Partial Replacement of Cement by Marble powder And River Sand by Quarry Dust And Lime Stone Waste Powder

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***Abstract*—This research focuses on concrete mix design using marble powder, quarry dust and lime stone waste powder. The disposal of marble powder from the marble industry is of environmental problem today. Then they used for replacement process M25 grade concrete. The partial replacement of 5%, 10%, 20%, 25% and 30% are used in marble powder and quarry dust increases for workability reduce. The physical property of marble powder, quarry dust and lime stone waste powder is specific gravity, water absorption, silt content and fineness modulus were measured using standard tests. This was followed by compression, split tensile and bending tests on cubes and cylinders to study the strength of concrete made of marble powder, quarry dust and limestone waste powder. The results were compared with the conventional concrete. The results showed that with increasing proportion of quarry dust, marble powder and limestone waste powder.**

***Index Terms*—Compressive strength test, Split tensile strength test, Flexural strength test**

I. INTRODUCTION

1.1 General

This research deals with the advanced construction technique by concrete technology replaced by different waste materials. Wastes marble powder, quarry dust and lime stone waste powder is generated as a by-product cutting marble powder and quarry dust. The waste generated every year is in tones which dumped open space. The environmental problems attributed by waste marble powder quarry dust and lime stone waste powder imposes to physical, chemical, biological components of environments. It is therefore very important to reuse the marble powder and quarry dust, lime stone waste powder which solve most of problem. This report describes the feasibility of using the waste of marble powder and quarry dust & lime stone waste powder as a partial replacement of cement and fine aggregate. The advancement of concrete technology can reduce the consumption of natural Resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of marble dust are generated in natural stone processing plants with an important impact on environment and humans. This research describes the feasibility of using the marble sludge dust in concrete production as partial replacement of cement Marble powder was collected from the dressing and processing unit in Jalgaon. It was initially in wet form (i.e. slurry); after that it is dried by exposing in the sun and finally sieved by IS-90 microns before mixing in concrete.

1.2 Marble Powder

Marble is a metamorphic rock consisting of carbonate minerals that recrystallize under the influence of heat, pressure and aqueous solutions, most commonly calcite ($CaCO_3$) or dolomite $(CO3)_2$ and has a crystalline texture of varying thickness. Marble is typically not foliated (layered), although there are exceptions. About 10-15 of the sedimentary rocks on Earth are composed of limestone. In geology, the term marble refers to metamorphosed limestone, but

its use in stonemasonry more broadly encompasses unmetamorphosed limestone. Marble is commonly used for sculpture and as a building material. Acids react with the calcium carbonate in marble, producing carbonic acid (which decomposes quickly to CO_2 and H_2O) and other soluble salts as shown in figure 1.

Figure: 1 Marble Powder

1.3 Cement

A cement is a binder, a chemical substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet most- consumed resource as shown in figure 2.

Figure: 2 Cement

1.4 Quarry Dust

The reduction in the sources of sand and the need to reduce the cost of construction projects has resulted in the increase need to identify alternative construction materials to sand as fine aggregates in the construction projects. Quarry dust a by- product from crushing process during quarrying activities is good alternative during construction projects. It is used as substitute to sand to make quarry dust concrete which is believed to be stronger and more durable than the regular concrete materials. It can be used as substitute to sand wholly or partly. It offers a comparatively good strength compared to sand with or without concrete admixtures. This type of dust is getting popular in construction projects such as road construction, building houses and making bricks and tiles. Quarry dust is ideal for these jobs and is expected to be the future and likely replacement for sand in construction project, since river sand is fast becoming scarce and very expensive. Sand is obtained from river beds, and is its availability is becoming challenging at reasonable price. In order not to compromise strength of building during construction, quarry dust come handy as an equal substitute without threat to quality at the same time rendering good strength to whatever construction project quarry dust is used as shown in figure3.

