Exploring possibilities of Utilization of Marble Slurry in Cement Concrete

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Abstract - **The research work will be undertaken on exploring possibilities of utilisation of marble slurry cement concrete. It will be a pain taking and hard work to explore the possibilities of utilisation of marble slurry in cement concrete. This waste material is hazardous to environment so badly that it affects all dimensions of Environment i.e. Air, Water and Soil. Effect's directly all living organisms. Even a grass leaf is not possible to grow in marble slurry area. Methodology adopted will be based on replacement of fine aggregate by marble slurry without over ruling recommendations of IS code. All experiments will be performed as recommended experiments by Indian standards. This research will be basically derived in two parts as below: Effects of Marble Slurry on binding properties of cement, equivalence of properties of marble slurry and fine aggregate, and strength related experiments, finding out optimum percentage of replacement of marble slurry with fine aggregates without disturbing the strength.**

keywords - **Marble Slurry, Cement Concrete, Waste.**

Introduction:

Marble occurs in abundance on earth. It is processed and had been quarried at number of mines worldwide since early times. Near about 90% production of the marble of world is produced in India and near about 85% production of India is produced in Rajasthan. For our study of the, processing and mining activities are concentrated around **Makrana**, District Nagaur in Rajasthan. There are about 4000 mines of marble and nearly 1100 marble sawing industries (gang saw) Jaipur, Ajmer, Alwar, Nagaur, Rajsamand, Udaipur, Chittorgarh, Banswara, and Sirohi districts which are famous for quarrying of marble stone.

At present time it is leading in progress of nos. of industrial units in related regions. Both of the process i.e, mining and processing increased phenomenally in Rajasthan within 20 to 25 years and had contributed to a very high level in the Industrial growth of the state.

This segment of industry includes quarrying and cutting and grinding activities in the manufacture of slabs to the walls tiles and flooring tiles, Statues, Embroidery and other furnishing goods. The whole segment of this industry is a opposite by any new industry by the real actuality about it that, this stone is a "Dimensional Stone" it's meaning that marble is precious and trading of this marble is done in sq-m, and sq-ft not by Tones, weighing(by area not by weight). Because the unit cost of stone goes up with size, all the activities including mining and cutting are attempted to find blocks and thatches as bigger as achievable. In this attempt amount of wastage or [Marble Slurry] increases and creates major problems to environment and human being. Due to Severe damage to eco system and hazard to environment, vegetation and human being, Indian courts have taken a tough posture and MSME & Khadi board started some projects utilizing marble waste the [Marble Slurry].

It is a violation of condition, according to High Court of Rajasthan Petition No.2150/2004 of control of pollution and water prevention act 1974. It is necessary to make use of hazardous waste [Marble Slurry] or a proper disposal system without disturbing the ecosystem. [Marble Slurry] according to MSME Jaipur and Khadi board can be utilized in some of industries for production of useful products.

Aims of Study:

WASTE CAUSES ENVIRONMENTAL HAZARDS.

Quarrying, sawing, and polishing processes pose a significant threat to the environment in Rajasthan Near about one thousand processing plants and many thousands of saws are generating 20-25 lack ton of marble waste i.e. [Marble Slurry] which is not destructible & hazard to human being. Some of the hazards of marble waste slurry can be scheduled as below:

1. The [Marble Slurry] is not destructible.
2. The proper places where dumping can be done as filling sites are not more and have a very bad look.
3. Fertile top layer of soil is getting polluted (unfertile) due to contamination of [Marble Slurry].
4. Contamination of the Nalas, water bodies and rivers taking place, which is severely polluting drinking water resources and irrigation.
5. Contamination of air by fine particles of [Marble Slurry].

As a result, solving the problem of [Marble Slurry] pollution is a scientific and engineering obligation of industry, as well as a social and legal responsibility of government. However, sustainably balanced industrialisation is the only way for the country to develop.. The precious national property is going waste by the older technology improper disposal. [Marble Slurry], if utilized properly, can perhaps improve the picture of the whole industry.

AIR POLLUTION
The [Marble Slurry]'s most dangerous effect is this. When slurry becomes dry, it creates air related problems and creates connected over all hazards.

POLLUTION OF WATER
The water is used in marble industry for its different functions as cutting, polishing and flushing. In different functions water becomes polluted with [Marble Slurry] and with rain water contamination goes to Rivers and different water bodies.

VISUAL IMPACTS
Un-operated mines, disposing yards, waste dumping yards, slurry deposits over almost every building, Trees and Plants and vegetation and nearby zones giving a poor, bad vision and creates visual troubles.

UNSCIENTIFIC DUMPING CAUSES ACCIDENTS
- Accidents by wrong disposal of un useful material and slurry dumped beside road creating fogging air with air blows of vehicles and creating less visible distance, due to slurry fogging and less visible distance many accidents takes place.
- In rains the slurry flow on the road dissolving in rain water. Because of this slurry road pavement behave greasy and no of accidents happens.(refer photo no.2)

LOSS TO FLORA & FAUNA
[Marble Slurry] creates aesthetic problem to structures and vegetation both. The fine grains of [Marble Slurry] fly in air and due to gravity these particles deposits on the leaf of the vegetation and hence leaf dries due to slurry deposition. Due to this reason not only grasses, bushes but also the trees dying. Animals also suffer for Green fodder and shelter. The particles are scaling on the top fertile cover of soil and hence the fertile soil is getting unfertile, unproductive. (Refer photo no.1)

Objective of research:
The main objective of this research is how to utilise [Marble Slurry] for safe and economic house construction. There are four sub-objectives related to the main objective.

