International Journal For Technological Research In Engineering
Volume 5, Issue 9, May-2018 *ISSN (Online): 2347 - 4718*

REVIEW PAPER ON USE OF BARITE POWDER IN CONCRETE

Bhruguli Gandhi
Lecturer, Applied Mechanics Department,
Government Polytechnic, Himatnagar, Gujarat Technological University, Ahmedabad.

Barite is a mineral composed of barium sulfate ($BaSO_4$). It receives its name from the Greek word "barys" which means "heavy". It has a specific gravity of 4.5 which is exceptional for non metallic material. The high specific gravity of barite makes it advantageous for widely use in all kind of industries. Barite also serves as the principal ore of barium. Barite of a size 0 – 100 microns basically is used in concrete. Barite is clean, smooth, unresponsive and inexpensive naturally available mineral. It is non-toxic & also chemically and physically non reactive. Barite has the ability to block gamma-ray emissions & used to make high-density concrete to block x-ray emissions in hospitals, power plants & laboratories.

P.Meenakshi, (2017) in this paper "Partial Replacement of Cement by Barites and Lime Powder in Concrete" author conclude that for M30 grade concrete was used for which the barites and lime powder is replaced and an experimental study was carried out and the effect on compressive strength characteristics (0%, 10%, 20%, 30%) was studied.

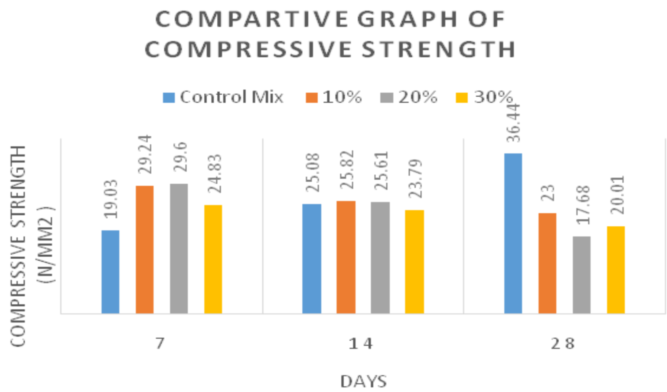

Figure 1. Compressive strength with barite ratio changing

- After 7th day testing, when compared to control mix, the compressive strength obtained for control mix is 19.03 N/mm2, for 5% barites and 5% lime, replacement is 29.24 N/mm2, for 10% barites and 10% lime replacement is 29.6 N/mm2, for 15% barites and 15% lime replacement is 24.83 N/mm2.
- After 14th day testing, When compared to control mix, the compressive strength obtained for control mix is 25.08 N/mm2, for 5% barites and 5% lime replacement is 25.82 N/mm2, for 10% barites and 10% lime replacement is 25.61 N/mm2, for 15% barites and 15% lime replacement is 23.7N/mm2.
- After 28th day testing, When compared to control mix, the compressive strength obtained for control mix is 36.44 N/mm2, for 5% barites and 5% lime replacement is 23 N/mm2, for 10% barites and 10% lime replacement is 17.68 N/mm2, for 15% barites and 15% lime replacement is 20.01N/mm2..
- From the above graphs it is observed that the initial strength of the concrete is gained, but later it decreased than the initial strength, so the replacement of cement by both barite and lime is not successful. Author observed that the only replacement by barite has shown good results,

Harinath Balimidi , Ramesh Sarakadam,(2016) "Compressive strength and anti radiation shielding of concrete by partial replacement of coarse aggregate by barites and cement by silica fume". In this paper author said
In contrast with conventional concrete weighing around 150 pounds per cubic foot, high-density concretes normally weigh from 200 to 250 pounds per cubic foot. Among the natural aggregates most commonly used are barite, magnetite, limonite, and hematite. The density will depend on the type of aggregate used. The high density concrete protects from harmful radiations X-rays, gamma rays, neutrons. Integral part of this project is to replacement of coarse aggregate with barite and natural sand is used as fine aggregate and 4% of silica fume are used by weight of cement. Water-cement ratio is to be kept same as that of normal concrete. The properties of HDC Concrete are low thermal expansion, creep deformation and high modulus of elasticity.
HDC have density is greater than 2600 kg/m3. It is also known as Heavy weight concrete. High density concrete is mainly used where high density is required. It has a better shielding property, so that it can protect harmful radiations like X-rays, gamma rays, and neutrons. High density aggregates are used to achieve heavy weight concrete.