Figure: 3 Quarry Dust

1.5 Fine Aggregate

In construction, aggregate refers to the particulate materials used in making concrete and fine aggregate refers to aggregate with particles so small that they may pass through a sieve with a mesh size of 4.75 millimetres. To choose the ideal fine aggregate, you need to be well- versed in its size, density, and classification, since it is frequently employed in the construction process to enhance the concrete volume at a low cost. In this article, we will cover all there is to know about fine aggregate, including its many types and other specifics. Fine aggregate, which may be granular material or crushed stone, is a fundamental component of concrete. The quality of the fine aggregate and the density of the fine aggregate both have a significant impact on the hardened qualities of the concrete as shown in figure 4.

Figure: 4 Fine Aggregate

1.6 Limestone Waste Powder

Limestone waste powder is generally a by-product or the left-over product from the limestone industry. It is basically obtained after the crushing process during the production of the aggregates. Basically, the limestone waste is generated by the limestone processing industry and it was a left-over product in the form of either fine particles or the coarse particles. Limestone waste can easily be used for improving the strength aspects of the normal concrete as it has the potential to fill pores and voids due to its certain cementitious as well as non-cementitious properties. Previously certain research works has been carries out regarding the usage of the limestone waste as replacement of both cement and natural fine aggregate for improving the strength aspects of the normal concrete as shown in figure 5.

Figure: 5 Lime Stone Waste Powder

1.7 Coarse Aggregate

Different materials are used in the construction industry. Among them, aggregate is one. Aggregate is the inert granular material that is used in the concrete as the filler material and provides volume to the concrete. There are two types of aggregates naming fine aggregate and coarse aggregate. We are discussing coarse aggregate in this article. Aggregates having a size of more than 4.75 mm are said to be coarse aggregate. In another word; aggregates retained on a 4.75 mm sieve are coarse aggregate as shown in figure 6.

Figure: 6 Coarse Aggregate

1.8 Objective

The main objective of the project is to study the effects of marble powder, quarry dust and lime stone waste powder on fresh and hardened concrete when cement was partially replaced by marble powder at 5%, 10%, 15%, 20%, 25% and 30%. Then river sand was partially replaced by quarry dust and lime stone waste powder.

- To compare it with the compressive, split tensile and flexural strength of ordinary M25 grade concrete.
- To find the percentage of marble powder replaced in concrete that makes the strength of the concrete maximum.

II. LITERATURE REVIEW

This chapter presents concreate in general as well as the effect of replacing marble powder by cement and quarry dust and limestone waste powder as fine aggregate with the concreate mix topics addressed include how the concreate materials are replaced with feasibility for use of natural aggregate in concrete (1). Concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens (cures) over time. Concrete is the second-most-used substance in the world after water, and is the most widely used building material(2).its usage worldwide, ton for ton, is twice that of steel, wood, plastics, and aluminium combined. Globally, the ready-mix concrete industry, the largest segment of the concrete market, is projected to exceed $600 billion in revenue by 2025(3).This widespread use results in a number of

environmental impacts. Most notably, the production process for cement produces large volumes of greenhouse gas emissions, leading to net 8% of global emissions Construction aggregate, or simply aggregate, is a broad category of coarse- to medium-grained particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates(4). Aggregates are the most mined materials in the world. Aggregates are a component of composite materials such as concrete and asphalt; the aggregate serves as reinforcement to add strength to the overall composite material (5). Due to the relatively high hydraulic conductivity value as compared to most soils, aggregates are widely used in drainage applications such as foundation and French drains, septic drain fields, retaining wall drains, and roadside edge drains (6). Aggregates are also used as base material under foundations, roads, and railroads. Aggregates are the vital material in construction. At present, a structure cannot be constructed without those materials. In concrete, the aggregate occupies75% to 80% of its total volume due to its strength (7).