Utilization of [Marble Slurry] at mass level in construction industry in preparing cement mortar and cement concrete for construction, i.e. cement mortar for masonry, plastering and cement concrete for casting of columns, beams, slabs and floors and also in manufacture of bricks and interlocking tiles.

These are:

To reduce the pollution by [Marble Slurry].

To make use of [Marble Slurry] for economic construction in [Marble Slurry] producing area.

To explore the area's of possibilities of utilization of [Marble Slurry].

Scope of Study
Marble industry in India is biggest in world and about 80% marble is produced in India of world total production. [Marble Slurry] is also produced accordingly. Hazards of [Marble Slurry] are severe in same percentage. So it is required to consume the waste in construction works such as in cement mortar and cement concrete, may be used to produce cement mortar and cement concrete items as well as civil construction works. It may be utilized in formation of roads and embankments etc in earth filling works. So it is required to make an IS: code of conduct for [Marble Slurry] like fly ash. Each and every property is needed to work out with detailed study and lot of experimental work.

Literature Review
Use of marble waste as a partial substitute for traditional coarse mixture Marble waste become judged as a cappotential substitute for traditional coarse aggregates first via way of means of Binici et al. (2008). They had as in comparison the behaviour of concrete mixes absolutely made with marble waste as coarse mixture with mixes containing limestone mixture. On comparing the homes, it become determined that density of concrete mixes did now no longer range an awful lot on utilisation of marble waste. However the compressive energy of those mixes accelerated via way of means of 76�ter 28 days of curing. Flexural and tensile strengths in conjunction with Young's modulus of elasticity had been additionally better withinside the variety of 57–64% whilst as in comparison to mixes made with limestone aggregates. These marble integrated mixes had higher sturdiness homes additionally. Resistance to chloride ions become accelerated via way of means of 71% and the residual compressive energy after publicity to sulphate answer for one year become up via way of means of 2.four instances whilst as in comparison to limestone primarily based totally concrete.

The have a look at performed via way of means of Hebhoub et al. (2011), used limestone mixture for the manufacturing of manage concrete. These limestone aggregates had been changed via way of means of marble waste withinside the steps of 25% from zero% to 100%. The consequences display that combines made with marble waste had barely lesser clean bulk density values whilst as in comparison to manipulate concrete. The workability additionally decreased appreciably on increment of marble waste incorporation. However, compressive energy stepped forward on inclusion of marble, wherein most overall performance become finished at seventy five% substitution degree. This become better via way of means of 25% whilst as in comparison to the manage blend. Split tensile energy become additionally better on the identical substitution degree.

Gencel et al. (2012) had used beaten stone as a baseline for assessment of marble waste as coarse mixture, had been substitution become accomplished in steps of 10% from zero% to 40%. The consequences confirmed that with growth in substitute degree of marble waste, the unit weight of concrete mixes decreased in conjunction with compressive energy. At 40% substitution, the compressive energy become most effective 78% of the manage concrete. There had been comparable versions in spilt tensile energy, Young's modulus, UPV and Schmidt hardness values additionally. Only superb characteristic of marble primarily based totally concretes is that they've been said to have lesser water absorption capacity, therefore their resistance to freeze and thaw become additionally better. At the stop of the freezing and thawing trying out regime the autumn in compressive energy become round four–7% for mixes with 40% marble waste, while for the manage mixes it become round 13–15%.

Martins et al. (2014) and André et al. (2014) used limestone, basalt and granite as their baselines for comparing overall performance of marble waste as coarse mixture. Marble waste become used to update those traditional aggregates via way of means of 20%, 50% and 100% ranges. Mixes made with marble mixture had been equal or marginally higher in resisting compressive and tensile strengths whilst as in comparison to limestone counterparts. Resistance to water penetration become better via way of means of 40% at whole substitution. However, there has been huge discount in Young's modulus values which become lesser via way of means of 28% at whole substitution whilst as in comparison to the manage blend. There become no huge variant in resisting chloride ions and carbonation whilst marble become used as coarse mixture.

2.2. Use of marble waste as a partial substitute for nice mixture

2.2.1. Marble waste as nice mixture for manufacturing of concrete

Marble waste has been examined as a probable substitute of nice mixture for the manufacturing of concrete mixes having w/c ratio withinside the variety zero.four–zero.6. Most of the research have used calcite primarily based totally marble waste for his or her research. As withinside the case of changing coarse mixture via way of means of marble waste, Hanifi Binici right here too become the pioneer in sporting out the studies on this domain. Binici, Kaplan and Yilmaz (2007) used marble waste finer than 1 mm to update sand of the identical length, in proportions of five%, 10% and 15%. They said that with inclusion of marble waste, compressive energy of the concrete mixes stepped forward via way of means of 24% at 15% substitution degree. After publicity to a 7% sulphate answer the compressive energy of the identical blend decreased via way of means of most effective 15% whilst as in comparison to manipulate concrete which misplaced 58% of authentic compressive energy. This blend had the excellent resistance to abrasive put on and water penetration additionally. These upgrades had been credited to marble wastes' pore filling capacity however on the fee of decreased workability. Hence a superplasticizer needed to be used to compensate this loss.