Table:1 Anti Radiation Results

Particulars	Distance	Radiation absorbed	Radiation emitted
3 days : Normal concrete	2000mm	108.0mR	12.0mR
25% BRT	2000	108.5mR	11.5mR
50% BRT	2000mm	110.0mR	10.0mR
7 days : Normal concrete	2000mm	108.0mR	12.0mR
25% BRT	2000mm	109.0mR	11.0mR
50% BRT	2000mm	110.0mR	10.0mR
28 days : Normal concrete	2000mm	108.0mR	12.0mR
25% BRT	2000mm	109.0mR	11.0mR
50% BRT	2000mm	110.0mR	10.0mR

 ISSN (Online): 2347 - 4718

Author said that replacement of 50% barite exhibited better shielding properties than 25% barium. Therefore, according to all the above statements, coarse aggregates and cement substitutes using Barites and silica fume have better shielding properties than ordinary concrete and show the same level of compressive strength as ordinary concrete.

Sanjay Kumar.Rand Suganya Devi.K, (2016) in their paper "Flexural Behavior of Self Curing Concrete Beam Encased with Steel section"
This paper is based on experimental Program. Cement they use OPC 53 grade, as a fine aggregate 4.75mm river sand and as a coarse aggregate author took hard granite stone less than 20mm. Self curing agent they used Poly Ethylene Glycol which is water soluble, nontoxic and odorless. In a beam 4# 20mm diameter main beam and 8mm diameter 200mm C/C stirrups are placed. The hot rolled steel section of ISMB 100 of 1 meter length is also encased in the beam as reinforcement in the centre of the beam.
The mix design is carried out to achieve specified age, workability of fresh concrete and its durability requirements by using IS 10262-2009.

Table :2 Mix prepositions

Water	Cement	Fine aggregates	Coarse aggregates
186 lit/m3	414 kg/ m3	610.30 kg/ m3	1172.32 kg/ m3
0.44	1	2.83	1.47

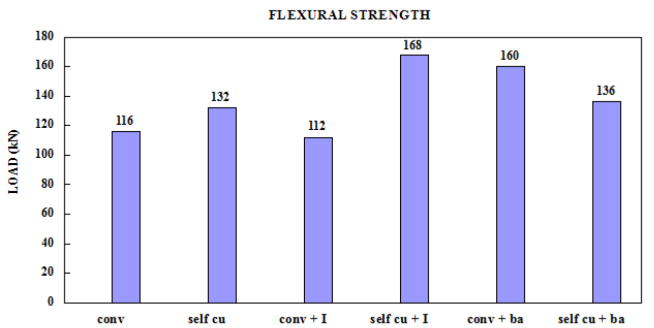

Figure 2 Flexural Strength of different mix

The conventionally cured concrete beam sustained maximum load of 160 kN that is 17% more than self-cured concrete with an ultimate load of 136 kN. The self-cured concrete beam attained lesser strength than conventionally cured concrete because of the high density of barite powder it has ability to absorb water faster hence there is in-sufficient water for self curing of concrete beam. Author conclude that
1) Poly ethylene glycol can be used as self-curing agent because of its good water retention capacity and it also seems to enhance the strength when compared to conventional concrete.
2) Barite powder as replacement for fine aggregate in concrete enhances the strength by 30 % in conventional concrete but where as in self-curing concrete there is only marginal increase in strength.
3) The self-curing concrete beam with encased steel section(I section) withstand more load than all the concrete beam and also increased the strength by 50% when compared to conventional concrete beam.