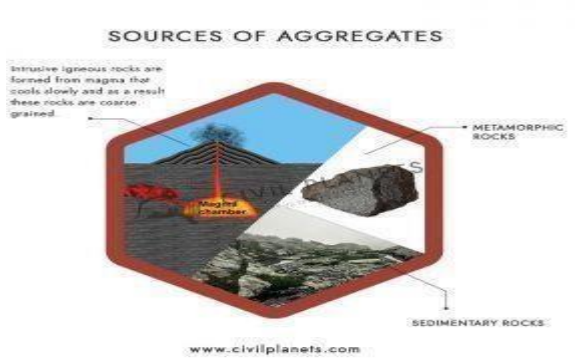

Figure: 7 Source of Aggregates

As you all know from our previous topic classification of aggregates, Aggregates are derived from river banks, and nature formed rocks. So, experts are desperately looking for a suitable alternative for coarse aggregate the low cost and lightweight, which does not affect nature much (9).

1. We have already started using M sand instead of river sand.
2. The natural or synthetic lightweight aggregates make lightweight concrete.
3. It is a low cost along with excellent durability.

When we use alternative material in construction, it may speed up the progress at a low cost (10). Workability was increased by using small amount of marble powder ratio as a replacement of cement and leads to increase the compaction and the strength of concrete (11). The increasing of marble powder ratio as a replacement of cement over the optimum dosage leads to the segregation of aggregate and bleeding of cement and aggregates lead to decrease the resistance of concrete (12). Increasing the marble powder ratio replacement of cement led to the increasing as the compressive strength by about (25% and 8%) for the marble powder replacement ratios (5% and 7.5%) compared to the control mix. Increasing the marble powder ratios higher than 5% decreased the compressive strength of concrete mixes (13). Increasing indirect tensile strength and modulus of elasticity was recast of the by using marble powder ratios (5% and 7.5%) compared to the control mix (14).

III. MATERIALS AND THEIR PROPERTY

3.1 Cement

Ordinary Portland cement is a cementing material obtained by fine grinding of Portland clinkers with a little amount of gypsum to adjust the setting time and prevent flash setting. It possesses binding properties to bind the materials together as well as adhesive properties. 95-100 % portland cement clinker is used while 0-5 % of minor constituents are present. These can be cementitious materials or filler materials, which can enhance the workability or water retention capacity of cement. Gypsum is added in OPC at the time of grinding to adjust the setting time of cement and to prevent the flash setting of cement as shown in figure 8.

Figure: 8 Cement

3.2 Fine Aggregate

River sand is a natural fine aggregate sourced from river beds, known for its smooth, rounded particles that provide excellent workability and ease of mixing in construction. It is widely used in concrete, plastering, and bricklaying due to its good gradation, cohesiveness, and load-bearing capacity. River sand contributes to higher compressive strength and durability of concrete, making it suitable for foundations, roads, and buildings. However, it may contain impurities like silt and organic matter, and excessive mining has environmental impacts. Despite this, river sand remains a preferred material for precise construction work because of its natural texture and stability as shown figure 9.

Figure 9 Fine aggregate

3.3 Coarse Aggregate

Coarse aggregate refers to granular construction materials like crushed stone, gravel, or recycled concrete with particle sizes typically retained on a 4.75 mm sieve, ranging up to about 63 mm in diameter. These aggregates provide bulk, strength, and stability to concrete and are essential for structural integrity in construction projects such as buildings, roads, and railway ballast. The quality, hardness, and shape of coarse aggregates significantly influence the strength and durability of concrete, making their selection and cleanliness crucial for optimal performance as shown figure 10.

Figure 10 Water absorption of Coarse aggregate

3.4 Marble Powder

Marble dust which is used in this investigation was obtained during polishing and cutting of marble. We can reduce the environmental pollution by utilising this marble powder table1.