Ural, Karakurt and Cömert (2014) repeated the above exercise, however with the usage of pozzolana-primarily based totally cement because the binder and with none superplasticizer. They ought to acquire equal overall performance to that of manage concrete at 10% substitution no matter a marginal growth in water content material to acquire vital workability. Kırgız (2016a) additionally reiterated the identical claims whilst he changed sand via way of means of marble waste finer than zero.half mm. He ought to acquire most compressive energy (better via way of means of eight% whilst as in comparison to manipulate concrete) at 20% substitute degree. Additionally he evaluated flexural energy, Schmidt floor hardness and resonant frequency which had been very an awful lot consistent with the variant in compressive energy. These upgrades but had been in large part insignificant.

Demirel (2010) used dolomitic marble slurry of length smaller than zero.25 mm to update sand of the identical length. Concrete homes like compressive energy, modulus of elasticity, unit weight and ultrasonic pulse velocity (UPV) had been superior due to decreased porosity. Most huge variant become observed for the alternate in modulus of elasticity become which approximately 24%, while for the ultimate parameters the growth become restricted to most effective 10%.

Unconventionally, Hebhoub et al. (2011) used marble waste (fineness modulus three.12) to update relatively finer sand (fineness modulus 1.92). He ought to acquire an stepped forward overall performance in phrases of compressive (an development of 24%) and tensile energy at 50% substitution. At 100% substitute, those parameters had been lesser than manage concrete.

Alyamac and Aydin (2015) and Aliabdo, Abd Elmoaty and Auda (2014) used marble waste of fineness 4372 and 4000 cm2/g to update river sand. Alyamac and Aydin (2015) used a super-plasticiser to atone for the loss in workability, via way of means of which they might update 90% of the nice mixture. The mechanical overall performance and resistance to abrasion for mixes with 40–50% marble waste become equal to manipulate concrete. Sorptivity become additionally applicable in the identical variety. While Alyamac and Aydin (2015) have a look at proved most compressive energy may be received at 20%, Aliabdo, Abd Elmoaty and Auda (2014) said that most advantage is received at 10% substitute of river sand. This development ranged among 7% and 15%. Both those research display that the ratio of tensile to compressive strengths increases, which suggest a more potent interfacial transition sector whilst marble waste is used. Apart from compressive and splitting tensile strengths, Aliabdo, Abd Elmoaty and Auda (2014) additionally evaluated metallic concrete bond energy, UPV and porosity. While the bond energy become most at 10% substitution, UPV values confirmed no alternate and porosity become least at 15% substitution.

Gameiro, De Brito and Correia da Silva (2014) and Silva, Gameiro and De Brito (2013) additionally evaluated the utilisation of marble mining waste as nice mixture for the manufacturing of concrete. They used river sand, basalt sand and granite sand because the base traces for assessment of marble waste. Unlike different research, the grading curve of person and composite nice aggregates become saved the identical throughout all mixes in an effort to take away the versions in overall performance bobbing up because of alternate in particle length distribution. The consequences display that regardless of the character of the traditional nice mixture, compressive energy of all concrete mixes decreased. A huge discount of 20% become observed whilst assessment become made to concrete with river sand. When as in comparison to mixes made with the aggregates of basalt and granite, the discount become four–eight%. However the discount in tensile energy and modulus of elasticity become now no longer as huge as that of compressive energy. This once more become an illustration of a more potent ITZ in marble integrated mixes whilst as in comparison to the mixes made with aggregates of non-carbonate sources. Durability homes like water absorption, carbonation and chloride ion penetration relied on the porosity of the combinationture, wherein the aggregates did now no longer play any huge function in converting the cement's chemistry. Drying shrinkage become the least in mixes with marble waste which the authors credited to its higher geometric features.

Vardhan, Siddique and Goyal (2019) additionally talked about that the workability of concrete mixes decreased with the growth in marble content material. However the compressive and break up tensile energy confirmed a top cost of 40% substitute degree of sand. Due to densification of the cement matrix via way of means of the formation of calcium carboaluminate, the resistance towards chloride ion penetration, water absorption and sorptivity decreased with the growth in marble content material.

Ashish (2018a) geared toward making use of the marble waste with out compromising at the mechanical overall performance of concrete. Hence they concurrently changed everyday Portland cement with both silica fume or metakaolin and supplied that the aggregate of marble powder and metakaolin completed higher than the aggregate of marble powder and silica fume.

2.2.2. Marble waste as nice mixture in mortars

Buyuksagis, Uygunoglu and Tatar (2017) had used marble waste debris finer than 1 mm as substitute for dolomite mixture withinside the manufacturing of adhesive mortars. They had substituted this traditional mixture from zero% to 100% in steps of 20%. They measured workability in phrases of glide desk check wherein that they'd recorded a minimum decline from 60% substitution onwards. The authors had additionally recorded a fall in placing instances of mortars with growth in substitution of marble waste. With regard to compressive energy they couldn't locate any particular sample in variant, while the tensile energy become equal for all mixes. Adhesive strengths but had been said to enhance with used of marble slurry which become most at 80% substitution degree. These mixes had additionally marginal growth in water absorption capacity.