Anežka Zezulová, Theodor Stanek, Tomáš Opravil,(2016)"The influence of barium sulphate and barium carbonate on the Portland cement",
The authors focus on the formation of Portland clinker and its effect on barium ions. As a source of barium, barium sulphate and barium carbonate have been added to the diet. Clinker and cement with different amounts of barium were prepared, and the effects of barium on clinker and cement properties were studied, respectively. We have studied clinker aspect ratios by Rietveld analysis (using X-ray diffraction) and fine point counting methods. As the amount of barium increased, the Alite:Belite ratio decreased and the amount of free lime increased. Sulphates reduce the rate of deceleration and grow alite crystals to a large extent. At different stages, the presence of barium was observed by EDS and SEM. The largest amount of barium was found in the molybdate and clinker melts. Lumps of barium were formed in the clinker melt. In addition, differences in the formation temperatures of the clinker phases were observed and some basis tests were performed on cement prepared according to European standards.
A small study of clinker with barium content showed the effect of barium ion on clinker composition. When barium ions are part of the raw food, barium is incorporated into the crystal lattice of the alright, bellwether and epileptic stages. Some authors have not found barium in ferrites, only tritium aluminates [1]. Because the crystal lattice of clinker minerals is different, different amounts of barium ions can be substituted for calcium ions or incorporated only in the lattice. Belite lattices can incorporate more external ions than alite lattices. The barium ratio of alite and barium in belite remains the same in barium of different proportion of clinker
The presence of SO3 reduces the viscosity and surface tension of the clinker melt. The athletic ability is good, but the calcium oxide slowly dissolves and moves away. Super-saturation of calcium oxide is essential for the crystallization of alite, but occurs later in the CaO with sufficient concentration. Due to its low viscosity, the alite crystallizes very quickly and reaches large dimensions.
The greatest amount of barium has been found in clinker melts that form agglomerates and are found in cliffs. There are few bariums in alite and free barium in free lime. The big difference in barium content in Alite and Belite is due to the crystal lattice. The barium content of Alite and Baite remains the same as that of BaO in the whole sample. As the amount of BaO increases, the formation temperature on the clinker is decreasing. The curve of TG-DTA shows a big difference for the carbonates that occur because of the different decomposition temperatures. BaCO3 is decomposed before formation on the clinker, and BaO individually affects formation. BaSO4 acts as a whole compound. The greatest amount of barium has been found in clinker melts that form agglomerates and are found in cliffs. There are few bariums

in alite and free barium in free lime. The big difference in barium content in Alite and Belite is due to the crystal lattice. The barium content of Alite and Baite remains the same as that of BaO in the whole sample. As the amount of BaO increases, the formation temperature on the clinker is decreasing. The curve of TG-DTA shows a big difference for the carbonates that occur because of the different decomposition temperatures. BaCO3 is decomposed before formation on the clinker, and BaO individually affects formation. BaSO4 acts as a whole compound.

Hanifi Binici,(2016) “Durability of heavyweight concrete containing barite” Osmaniye's supplemental waste barite deposits in southern Turkey are estimated at about 500 million tons in 2007 records. The purpose of this study is to investigate the durability of waste verite in concrete of coarse river sand (RS), granulated blast furnace sludge (GBFS), granular basalt pumice (GBP) and granular _4 mm granule (B). Good aggregates. The characteristics of the fresh concrete determined included air content, slump, slump loss and curing time. It also includes compressive strength, flexural and ting tensile strength and elastic modulus, repeatability to wear and sulphate resistance of cured concrete.

Heavyweight concrete has been widely used to protect radiation from new clean power plants, medical institutions, and structures that require radioactivity absorption. Compressive strength is not a major factor in the radiation shield thickness and the use of high quality concrete in mixed concrete.