SI.NO	Properties	Test Values
1	Colour	White
2	Form	Powder
3	Specific gravity	2.66
4	Odour	Odourless
5	Moisture content	0.60
6	Sieve	0.90mm
7	Hardness	3 on Mohr"s sclae
8	Water absorption	0.97%

Table: 1 Physical Properties of Marble Powder

3.5 Batching and Mixing of Concrete

3.5.1 Weighing of Materials

Concrete is prepared for M25 mix, designed for plain concrete and concrete with CSA. Materials such as cement, fine aggregate, coarse aggregate and CSA are free from impurities are weighed with an accuracy of 5%, 10%,15%, 20%, 25% and 30% weight of cement as shown in figure 11.

Figure: 11 Batching

3.6 Mixing of Materials

Concrete is mixed in a non-absorbent clean platform i.e in a mixing tray with a trowel. Initially fine aggregate is put into the platform following cement, marble powder and fine aggregate such as sand, limestone waste powder and quarry dust for plain concrete. For concrete with CSA, initially fine aggregate is put into the mixing tray followed by mixture of cement and slag and then coarse aggregate are mixed properly. At last required quantity of water as per water- cement ratio is added

and mixed well within 2 minutes as shown in figure 12.

Figure: 12 mixing

IV. TESTS ON FRESH CONCRETE

1. Slump cone test
2. compaction factor test
3. flow table test
4. vee-bee consistometer

4.1 Slump Cone Test

slump cone test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work. Concrete slump test is carried out from batch to batch to check the uniform quality of concrete during construction. The slump test is the simplest workability test for concrete, involves low cost and provides immediate results.

Factors which influence the concrete slump test:

1. Material properties like chemistry, fineness, particle size distribution, moisture content and temperature of cementitious materials. Size, texture, combined grading, cleanliness and moisture content of the aggregates,
2. Chemical admixtures dosage, type, combination, interaction, sequence of addition and its effectiveness,
3. Air content of concrete,
4. Concrete batching, mixing and transporting methods and equipment,
5. Temperature of the concrete,
6. Sampling of concrete, slump-testing technique and the condition of test equipment,
7. The amount of free water in the concrete, and
8. Time since mixing of concrete at the time of testing.

4.2 Sampling of Materials for Slump Test

A concrete mix (M15 or other) by weight with suitable water/ cement ratio is prepaid in the laboratory similar to that explained in 5.9 and required for casting 6 cubes after conducting Slump test as shown in figure 13.

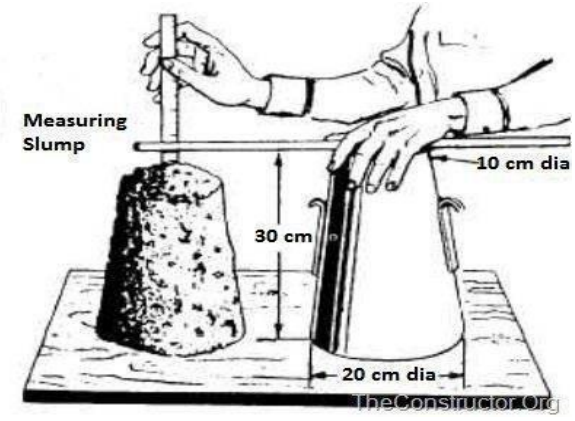

Figure: 13 Slump representation

Procedure for Concrete Slump Cone Test

1.Clean the internal surface of the mould and apply oil.

2.Place the mould on a smooth horizontal non- porous base plate.

3.Fill the mould with the prepared concrete mix in 4 approximately equal layers.

4. Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.

5.Remove the excess concrete and level the surface with a trowel.

6. Clean away the mortar or water leaked out between the mould and the base plate.

7.Raise the mould from the concrete immediately and slowly in vertical direction.

8. Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested.

4.3 Results of Slump Test on Concrete

Slump for the given sample 22mm (true slump) When the slump test is carried out, following are the shape of the concrete slump that can be observed as shown in figure 14.