With regard to manufacturing of masonry mortars, the maximum current posted literature to be had is of Khyaliya, Kabeer and Vyas (2017). The authors right here had used marble waste of debris starting from four.seventy five mm to seventy five µ to replacement nice mixture from zero% to 100%. The glide cost of those mortars become constant at 105–115%. The consequences confirmed that water requirement become the least for 50% substituted blend. Consequently compressive energy become most at 50% substitution at the same time as the absolutely substituted blend had 125% extra energy than the manage blend.

Romania's Molnar and Manea (2016) explored the suitability of calcite-primarily based totally marble slime in plaster (1:five) as a substitute for nice mixture. Each length fraction become substituted in proportions of 25%, 50%, seventy five% and 100%. The authors said that in regards to consistency, inclusion of marble decreased workability which become reasoned out to be due to the binding nature of marble powder. Seventh day compressive energy for the combinationture with 25% marble sludge become extra than manage mortar's energy via way of means of eight%. But assessment of the twenty eighth and sixtieth day energy, specimens recorded a decline of five% and 40%, respectively, for the identical blend. However even 100% substitution glad the standards of reaching a minimal energy of 6 MPa after 28 days of curing. Lastly, on assessment of energy of adhesion to the guide layer, blend with 25% marble waste had 160% extra energy than manage mortar. Substitution of seventy five% and upwards confirmed a decline in overall performance for the identical assets.

Earlier in 2014, Keleştemur et al. (2014b) tested the utilisation of marble sludge produced via way of means of the Turkey's marble slicing and sawing enterprise, as a substitute of nice sand (<zero.25 mm) withinside the substitution of 20%, 40% and 50% (via way of means of volume). A w/c ratio of zero.five become saved consistent for the combinationture ratio 1:three via way of means of volume. Compressive and flexure strengths had been evaluated after 30 cycles of freeze and thaw. The author's end become that considering that marble become finer than the sand it changed, it served the cause of a filler ensuing in higher compressive and flexural strengths. But but the identical filler impact decreased the mortars resistance to freeze and thaw cycles. This is because, pores assist lessen the tensile stresses created withinside the cement paste via way of means of the accelerated frozen water. Reduction of those pores caused a huge fall in flexural energy than compressive energy whilst specimens had been handled to freeze and thaw cycles.

2.2.three. Use of marble waste as nice mixture/filler in self-compacting concrete

Alyamaç and Ince (2009) geared toward building a monogram for the layout of self-compacting concrete (SCC) with marble waste as a filler. To acquire this, the authors had used marble from 3 distinctive sources, and introduced them at distinctive ranges to concrete mixes from zero to four hundred kg/m3. Cement content material and w/c had been additionally numerous among 300–500 kg/m3 and zero.36–zero.7, respectively. These variables ended in layout of forty seven distinctive blend proportions. Based at the consequences of the exams of clean and hardened homes which had been analysed statistically caused the layout of a monogram. This unmarried graph makes it viable to estimate the portions of cement, water and powder content material to acquire preferred compressive and break up tensile strengths with distinctive glide values.

Hameed et al. (2012) geared toward absolutely changing river sand with beaten rock dirt and incorporating marble waste as a filler for the manufacturing of SCC. The authors had been a hit in changing the whole river sand with beaten rock dirt and incorporation of marble waste helped in lowering pores. Hence, such concrete mixes had higher compressive and break up tensile strengths. This increment numerous among 2% and 17% for each the above mechanical parameters. Water permeability which accelerated via way of means of 21% on changing river sand via way of means of rock dirt become decreased via way of means of the identical quantity whilst marble waste become used as a filler. Such mixes additionally had better penetration resistance to chloride ions and higher electric resistivity.

Sadek, El-Attar and Ali (2015) attempted to mix granite and marble waste and use them as fillers for the manufacturing of SCC. On analysing the consequences the authors justified that marble waste imparted higher mechanical and sturdiness homes whilst mixed with granite waste. Best overall performance become received whilst those wastes had been used as 50% via way of means of weight of cement. Compressive energy of such mixes had been better via way of means of 28% whilst as in comparison to mixes made with 10% silica fume (introduced via way of means of weight as a percent of cement content material). Water absorption become additionally decreased via way of means of 17% whilst those mixes had been as in comparison. This superior behaviour of those mixes become because of suspected pozzolanic assets of granite waste, while marble waste acted most effective as a filler. These mixes additionally had a marginal benefit over resisting assault from sulphate reagents. Utilisation of such waste additionally proved to be an green opportunity to achieve the vital clean homes of SCC with out growing the cement content material or with out utilisation of fines like silica fume.

Tennich, Kallel and Ben Ouezdou (2015) as in comparison the mechanical overall performance of SCC made with marble waste as a filler with the ones mixes made with traditional limestone fillers in first in their research. The authors talked about mixes made with marble waste had similar fluidic and hardened homes to that of manage mixes. However, sulphate resistance of mixes with marble waste become appreciably higher than the ones mixes with none filler. The mixes made with marble waste ought to higher maintain the desired elastic modulus for an extended length of publicity to sulphate solutions (14–20 months) whilst as in comparison to manipulate mixes (five–eight months). Weight loss skilled via way of means of such mixes become additionally lesser. However, SCC mixes with limestone confirmed decrease deterioration traits than the ones made with marble waste. Tennich, Ben Ouezdou and Kallel (2017) reasoned this alteration in overall performance to be due to better alumina content material in marble waste whilst as in comparison to limestone filler, i.e. better the alumina content material extra is the susceptibility to harm via way of means of the sulphate reagents.