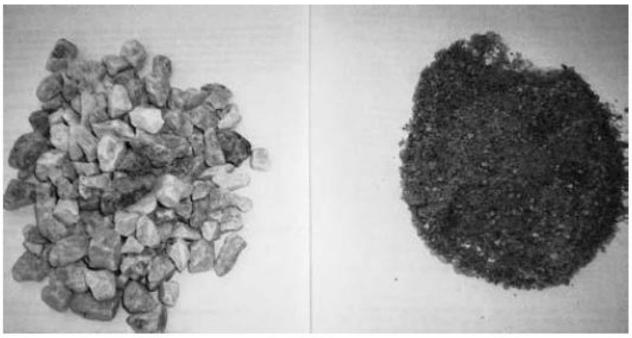

Figure :3 Coarse and Fine Particle of Barite Aggregates Used

The pumice contains an average of 85% volcanic glass, 15% phenocrystic feldspar and a small red-light mineral determined by microscopy, and GBFS samples are obtained from the Iskenderun cement mill. The hardness of barite and basalt pits was 3.5 and 5.2 Mohs, respectively. Coarse aggregates and fine aggregates were separated into fractions of different sizes and reassembled to the specific grades listed in Tables 3 and 4. Waste barite and pulverized limestone coarse bark showed the ratio of 4.20 and 2.65. RS, GBFS, and GBP agglomerates were 2.6, 2.54, and 2.33, respectively. Waste dichromate and crushed limestone coarse aggregate showed 0.01% and 1.5% absorption, respectively. RS, GBFS and GBP were absorbed by 2.6%, 0.65% and 0.78%, respectively.

All concrete mixtures were mixed in a boric acid counter current mixer for 10 minutes. 100 and 200 mm cylinders were used to measure compressive strength on 3, 7, 28, 90 and 180 days. Resistance to chloride penetration of concrete and 100 • 200 mm cylinders were used to eliminate corrosion resistance. The split tensile strength and elastic modulus are terminated. In order to determine the curing time of the concrete, the mortar obtained by sifting the fresh concrete was filled with a 152 × 152 × 152 mm mould. Four 76, 102, and 406 mm prisms were cast to measure the flexural strength of the concrete, and three specimens of 150 x 150 x 50 mm were cast to measure the abrasion resistance of the concrete.

The mass attenuation coefficients were calculated from photon energies of 1 Kev to 100 GeV using a single proportional measurement device (XCOM), and the results obtained were compared to the measurements at 0.66 and 1.25 MeV. Barite concrete results were also compared with other samples. All concrete samples were cast with a cube module (100mm).

The fresh concrete barite produced by using the waste concrete block has higher cohesion and workability than the conventional concrete block. This is because the water absorption is so small that the surface texture of the barite-poured aggregate is softer. Compressive strength varied from 63.4 to 33.2 MPa. As far as strengths are concerned, the basic trend for the behaviour of coarse aggregate concrete in barite waste is not significantly different from that of conventional pulverized lime aggregate concrete.

Resistance to chloride penetration was significantly higher for concrete containing CC, B, RS, GBFS, GBP and B compared to the control concrete. The BC2 specimens, concrete made of barite RS and GBFS showed high stability against chloride penetration after 28 days compared to other concrete. This reiterated that the use of precise GBFS increases the chloride penetration resistance of concretes. In general, barite containing GBFS has a significant impact on chloride penetration depth. The chloride penetration depth test was in good agreement with the additive type.

The BC4 specimen in the BC concrete group has a higher compressive strength than the other specimens. The compressive strength of concrete is closely related to abrasion resistance, moderate strength, GBFS and GBP. The minimum wear rate is obtained from the BC4 specification and the maximum wear rate is obtained from the control sample. BC4 specimens have an average 72% less wear than the control specimens.

Measurement of chloride penetration depth provided more meaningful results to observe the difference between dense and fine aggregates. BC2 test specimens are much more resistant to chloride penetration than other test specimens. The shipped test results indicate that the addition of GBFS and barite to concrete reduces chloride penetration depth by about 60%. This lessens the penetration of chloride ions into the concrete structures pre-sent in the test results.

BC4 (used as agglomerates through waste aggregates and using RS, GBFS and GBP as micro aggregates) showed higher sulphate resistance than other samples. At 365 days, the compressive strength reduction for Sample C in Na2SO4 is significantly higher than for BC group specimens. Because radiation shielding depends on the density of skin colour. As the results show, there is wrinkling as the concrete density increases. The effect of the barite on the linear damping coefficient (l) is evident from the measured results. Therefore, rod-shaped rod concrete can be preferred as building material for radiation.

