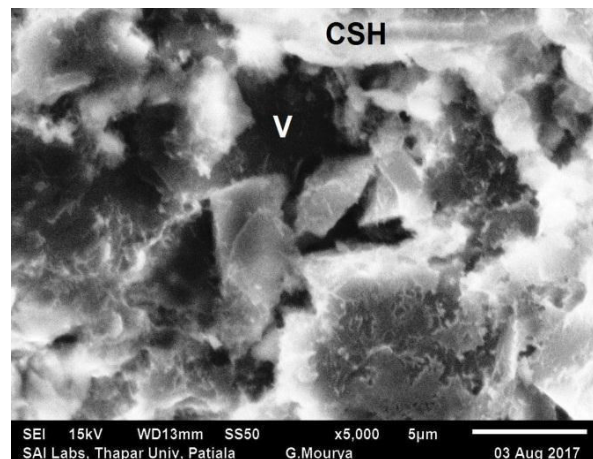
Figure 6: sandstone fly ash or coal ash, marble and granite powder" as a partial substitute for natural sand in a mortar with a magnification factor of 1000 at 28 days of age



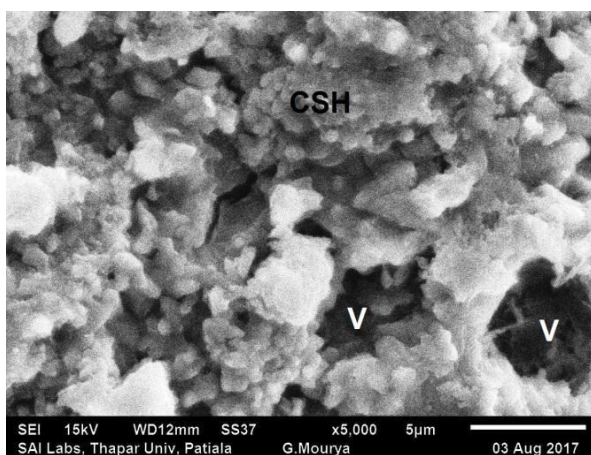
Cm: control mix



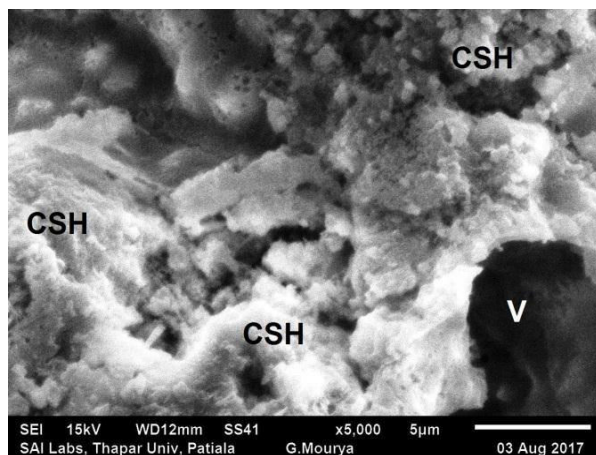
Qd10:10% sand replacement



Qd20:20% sand replacement

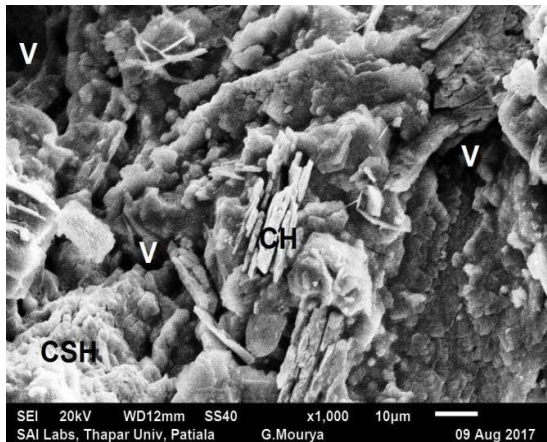


Qd30: 30% sand replacement

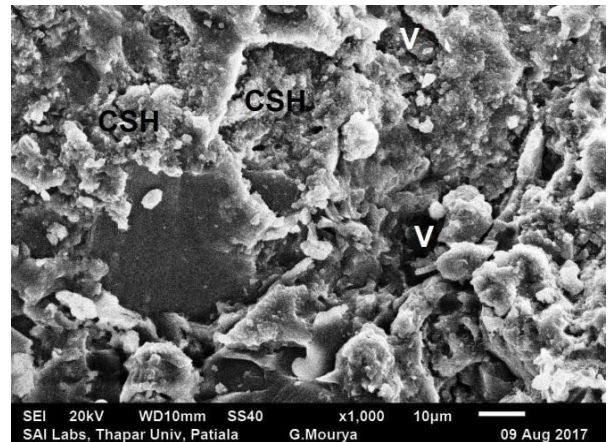


Qd40: 40% sand replacement

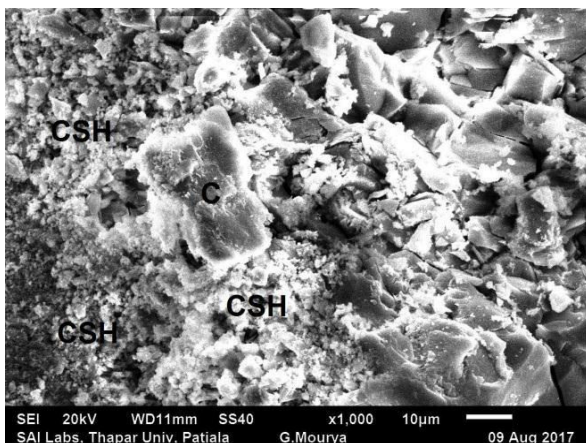
Figure 7: mixed mortar at 28 days with magnification factor of 5000 using "marble and granite powder" in lieu of natural silt as the main ingredient of the mix