2.three. Use of marble powder as a partial substitute for cement

2.three.1. Marble slurry as supplementary cementitious cloth

Agarwal and Gulati (2006) had been capable of produce mortars with as much as 20% marble waste (via way of means of changing cement) from dolomitic starting place which had identical energy as that of manage mortars after 28 days of curing for a combination share of 1:three. After a hundred and eighty days of curing, the growth in energy become at a decrease rate, which ended in a drawback in overall performance of 12% to 25% for 10% and 20% substitutions, respectively. By the usage of a share of 1:6, the advantage in energy become extra principal with 10% and 20% substitutions having 42% and eight% extra energy than manage mixes. These blessings but had been worn out on utilization of a super-plasticiser in each the proportions, with mixes having marble waste reporting bad overall performance.

Corinaldesi, Moriconi and Naik (2010) characterized the rheological homes of composite binders via way of means of changing cement via way of means of marble slurry withinside the ranges 10% and 20% with and with out super-plasticising admixture and with w/c ratios of zero.four and zero.five. It become said that presence of marble powder stepped forward yield strain of the cement pastes i.e. stepped forward cohesiveness vital for self-compacting concrete. Marble powder additionally stepped forward segregation resistance. Thixotropy values of cement pastes with marble powder had been low, indicating higher glide via slim sections whilst set in motion. On changing cement via way of means of 10% for the manufacturing of mortars, compressive energy of the mixes become much less via way of means of 10% whilst as in comparison to traditional mortars. Rai et al. (2011) additionally echoed the identical consequences as depicted via way of means of Corinaldesi, Moriconi and Naik (2010) wherein the compressive energy of cement mortars decreased even for the 10% substitution degree.

Aliabdo, Abd Elmoaty and Auda (2014) used calcite marble of fineness 3996 cm2/g to update OPC in versions of five%, 7.five%, 10% and 15%. On comparing the clean and hardened homes it become summarised that there has been no alternate observed withinside the water requirement of pastes to acquire the vital consistency. Both preliminary and very last placing instances had been additionally equal for all versions. The enlargement of the composite cement pastes become additionally inside limits. Maximum compressive energy become received for pastes with 10% substitute wherein an increment of 12% in overall performance become recorded.

Mashaly et al. (2015) had additionally recorded clean and hardened homes of cement composites organized via way of means of substituting cement via way of means of marble waste withinside the steps of 10% from zero% to 40%. On comparing their consistency, those samples required extra water than the natural cement pastes. This is probably because, marble powder used on this have a look at had fineness two times as an awful lot as cement it become changing (6700 cm2/g). Both the placing instances recorded had been very an awful lot decrease than others for a substitution of 10%. With better water contents in them, mortars organized with those pastes recorded decreased resistance to compression even for the smallest substitution cost.

The pattern utilized by Vardhan et al. (2015) to update cement become of dolomitic starting place. This marble waste decreased the water portions required even from minimum substitution degree of 10% to a most substitution degree of 50%. Flow time of cement pastes become additionally drastically decrease with huge discount in time mentioned for 10% substitution degree itself. This waste additionally extended each preliminary and very last placing instances of OPC. However the time hole among preliminary and very last placing instances decreased for a substitution variety of 10–20%. On similarly growth in incorporation this time hole broadened. Similar consequences had been additionally supplied via way of means of Singh et al. (2017a).

Vardhan et al. (2015) had said that 10% substitute of OPC could produce cement paste with the identical energy as that of manage samples, while Singh et al. (2017a) had sanctioned utilization of 25%. This benefit may be due to particular reasons. Firstly, Singh et al. (2017b) had used marble waste become finer than cement they had been changing, which improves the possibilities of filler impact. Secondly the paste with 25% MS had eight% lesser water additionally in an effort to acquire vital consistency.

Kırgız (2016b) used calcite marble slurry to update OPC and examined the composite cement mortars for his or her compressive strengths. Substitutions had been accomplished in versions of 6%, 20%, 21% and 35% to put together mortars of share of 1:three with a consistent water cement ratio of zero.five. Maximum compressive and flexural strengths had been received for 6% substitute most effective.

Li et al. (2018) used marble waste debris finer than a hundred and fifty microns to update cement withinside the manufacturing of mortars. They had evaluated 4 distinctive w/c ratios of zero.four, zero.45, zero.five and zero.fifty five and changed cement in degrees of five%, 10%, 15% and 20%. Durability homes like drying shrinkage, carbonation and water absorption of those mortars had been studied. By the usage of marble waste as a binder and lowering the water content material via way of means of utilization of a superplasticizer, carbonation intensity of those mortars become appreciably decreased via way of means of round 30–40%. Water absorption and drying shrinkage had been additionally decreased via way of means of extra than 40%.