KhaledSaidani, LasaadAjam, and MongiBen Ouezdou,(2015) "Barite powder as sand substitution in concrete: Effect on some mechanical properties"
Khaled Saidani conducted a study of five concrete sample groups with density (2.31-2.48), corresponding to a percentage of heavy metals ranging from 0% to 25%. The effect of the barite ratio on physical and mechanical properties such as compressive strength, tensile strength, density, shrinkage, expansion and elastic modulus was measured and compared with regular concrete as a control. Tensile strength has been reduced by 50%, but it has proven possible to produce barite-based concrete with a small impact on key mechanical parameters. The compressive strength of 28 days was reduced by only 10% and the modulus of elasticity at 1 year was 20%. This is possible by wrapping the initial limestone skeleton and using barite size (0-100 lm). New design mixes containing powdered barite can be used for structural aggregates.
The medium density reaches a value of 4.48 at 26 LC. This value is close to the value of some iron or lead ore, such as hematite or galenaM100 mixture containing the maximum heavy metal in the studied mixtures, and can be used for radiation shielding while at the same time the role of the structure (minimum compressive strength of 25 MPa and slump value maintenance).

Table:3 Mixtures Composition

Mix	Cement	Sand	Barite	Coarse aggregates	Water
M0	410	644.84	–	1114.78	212
M5	410	663.28	35	1079.4	213
M40	410	445.64	297	1150.18	235
M70	410	231.03	539	1203.27	263
M100	410	–	700	1309.44	286

The limestone skeleton must be preserved to reduce the loss of compressive strength ob-served in previous studies. Sand substitution by barite powder does not adversely affect compressive strength. In the case of total substitution, a small decrease (about 10%) was observed. The reduction is about 50% compared to the reference concrete. This can be explained by the reduction in the cohesion between the concrete components due to the filler of barite affecting transitional areas around limestone aggregates. Therefore, cracks occur under the heat sink.
The main Highlights is 1) The effect of sand substitution by barite powder on concrete has been examined. 2) Limestone skeleton should be conserved to reduce the compressive strength loss. 3) The use of barite induces a reduction of elasticity modulus around 20%. 4) Replacing sand by barite reduces the tensile strength of concrete to half. 5) Barite powder does not affect the concrete swelling but reduces shrinkage. 6) They replace the barite % from 0 to 25%. And concluded that although the tensile strength has been reduced up to 50%, it has been shown that is possible to produce a barite-based concrete with a minor effect on the main mechanical parameters: the compressive strength at 28 days has decreased only by 10% and the elastic modulus at one year of age by 20%. 7) This was possible by conserving the initial limestone skeleton and using barite in size (0–100 µm). The new designed mixture containing barite in powder form can be used for structural concrete.
Hanifi BINICI & Ersin ORTLEK (2015) "ENGINEERING PROPERTIES OF CONCRETE MADE WITH CHOLEMANITE, BARITE, CORN STALK, WHEAT STRAW AND SUNFLOWER STALK ASH" This paper is based on experimental studies.

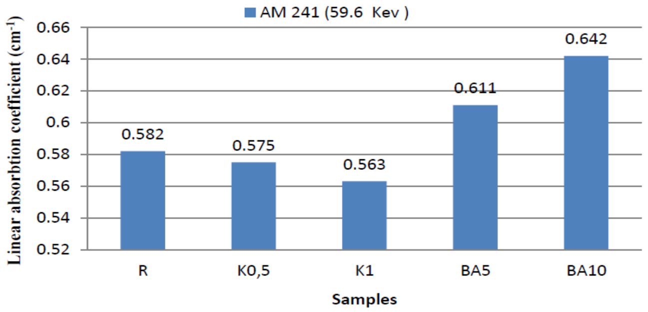

Figure:4 Linear absorption coefficient values of barite and cholemanite doped samples

When the amount of the barite increased the linear absorption coefficient increased in barite doped samples. The high amounts of $BaSO_4$ in chemical structure of barite, heavy aggregate is fading gamma rays.