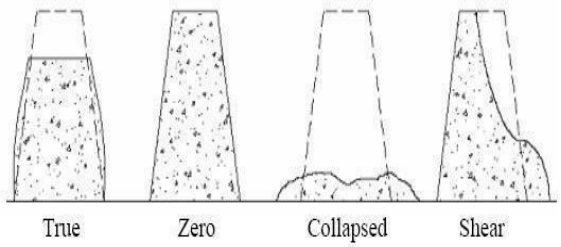

Figure: 14 Slump

Table: 2 Slump cone test of fresh concrete

Percentage of replacement	W/C Ratio	Slump value	Nature of collapse
Conventional concrete	0.45	75	True
10%	0.45	70	True
15%	0.45	68	True
20%	0.45	57	True
25%	0.45	55	True

Figure: 15 Slump cone test

4.4 Compaction Factor Test

Compaction factor test is the workability test for concrete conducted in laboratory. The compaction factor is the ratio of weights of partially compacted to fully compacted concrete. It was developed by Road Research Laboratory in United Kingdom and is used to determine the workability of concrete. The compaction factor test is used for concrete which have low workability for which slump test is not suitable as shown in figure 16.

Compaction Factor Value= (W1-W) / (W2-W)

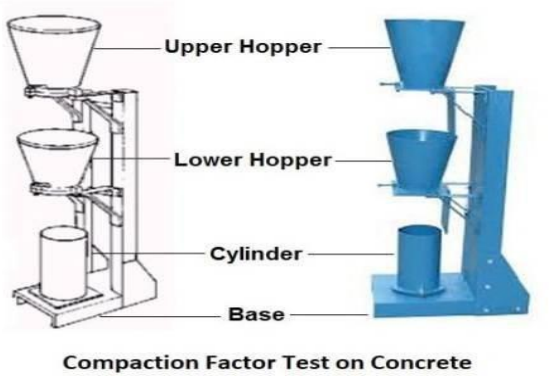

Figure: 16 Compaction factor test

Table: 3 Relation Between Workability & Slump

workability	Compaction factor	Slump value(mm)
Very low	0.78	0-25
Low	0.85	25-50
Medium	0.92	50-75
High	0.95	75-100

4.5 VEE-BEE Consistometer

Vee-bee test carries out the relative effort measurement to change the mass of the concrete from a definite shape to the other. That is, as per the test, from the conical shape to the cylindrical shape by undergoing vibration process. The measurement of the effort is done by time measurement in seconds. The amount of work measured in seconds is called as the remolding effort. The time required for the complete remolding is a measure of the workability and is expressed in the Vee-Bee seconds. The experiment is named after the developer V Bahrmer of Sweden. The method can be also applied for dry concrete. For concrete that have slump value more than 50mm, the remolding activity will be so fast that the measurement of time is not possible as shown in figure 17.

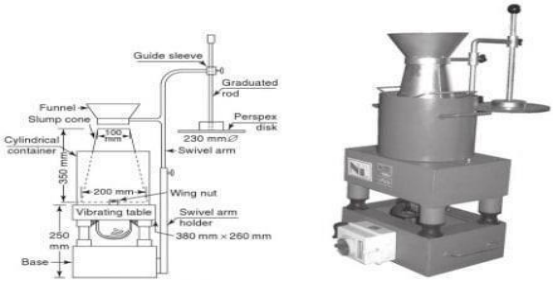

Figure: 17 vee bee apparatus

4.6 Mould Preparation and Casting of Concrete

Mould is cleaned properly and greased with mould oil. Concrete is placed in the mould of dimension 150mm X 150mm X 150mm in three layers each layer of height approximately 50mm. After the placement of first layer of concrete it is compacted by a tamping rod of 16mm diameter, 0.6m long and bullet pointes at the lower end. The stroke of the bar is uniformly distributed over the cross section of the mould. Each layer is compacted with 25 strokes and next scoop of concrete is placed followed by same manner of compaction and top layer is finished as shown in figure 18.