Fall in compressive energy appears to be extra principal in case of air cured samples as exhibited via way of means of Toubal Seghir et al. (2018). The obvious density of pastes made with changing cement with marble slurry in versions of five%, 10%, 15% become observed to lessen with huge growth in porosity values additionally. Ashish (2018a) evaluated the consistency and placing instances of composite cement pastes made with marble and everyday Portland cement and confirmed that those homes had been now no longer adversely stricken by inclusion of 15% of marble waste.

2.three.2. Marble slurry as supplementary cementitious cloth in manufacturing of concrete

The following are the research which may be traced, that speak the impact of marble slurry as a supplementary cementitious cloth (SCM) withinside the manufacturing of concrete.

Based at the final results of the traced literature, those may be categorized in categories. First, the research supplied via way of means of Rana et al. (2015a) and Rodrigues, de Brito and Sardinha (2015) display that on utilization of MS in vicinity of cement, the direct outcome is discount in compressive energy, even for the meniscal substitution of five%. Thereby all different related mechanical homes additionally display a bad trend. However, at this substitution, the goal energy in compression become finished via way of means of the concrete mixes in each the research.

Nevertheless, Rana et al. (2015b), have said that, addition of marble slurry results in discount in porosity and therefore stepped forward resistance to chloride and water penetration become mentioned. These parameters have proven development compared to manipulate mixes at a substitution variety of five–10%. Corrosion resistance of the combinationture with five% marble waste become most amongst all of the said mixes.

Contrastingly, Rodrigues, de Brito and Sardinha (2015) confirmed accelerated susceptibility to harm via way of means of carbonation, chloride penetration, water, abrasive put on and drying shrinkage. This distinction in consequences supplied via way of means of the 2 research is probably because of the distinction in floor place of marble slurry used. The pattern utilized by Rana et al. (2015a) had a floor place of 7350 mm2/kg while Rodrigues, de Brito and Sardinha (2015) had used a pattern of floor place 2150 mm2/kg. Hence, in an effort to enhance the great of those mixes with marble slurry, the authors added using distinctive varieties of superplasticizer via way of means of which they might enhance those sturdiness homes via way of means of 9–33%. The most effective disadvantage of those mixes become their accelerated drying shrinkage values which become better via way of means of 20–93�sed at the super-plasticizer used.

Secondly, the research supplied via way of means of Aliabdo, Abd Elmoaty and Auda (2014) and Mashaly et al. (2015) display that, there's discount in porosity, and this benefit has transpired in to higher compressive energy additionally at 20% and 10% substitutions, respectively. Ergün (2011) produced concrete mixes having the excellent resistance to compression at 7.five% substitution of OPC.

Aliabdo, Abd Elmoaty and Auda (2014) have proven mixes with 7.five–10% marble waste have higher metallic concrete bond. On the alternative hand Mashaly et al. (2015) have said mixes with 20% marble waste have better resistance to freeze and thaw, stepped forward bulk density, higher resistance to water penetration and decreased abrasive put on. These homes stepped forward via way of means of 11–26% compared to manipulate mixes.

Singh, Srivastava and Bhunia (2017b) hooked up a correlation among rebound hammer values and compressive energy of mixes made with marble slurry. Ashish et al. (2016) evaluated whether or not marble powder is excellent appropriate for substitute of cement or sand, and said that marble waste is higher acceptable for substitute of sand most effective.

Singh, Srivastava and Bhunia (2019a) investigated and reaffirmed that 10% of everyday Portland cement may be changed via way of means of marble waste and therefore proved that this will bring about discount of CO_2 emissions related via way of means of cement manufacturing. The authors additionally created mathematical fashions which could assist the development enterprise to layout concrete mixes with marble waste to achieve a vital goal energy.

Singh, Srivastava and Bhunia (2019b) evaluated the mechanical and sturdiness homes of concrete mixes made with marble waste via way of means of substitute of cement for a length of 360 days and reassured that a most substitution of 15% does now no longer adversely have an effect on the concrete blend's overall performance.

Seghir et al. (2019) additionally tried to update everyday Portland cement with waste marble dirt to supply air cured mortars. But but, the authors observed growth in porosity at minimum substitution ranges and therefore the compressive energy and obvious density had been said to decline. In a separate have a look at, Seghir et al. (2018) examined the utilisation of waste marble dirt as a substitute of cement via way of means of generating composite binders. Their exams consequences confirmed that water cured pastes with 10% marble waste had no impact at the era of CSH. Seghir et al. (2019) performed restrospective evaluation at the identical the usage of scanning electron microscopy and proved the identical.

2.three.three. Composites of marble slurry and different supplementary cementitious cloth in manufacturing of binders
Understanding the truth that marble slurry can not be substituted in vicinity of traditional cement, researches later grew to become their attention on combining it with different supplementary cementitious substances after which replaces cement. Materials which have been evaluated with this purpose encompass fly ash, slag and silica fume in conjunction with different mineral admixtures like diatomite, pumice, nano-graphite and granite dirt.

Agarwal and Gulati (2006) had been a hit in generating mortars of proportions 1:three and 1:6 via way of means of changing 20% of cement via way of means of identical proportions of dolomite marble waste with fly ash, silica fume or slag. Leaner the combinationture, extra become the benefit of advantage in compressive energy (a minimum increment of 17% and 20% for 1:three and 1:6 blend proportions, respectively), which become negated partly or completely with use of a super-plasticiser. The most increment in compressive energy become observed whilst marble dirt become mixed with silica fume, fly ash and slag had been 170%, 114% and 20%, respectively, for the combinationture share 1:6.