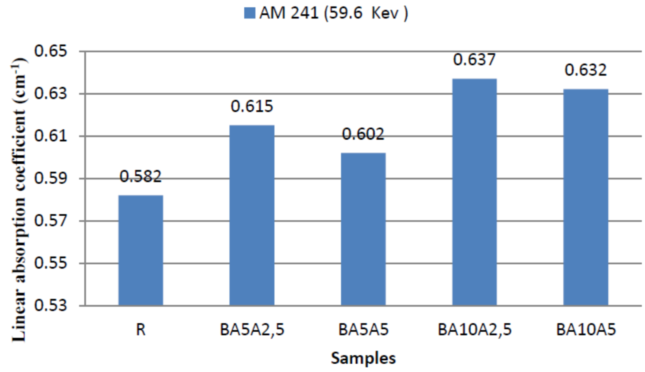

Figure 5. Linear absorption coefficient of barite, cholemanite and sunflower stalk ash doped specimens

The increased rate of the Sunflower stalk ash in the sample decreased the linear absorption coefficient. In cholemanite added samples amount of cholemanite decreased, linear absorption coefficient decreased. Gamma ray was fading depending on the amount of B2O3 in the chemical structure of cholemanite, Whereas linear absorption coefficient of control samples were low. The author conclude Author finally conclude Under the Am-241 gamma rays of mortar specimens for the radiation absorption the highest linear absorption coefficient for corn 10% barite added instead of aggregates and 5% corn blended BA10M5 replaced with cement, for wheat 10% barite addition instead of aggregates and 2,5% wheat blended BA10B2.5 instead of cement, for sunflower 10% barite added instead of aggregates and 2% 5 sunflower doped BA10A2.5 samples instead of cement, and minimum linear absorption coefficient for corn 1% cholemanite added instead of aggregates and 2.5% corn doped K1M2.5 instead of cement, substituting aggregate wheat 1% cholemanite added and 5% wheat tempered K1B5 instead of cement, for sunflower 10% cholemanite added instead of aggregates and 5% sunflower K1A5 samples instead of cement were added. Finally, while barite increases in barite doped samples, the linear absorption coefficient increases. In addition, when cholemanite decreased in cholemanite doped samples, amount of residual linear absorption coefficient decreased.

Saraya, M.E.I. and Bakr, I.M.(2015) "Influence of Nano-Barium Sulphate Agglomera-tion on Microstructure and Properties of the Hardened Cement-Based Materials".

In this paper Nano-Barium sulphate was prepared by pre-capitation method. Eight mixtures of filled cement pastes containing both 0.5% by weight, 1.0% by weight, 1.5% by weight and 2.0% by weight of Nano barium sulphate and micro-limestone were prepared and compared to the base OPC. Hydration characteristics were assessed by measuring the moisture content, bulk density, total porosity and compressive strength of the hydrated samples for up to 90 days. The progress of the hydration reaction was followed by XRD analysis. Morphology and microstructure were studied by SEM. Nano-sized barium sulphate acts as a nucleating agent, improving the hydration of cement paste to a mass content of 2.0%. The microstructure is also significantly improved. Thus, nano-sized barium sulphate can be successfully used in the manufacture of filled cements.

Table: 4 Compositions of the Investigated Mixes, mass %

Mix	OPC	Composition, mass % Nano-barium sulphate	Limestone
NBS1	99.5	0.5	0.0
NBS2	99.0	1.0	0.0
NBS3	98.5	1.5	0.0
NBS4	98.0	2.0	0.0
LS1	99.5	0.0	0.5
LS2	99.0	0.0	1.0
LS3	98.5	0.0	1.5
LS4	98.5	0.0	1.5

The mixed moisture content of the cement filled with Nano barium sulphate gradually in-creased to 2 mass%, but when the limestone filler was added, the combined moisture con-tent decreased to 1 mass% or more. The bulk density, total fluidity and compressive strength of samples filled with Nano barium sulphate were significantly improved compared to OPC and limestone filled samples in all filler contents. The compressive strength values of the cured cements were compatible with the porosity change. Cement filled with Nano barium sulphate is characterized by fine crystals, small and smooth microstructures.

Yüksel Esen* and Berivan Yilmazer,(2010) in this paper "Investigation of some physical and mechanical properties of concrete produced with barite aggregate" author replaced normal crushed stone aggregate with barite aggregate of size 0-16 mm.