Cm: control mix



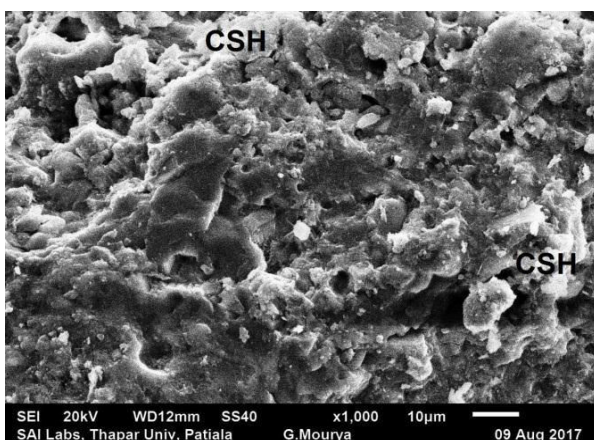
qd10:10% sand replacement



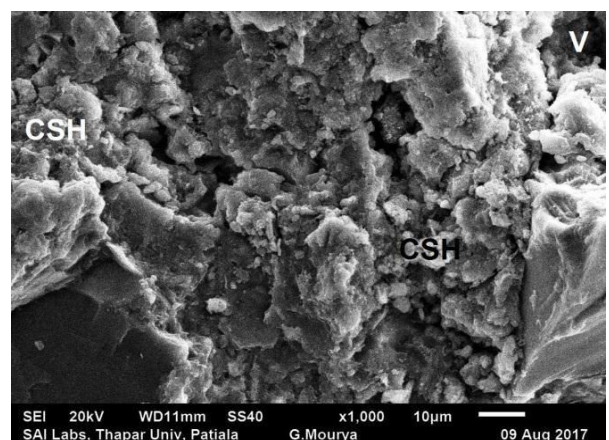
Qd20: 20% sand replacement



qd30: 30% sand replacement

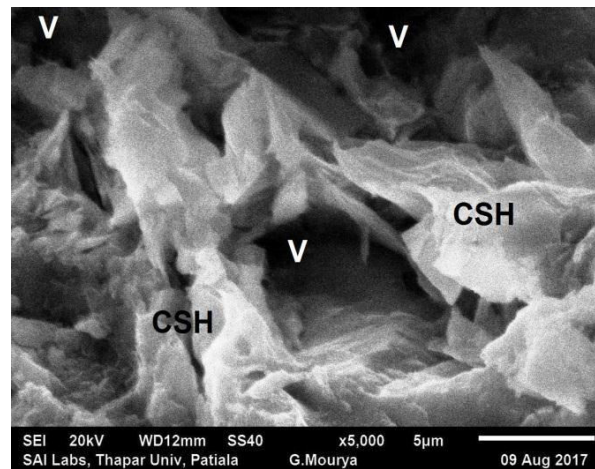


Qd40: 40% sand replacement

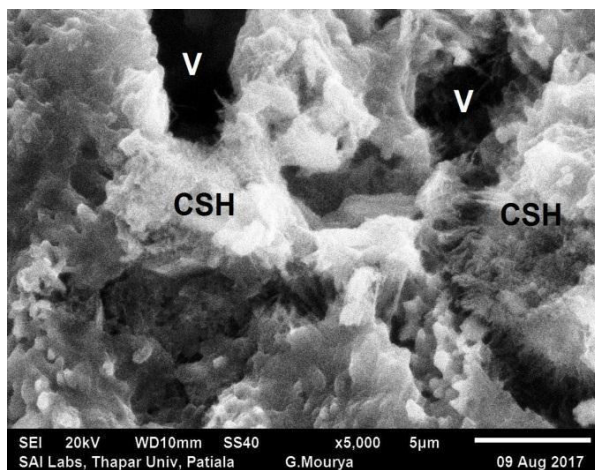


qd50:50% sand replacement

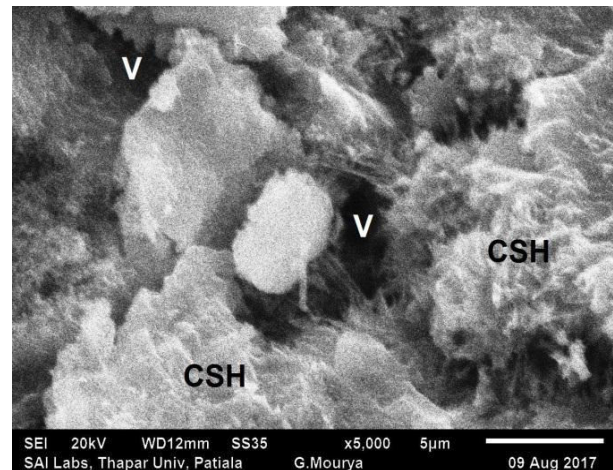
Figure 8: sem morphology of mortar mixes containing sandstone fly ash or coal ash,marble and granite powder” as partialreplacement ofnatura sandat ageof90dayswithmagnificationfactorof1000