Figure: 18 Casting of Concrete

4.7 Mould Making

The mould must be watertight. This can be ensured by precise tailoring of the components from which the mold is made. If this is not the case any seams can be sealed with acrylic kit. The shape must be solvable. A releasable form is constructed from wide to narrow and has no projections or protrusions. Any locked parts must be filled with foam. If this is done with a different material, the unloading will be prevented due to shrinkage. It is important which material is chosen for the construction of the mold. The materials that work best are plywood, vivak, EPS foam sheet and silicone rubber. When plywood and foam plates are used, the inside of the mold needs to be treated with oil.

4.8 Concrete Mixing

Before the concrete is mixed the volume must be determined. The solid particles can be measured in a bucket or a tub. Then water can be added. The amount of water must in the end be about 1:4. It is advisable to add it into parts while mixing. If the substance changes from solid to liquid, there is just enough water.

4.9 Composition

Normal concrete consists of: 1 part cement, 2 parts of sand, 3 parts of stones and 1 part water. The concrete that we usually have in stock misses the stones, instead some gravel or fibers have been added.

4.10 Casting

During the casting of the concrete a large opening is needed. When the mold is filled, shake slightly to get rid of the bubbles. A compact size causes a high temperature. It‟s recommended to cover the mould with foil for one day to prevent the concrete from drying out.

4.11 Curing of Specimen

The test is specimen are stored in place free from vibration, in moist air of at least 90% relative humidity and at a temperature of 27for 24 hours from the time of addition of water to the dry ingredients. After this period, the specimens are marked and removed from the mould and immediately submerged in cleaned fresh water and kept there until taken out just prior to test. The water in which the specimens are submerged, are renewed every 7 days and maintained at a temperature of 27. The specimens are not allowed to become dry at any time until they have been tested as shown in figure19.

Figure: 19 Curing of Specimen

V. TESTS ON HARDENED CONCRETE

1. Compressive strength test
2. Split tensile strength test
3. Flexural strength test
4. Sulphate resistance test

5.1 Compressive Strength Test

The compressive strength of the concrete cube test provides an idea about all the characteristics of

concrete. By this single test one judge that whether Concreting has been done properly or not. Concrete compressive strength for general construction varies from 15 MPa (2200 psi) to 30 MPa (4400 psi) and higher in commercial and industrial structures. Compressive strength formula for any material is the load applied at the point of failure to the cross-section area of the face on which load was applied as shown in figure20.

Compressive Strength = Load / Cross-sectional Area

Figure: 20 Compression strength test

Table: 4 Compressive Strength Test on Cude

Percentage of replacement	Compressive strength		
	7^{th} day	14^{th} day	28^{th} day
Conventional concrete	15.3	17.4	22.6
10%	16.4	19.6	23.7
15%	17.8	21.7	25.4
20%	18.5	23.2	27.6
25%	14.8	18.5	23.1

5.2 Split Tensile Strength Test

The tensile strength of concrete is one of the basic and important properties which greatly affect the extent and size of cracking in structures. Moreover, the concrete is very weak in tension due to its brittle nature. Hence. it is not expected to resist the direct tension. So, concrete develops cracks when tensile forces exceed its tensile strength. Therefore, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. Furthermore, splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete as shown in figure 21.

T= 2P/ pi LD

Where:

T = splitting tensile strength, MPa

P: maximum applied load indicated by the testing machine,

D: diameter of the specimen, mm

L: length of the specimen, mm

Figure: 21 Split Tensile Test

5.3 Flexural Strength Test

Flexural test evaluates the tensile strength of concrete indirectly. It tests the ability of unreinforced concrete beam or slab to withstand failure in bending. The results of flexural test on concrete expressed as a modulus of rupture which denotes as (MR) in MPa or psi. The flexural test on concrete can be conducted using either three-point load test (ASTM C78) or center point load test (ASTM C293) as shown in figure 22.