Ergün (2011) used diatomite (a sort of sedimentary rock) to offset the autumn in compressive energy whilst marble waste become utilized in vicinity of OPC. He too ought to lessen cement intake via way of means of 20% on the usage of identical proportions of diatomite and marble waste. Such mixes had equal overall performance in phrases of compressive and flexural energy after 28 days of water curing.

However, Bacarji et al. (2013) consequences had been now no longer an awful lot encouraging after they used a composite waste cloth of granite and marble to update OPC. Their consequences confirmed a most substitution of five% most effective is viable to save you any huge fall in compressive energy. At this substitution degree, modulus of elasticity decreased and water absorption become better than the manage concrete mixes.

Sancak and Özkan (2015) used a aggregate of identical proportions of pumice and fly ash in conjunction with marble, which additionally produced concrete mixes of inferior great. Composite cement pastes made with the above aggregate required extra water to acquire consistency and set faster. When used to put together concrete, they produced mixes whose compressive and flexural strengths had been lesser via way of means of 32–58% and 36–61%, respectively. Their resistance to outside sulphate assault become additionally low.

Nano-graphite become used withinside the visionary studies performed via way of means of Kirgiz (2016) wherein he ought to get better the loss in overall performance of compressive energy via way of means of changing 35% of OPC via way of means of marble waste. More realistically Ashish (2018a) used marble slurry of dolomitic starting place to update each OPC cement and sand. With a marginal fall in workability, via way of means of changing 30% of OPC and sand mixed, the concrete blend had four.65% extra compressive energy. Tensile energy become even better with out a alternate in UPV values.

Taking account of the studies performed via way of means of Agarwal and Gulati (2006), Khodabakhshian et al. (2018) used silica fume to growth the utilisation of marble slurry. Their preliminary have a look at ought to permit them update five% of OPC with marble waste, which may be accelerated to 20% via way of means of changing a further 10% OPC via way of means of silica fume. These mixes had decreased workability however had better stiffness and compressive and tensile strengths via way of means of a completely minimum margin. They barely absorbed extra water however nevertheless had higher electric resistivity which become better via way of means of 2.28 instances than the manage concrete. These mixes additionally completed equal to the traditional mixes whilst subjected to sulphate assault. Significant development towards acid assault become observed wherein the residual compressive energy on the stop of the sixty three days check length become 1.sixty three instances extra than manage blend (Khodabakhshian et al. 2018).

Ma et al. (2019) used nano-silica to offset the decline in fall of compressive energy whilst waste marble is used to update everyday Portland cement for the manufacturing of binders. They encouraged 10% waste marble, three% nano-silica and the ultimate as everyday Portland cement because the highest quality aggregate ratios for high-satisfactory overall performance as a composite binder.

Gap in Literature:

Lot of work has been done and lot of work is to be done infield of [Marble Slurry] utilization.

PRESENT UTILIZATION OF [MARBLE SLURRY]

If [Marble Slurry] production is minimized, even then it is not perfect solution. [59] So it is necessary to find out different methods of utilizing of [Marble Slurry]. But other efforts cannot utilize so much quantity of [Marble Slurry]. So [Marble Slurry] should be utilize in specific civil works whether major or minor.

This is required to find out probabilities of other uses. To achieve a properly required and technically safe and economical technology to consume marble waste / [Marble Slurry] at the same time find out a proper plan for future [Marble Slurry] handling in different Areas Industrial, mining and other.

The area's in which the consumption of marble waste and [Marble Slurry] is done in very few amount and it is required more investigation for replacement of traditional fillings or fillers. Some of utilization given below:

(A) Preparing embankments of road and canal used as a filler material

[Marble Slurry] is marble dust and a filler substance it should be batch up with different type of filler for the construction of embankment filling, bank etc. It will save the fertile and precious soil. Central Institute for Road

Research (CRRI), New Delhi has conducted primary investigation on the consumption of [Marble Slurry] in construction of road Embankment.
From Unconfined Compressive Strength (UCS) test it has been examined that,

- In silt soil, it is 12 percent improvement in Un Confined compressive Strength by 10% mixing of marble dust
- There's a 20% improvement in U C S by 30% mixing of marble dust in sandy soils.
- No increase in U C S in clayey soil

There is 15% improvement in compressive force while fine aggregate is mixed with 35% [Marble Slurry] preparing cement Concrete. It is showing a growth in the mass density of the cement concrete mix over all. Primary experiments reveals it that [Marble Slurry] may be mixed easily in silts and sand Soils and mixture compaction should produce a strong bottom layer over which WBM (water bound macadam) can be laid primary reports are very good and so detailed and higher studies are required to be performing on this aspect needful.

(B) For manufacture of bricks

[Marble Slurry] is geologically dolomite by composition and made of marble fines. Keeping in mind the physical-chemical strengths, [Marble Slurry] can replace partially the sand in molding of mortar blocks by using any Pozzolanic material. Central Institute for Brick Research (CBRI), Roorkee had performed practical research for this topic. The investigation and conclusion are fruitful and the physical strength of the product manufactured by this procedure is much better.