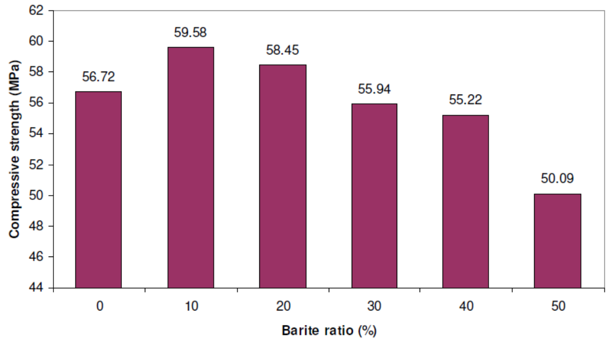

Figure 6. Graph showing change of barite ratio in concrete and compressive strength.

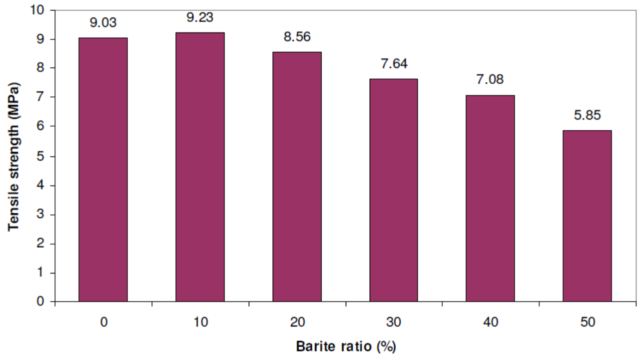

Figure 7. Graph showing change of barite ratio in concrete and tensile strength.

Figure shows compressive strength values of the concrete specimens according to the change of barite ratio. Average compressive strength was calculated as 56.72 MPa in control specimens. In the specimen containing 10% barite aggregate, compressive strength was calculated as 59.58 MPa. As the barite ratio increased, compressive strength tended to decrease. This might be related to the characteristic structure of barite aggregate or to the high w/c ratio. Figure shows tensile strength values depending on the barite ratio. In control specimens, tensile strength was calculated as 9.03 MPa; in the B10 series, tensile strength was measured as 9.23 MPa and in B50 specimens, this value was measured as 50.09 MPa. In the present study, it was found that compressive strength and tensile strength curves were parallel.

Author conclude that The experimental results indicated that the changes in barite aggregate ratio change physical and mechanical properties of the concrete. It was found that unit weight, modulus of elasticity, ultrasound pulse velocity (UV) and thermal conductivity coefficient values of 400 dosage barite aggregated concretes with a w/c ratio of 0.60 increased in parallel to the increase in barite ratio; however Schmidt hardness (SH), water absorption (%), compressive strength and tensile strength values were found to decrease with increasing barite content. Considering that, particularly in Turkey, known reserves of natural heavy aggregate are scarce and that artificial heavy aggregates are costly, the costs should be compared with those of conventional concretes before deciding to use heavyweight concretes produced with these aggregates.

M.A. González-Ortega, S.H.P. Cavalaro, A. Aguado,(2015) "influence of barite aggregate friability on mixing process and mechanical properties of concrete", spain

In this paper author studied three types of aggregates : barite (in two states, dry and wet), limestone and EAF slag.

• Concrete with barite showed greater workability than that of equivalent mixes with limestone aggregate and EAF slag. The main reason for that is the low absorption of barite and its low capacity to absorb water.

• The introduction of barite in the concrete mixes led to a generalized reduction of the mechanical properties. Reductions from 30% to 50% in terms of the compressive strength and the elastic modulus were verified in comparison with equivalent concrete mixes with limestone aggregate and EAF(electric arc furnace) slag. On one hand, this is the result of the barite microstructure, which is composed by adjacent layers that present weak planes and is prone to delamination. And mixing time should be reduced to mitigate negative repercussions

- On the other hand, this is the consequence of the poor performance of the interface transition zone caused by the deposition of a fine dust around the aggregates during the mixing process.
- The observations from the study help to explain this behavior and provide important guidelines for the design, the production and the use of barite as an aggregate for concrete

CONCLUSION

1) Upto 20 % Barite used as aggregates in concrete with cement content 400 kg/m3 to 450 kg/m3 and water/cement ratio of 0.35 to 0.40 improves mechanical properties of concrete like compressive strength, flexural strength, splitting tensile strength, modulus of elasticity.