T=PL/BD^2

Where, P – load

L – length of the beam

B – dia of the beam

D – depth of beam

Figure:22 Flexural Strength Test

Table :5 Test Result for Conventional Beam Deflection Test

S.NO	Load	Deflection (mm)
1	0	0
2	100	5.2
3	200	9.8
4	300	15.2
5	400	19.8

5 . 4 sulphate resistance test

The resistance of concrete to sulphate attack is often analyzed using laboratory test methods on mortar samples and expansion measurements. In rare cases the loss of strength is measured by bending or tensile strength tests. To reduce the effort of sample preparation for tensile strength testing, briquet specimens according to ASTM C307 were used in the present research work as shown in figure 23.

ftm(t)= βtc(t)·ftm,28d with βtc(t)= es·(1−28dt√)ftmt= tct·ftm,28d with tct= es·1−28dt

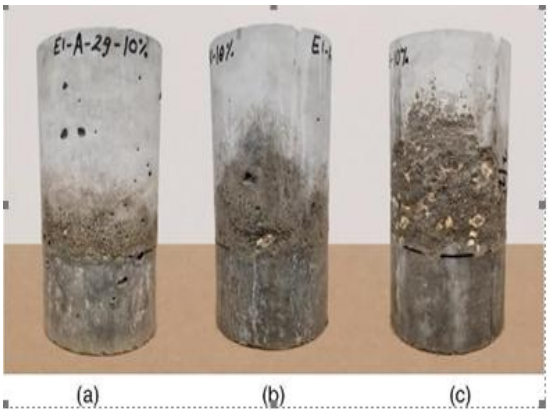

Figure:23 sulphate resistance test specimen

Table: 6 compressive strengths after immersion of sodium sulphate solution

Percentage of replacement	Compressive strength after sulphate resistance test
Conventional concrete	26.63
10%	27.73
15%	27.98
20%	28.12
25%	27.17

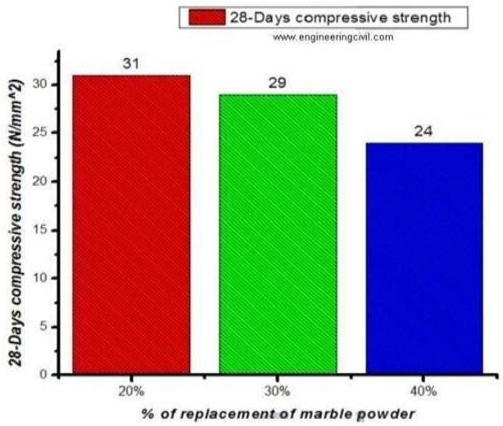

Figure:24 Replacement of Marble Powder

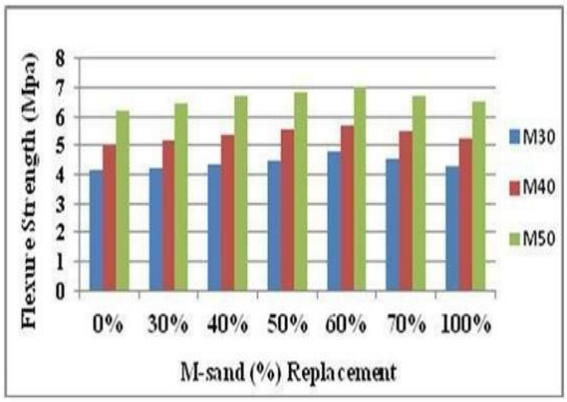

Figure:25 Flexural strength of specimen after replacement

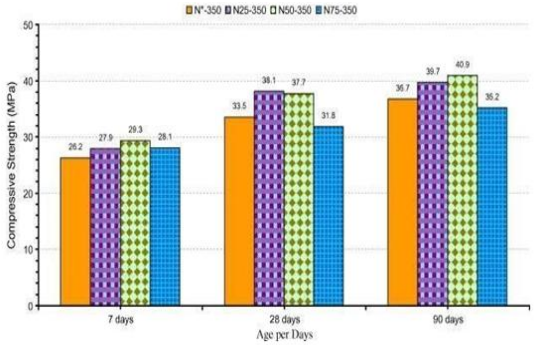

Figure:26 Compression strength of specimen after replacement

VI. CONCLUSION

In this study of concrete mix design using marble powder, quarry dust and lime stone waste powder. The disposal of marble powder from the marble industry is of environmental problem today. Then they used for replacement process M30 grade concrete. The partial replacement of 5%, 10%, 20%,