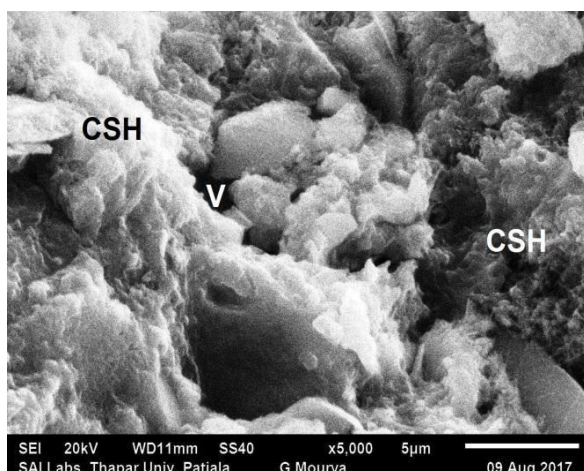
Cm: control mix



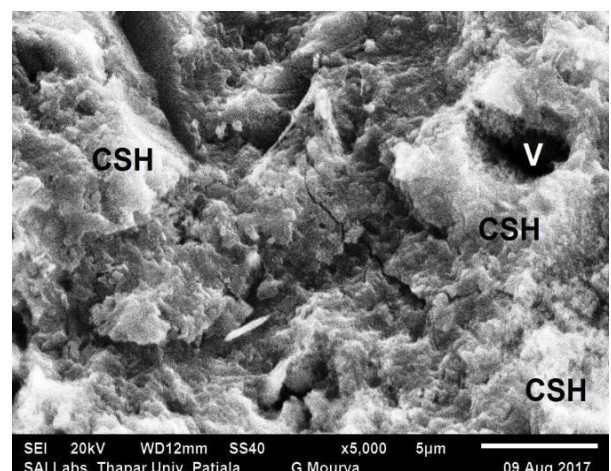
Qd10: 10% sand replacement



qd20: 20% sand replacement



Qd30: 30% sand replacement



qd40: 40% sand replacement

Figure 9: Mortar mixes including sandstone fly ash or coal ash, marble powder, and granite powder were examined for morphology using a magnification factor of 5000 at 28 days of life.

V. CONCLUSION AND FUTURE WORK

Sandstone fly ash, coal ash, marble, and granite powder were tested for their applicability in this research "As a partial substitute for natural sand in mortar. Water permeability, sorptiveness of mortar and fast chloride ion permeability were all investigated by substituting different percentages of ash fly, marble powder, and granite powder for the native sand in the mortar." In order to better understand the variations in cement phases and the microstructures of mortar, Xrd and sem analyses were conducted on fly-ash from sandstone, coal ash, marble, and granite powder. A variety of materials, including marble powder and fly ash or coal ash, may be substituted successfully for organic sand in mortar by using sandstone, according to research "Byproduct of the manufacturing process.

An increase in the proportion of natural sand replacement affected the workability of sandstone ash and marble as well as granite powder. "When it comes to the micro-fines in fly ash, coal ash, marble powder, and granite powder, as well as the corner form, "decreased the workability of the cement by increasing the water usage. There has been an increase in the area devoted to fine aggregates. However, the build ability of all mortar mixtures up to 50% sand substitution was suitable for structural purposes. Sand, marble, and granite powder may be substituted with natural sand to boost the mortar's solidity. " The cement mortar with 40% sand substitution had a greater maximum density than the control mix by 4%. Mortar density increases as a result of the filling effects of microfines composed of fly ash or coal ash, marble as well as granite powder, as well as the enhanced specific strength of these materials "Natural sand in close proximity. Compressive strength of compaction mortar has been improved with the addition of marble and granite powder to fly ash or coal ash "In most cases, it serves just as part of the solution. At all ages, the 40% sand replacement mortar mix had the strongest compressive strength. Increasing the density of the mortar with fly ash or coal ash, marble and granite powder, and improving the hydration conditions for cement in the presence of micro-fines in these materials boosted the compaction mortar's strength. As a replacement for natural sand in mortar, sandstone fly ash, coal ash, marble, and granite powder have been used to increase the tensile strength. Tensile divisions of up to 40% were observed in all mortar mixes, regardless of age. As with compression, the improvement in tensile splitting strength for mortar was mostly due to an increase in mortar density and improved conditions for cement hydration with fly-ash, marble, and granite powder's micro-fines.

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