2) Barite used as fine and coarse aggregates in proportion of 50/50 with cement content 350 kg/m3 and water/cement ratio of 0.45 gives highest compressive strength.

3) 53.8 % Barite as an aggregate with water/cement ratio of 0.5 gives simultaneous protection against neutron and gamma-rays.

4) Upto 2 % Nano Barium sulphate in cement improves hydration and compressive strength of cement paste.

5) 50 % replacement of coarse aggregate with Barites and the cement with Silica fume had given better shielding properties compared to plain concrete and exhibits the same level of compressive strength of normal concrete.

6) Barite loaded concretes can be preferred as materials in building construction against radiation.

7) The concrete with barite as aggregates gives compressive strength at 28 days very close to M60 and exceeds upon continuing for 90 days.

REFRENCES

[1] P.Meenakshi "Partial Replacement of Cement by Barites and Lime Powder in Concrete" International Journal of ChemTech Research, 2017

[2] Harinath Balimidi , Ramesh Sarakadam,(2016) "Compressive strength and antiradia-tion shielding of concrete by partial replacement of coarse aggregate by barites and cement by silica fume", International Journal of Research in Engineering and Technology,(2016).

[3] Sanjay Kumar.R, Suganya Devi.K, " lexural Behavior of Self Curing Concrete Beam Encased with Steel Section", International Journal for Scientific Research & Development| Vol. 4, Issue 02, 2016

[4] Hanifi BINICI & Ersin ORTLEK (2015) "ENGINEERING PROPERTIES OF CONCRETE MADE WITH CHOLEMANITE, BARITE, CORN STALK, WHEAT STRAW AND SUNFLOWER STALK ASH", European Journal of Engineering and Technology, Vol. 3 No. 4, 2015 ISSN 2056-5860

[5] Yüksel Esen* and Berivan Yilmazer, " Investigation of some physical and mechanical properties of concrete produced with barite aggregate" Scientific Research and Essays Vol. 5(24), pp. 3826-3833, 18 December, 2010.

[6] KhaledSaidani, LasaadAjam, and MongiBen Ouezdou, "Barite powder as sand substitution in concrete: Effect on some mechanical properties", Science direct, Construction and building material , Volume 95, 1 October 2015, Pages 287-295.

[7] M.A. González-Ortega, S.H.P. Cavalaro, A. Aguado, "influence of barite aggregate friability on mixing process and mechanical properties of concrete", spain

[8] IS 456-2000, Plain and Reinforced Concrete-Code for practice

[9] IS 10262-2009, Concrete mix proportioning-Guidelines

[10] Khaled saidani, lasaad ajam, mongi ben ouezdou "Barite powder as sand substitution in concrete: Effect on some mechanical properties" Construction and Building Materials 2015. Vol. 95

[11] I. Akkurt, R. Altindag, C. Basyigit, S. Kilincarslan "The effect of barite rate on the physical and mechanical properties of concretes under F–T cycle" Materials and Design 2008. Vol. 29

[12] Kılıncarslan, Ş. 2004. Barit Agregalı Ağır Betonların Radyasyon Zırhlamasındaki Ozellikleri ve Optimal Karısımlarının Arastırılması. S.D.U. Fen Bilimleri Enstitusu, Doktora Tezi, Isparta. 106 s(In Turkish). .

[13] [10] Akkurt, I., Altındag, R., Basyigit, C., Kılıncarslan, S. The effect of barite rate on the physical and mechanical properties of concretes under f-t cycle, Mater. & Des. 29(2008) 1793.

[14] Khaled Saidani, Lasaad Ajam, Mongi Ben Ouezdou ," Barite powder as sand substitution in concrete Effect on some mechanical properties",Construction and building materials,95,287-295,(2015).

[15] Saraya, M.E.I. and Bakr, I.M. "Influence of Nano-Barium Sulphate Agglomera-tion on Microstructure and Properties of the Hardened Cement-Based Materi-als", Journal of Materials Science and

Chemical Engineering,3, 72-81,(2015).

[16] Anežka Zezulová, Theodor Stanek, Tomáš Opravil ,“The influence of barium sulphate and barium carbonate on the Portland cement”, International Confer-ence on Ecology and new Building materials and products, ICEBMP,(2016).