25% and 30% are used in marble powder and quarry dust increases for workability reduce. The physical property of marble powder, quarry dust and lime stone waste powder are specific gravity, water absorption, silt content and fineness modulus were measured using standard tests. This was followed by compression, split tensile and bending tests on cubes and cylinders to study the strength of concrete made of marble powder, quarry dust and limestone waste powder. The results were compared with the conventional concrete. The results showed that with increasing proportion of quarry dust, marble powder and limestone waste powder, In Result by replacing the Materials upto Max 15-20% gives cost effective and strength, by replacing more than 20% results failure of structure.

REFERENCES

[1] Manju Pawaret.al (2014) Feasibility and need of use of waste marble powder in concrete production. ISSN No. 2349-943435.PP 1-6.

[2] V.M.Sounthararajan and A. Sivakumar (2013) Effect of the lime content in marble powder for producing high strength concrete. ISSN 1819-6608.PP 260- 264.

[3] Corinaldesi V, Moriconi G, Naik TR, (2010), ―Characterization of marble powder for its use in mortar and concrete‖, Const. Build. Mat., 24, pp 113-117. [4] Vaidevi C (2013) Study on marble dust as partial replacement of cement in concrete.ISSN 2319 – 7757.PP14-16.

[4] Candra Aditya, Abdul Halim Chauliah, Fatma Putri, Waste Marble Utilization from Residue Marble Industry as a Substitution of Cement and Sand within Concrete Roof tile Production International Journal of Engineering Research Volume No.3, Issue No.8, pp.: 501-506 ISSN: 2319- 6890) (online), 2347-5013(print) 01 Aug2014.

[5] Prof. Veena G. Pathan1, Prof. Md. Gulfam Pathan2012 Feasibility and Need of use of Waste Marble Powder in Concrete Production IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 23-26.

[6] ArchaneswarKumar. K, Dr. k. Rajsekhar, Dr.C.Sashidhar, "Experimental Investigation on Fly Ash and Lime sludge in Cement Mortar", Volume – V, Issue – II, February 2016.

[7] Sajad Ahmad, "Study of concrete Involving use of waste paper sludge Ash as partial replacement of cement", IOSR Journal of Engineering (IOSRJEN) e- ISSN: 2250-3021, p-ISSN: 2278-8719 Vol. 3, Issue 11(November. 2013).

[8] Sarika G.Javiya, Zalak P.Shah, "Development of low-cost cement mortar by utilizing paper industrial waste Hypo sludge", International journal for scientific research &development 2,2014, .2321-0613.

[9] Raghunathan T, Gopalsamy P, Elangovan R (2010) Study on strength of concrete with ETP sludge from dyeing industry. Int J Civ Struct Eng 1(3):379–389

[10] Rahman MM, Khan MMR, Uddin MT, Islam MA (2017) Textile Effluent treatment plant sludge: characterisation and utilisation in building materials. Arab J Sci Eng 42(4):1435–1442.

[11] Zhan BJ, Li JS, Xuan DX, Poon CS (2020) Recycling hazardous textile effluent sludge in cement-based construction materials: physicochemical interactions between sludge and cement. J Hazard Mater 381(2018).

[12] Minnu SN, Bahurudeen A, Athira G (2021) Comparison of sugarcane bagasse ash with fly ash and slag: an approach towards industrial acceptance of sugar industry waste in cleaner production of cement. J Clean Prod 285(xxxx):124836.

[13] Batool F, Masood A, Ali M (2020) Characterisation of sugarcane bagasse ash as pozzolan and influence on concrete properties. Arab J Sci Eng 45(5):3891–3900.