- [Marble Slurry]-concrete blocks was made utilizing [Marble Slurry], fine aggregate and Pozzolanic material in many ratios and molded by vibro-compacting method; curing done by steam at atmospheric pressure. It
achieved a physical strength ranging from 80 to 120 kg / cm^2. Water cured bricks was with a physical strength of 100 kg /cm^2.

The brick manufactured by this process having a perfect shape and size, providing very thin joints facility, hence very high strength of masonry is achieved with very low consumption of cement mortar.

(C) Portland cement Manufacturing

The main ingredient of cement for manufacture of Cement is Lime stone. Clay and other supporting materials are also compulsory in the manufacture of Portland cement The chemical components of marble waste show that it is a perfect material that meets the quality requirements of limestone to a satisfactory extent. Marble waste or a proportioned mix can be utilised as a partial replacement for limestone..

(D) Manufacture of Ceramic Tiles

An opportunity of consuming marble waste as an ingredient for manufacturing of Walls and floors ceramic tiles required a compulsory valuation at industry level. A leader in ceramic industry in India has undertaken charge for research in laboratory and conducting investigations on this matter, results were found highly successful and technique may develop for utilizing.

(E) Thermo set Resin Manufacturing of Composites

They had started training program (short term) for finding out possibilities of making resin composites with [Marble Slurry]/ waste. The primary investigations were exciting showing the techno scientific possibility of this type of an opportunity.
Manufacture of lime

For manufacturing of lime Limestone is the main ingredient out of raw materials required. Limestone may be exchanged by [Marble Slurry].

(G) Production of Activated CaCo3Calcium Carbonate

Combination of limestone with wastage of marble industry i.e. [Marble Slurry] (from marble quarry) may utilize in the manufacturing of un-hydrated or precipitated calcium carbonate.

(H) Wall Tiles and Hollow Blocks

Marble waste [Marble Slurry] and some proportion of clay may be consumed in the production of solid cubes and precast items for buildings while utilized in the proper ratio.

(I) Ground Calcium Carbonate Production

A thorough feasibility analysis and pilot studies are required for the above..

(J) Other Marble Waste Applications

Because of the higher concentration of lime in [Marble Slurry], it can be used as an ingredient for lime in a variety of production and application processes. It may contain many compounds such as dolomite, serpentine, or calcite..

Here is an opportunity of the utilization of marble waste in different manufacturing industries; major component as for placing for lime in activities below:

- In manufacturing of polymer based marble
- For production of glass
- For chemicals manufacturing units
- Lime manufacturing.
- Plastics manufacturing.
- Base of pesticides and as potency reducer and base.
- As a replacement of limestone in different chemistry reactions.

Chemical uses in Industries:

- In metallurgy work of iron or steel used as a replacement for lime (as refining flux in metallurgy)
- In the floating of gold & silver in production of magnesium and magnesia, alumina, nickel, Uranium, tungsten. In non-ferrous metallurgy
- As a filler and neutralizer for paint, rubber, and other materials
- As an aggregate for concrete
- For use as railroad ballast
- Dam spillways, docks, piers, and breakwaters, in the form of irregularly shaped shards ranging in size from 25 to 30 cms.
- As a filler for asphalt
- In rick wool insulation bats and pellets as an insulating material
- An inert filling material for putty and chalking material prepared in turpentine oil or polymer.
- For domestic animals as a mineral feed addition
- In the treatment of waste water
- Stack gases from coal-burning boilers in utility and industrial plants are de-sulfurized.
- To reduce unpleasant odours from sewage sludge treatment
- Filter bed preparation as a fine aggregate screening

What is required here just to find out the systems of utilization of [Marble Slurry] Only construction the slurry marble in bulk amounts. So it is required to make research in direction to consume [Marble Slurry] in construction industry.

Methodology of Study

- **Cost effective materials -** Exploring possibilities of utilization of [Marble Slurry] for cost effectiveness.
- **Reusable and Recycled Materials -** Construction, operation, and maintenance make up the majority of the building phase, whereas disposal, where materials can be recovered or repurposed, is the final stage..
- **Pollution prevention -** Building materials should be made in an environmentally sustainable manner..
    1. Efforts should be made to research and develop technology for manufacturing high-quality, energy-efficient building materials. Consumption of energy is being reduced.

2. Use of natural materials: Embodied energy is the overall energy necessary to make an item. The more a material's embodied energy, the more non-renewable resources it consumes. As a result, it is advantageous to use materials or composite materials made from waste..

Summary

After study of all the research experiments performed on [Marble Slurry] there is possibility of utilization of [Marble Slurry] as a partial substitution of fine aggregate in cement mortar and cement concrete preparation. It thereby saves fine aggregate which is natural resource and at the same time consumes waste [Marble Slurry] which is an environmental Hazard.

As a Curing Aid, [Marble Slurry] can be employed for the Cement plaster and Cement Concrete works by spraying it on the surface. Maximum Curing is achieved with minimum of water which is a Natural resource.

As a finishing material, [Marble Slurry] can be utilised marble paste. Due to its stability and bright white colour maximum solar heat will be reflected away, keeping building cool naturally saving electricity which is National resource.

"In all above operations the hazardous waste [Marble Slurry] may be utilized in construction industry in lot amount protecting Environment, saving Natural Resources and Saving Money".

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