CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

This chapter presents the literature reviewed on the effect of using crushed rock material, quarry dust in place of sand in the preparation of concrete. Some of the experimental investigations on the strength and durability behaviour of concrete on the use of quarry dust in the place of natural sand are listed here.

In addition to crushed rock material, the fly ash may be used as an alternative material for fine aggregate sand. To increase the workability and strength of concrete super plasticizer may be used. These criteria viewed from different literature are listed in this chapter.

2.2 LITERATURE REVIEWED

Hudson (1997) has conducted experiments to study the performance of concrete by adding manufacturing sand instead of sand. He prepared trial mixes by using 3 to 20 percentage partial replacement of sand by manufactured sand of minus 75 micron or dust. The w/c ratio was fixed as 0.7. From the experimental results it was found that there was remarkable increase in compressive strength in the concrete manufactured with 20 percentage replacement of sand with manufactured sand. This was due to the inclusion of high percentage of minus 75 micron dust in a suitably graded form with a good particle shape that allows aggregate packing and results in a
denser concrete. The concrete has lesser permeability and so more durable. This was due to the increased efficiency in void filling particle force to close capillaries, thereby stopping the passage of liquids decreasing permeability and durability preventing chemical or liquid ingress into the concrete. He concluded that the concrete may be used with 20% replacement of sand by manufactured sand and it was more durable and less permeable.

Patagundi and Patil (2002) have conducted experiments to investigate the properties of concrete when cement was partially replaced by fly ash and natural sand by crusher stone powder simultaneously. The compressive strength and flexural strength were studied. The behaviour of concrete when subjected to heat cycles was also studied. The replacement of sand was from 0- 40% at increments of 10%. Using OPC the design mix 1: 1.2 : 2.4 was prepared with water cement ratio 0.30. To facilitate the flow of concrete a super plasticizer was used. In temperature resistance test, the concrete cube specimen were subjected to heat cycles say 8 hours of heating at 60°C followed by 16 hours of cooling at 25°C. Two heat cycles say 15 day cycle and 30 day cycle were adopted. From test results it was observed that 28 day compressive strength was maximum at 30% sand replacement and this was due to the fact that crusher powder fills up the maximum voids to get dense concrete and fly ash liberates strength during later periods. Similarly flexural strength was also maximum at 30% replacement itself. Due to heat cycle there will be some loss in compressive strength as well as flexural strength. The maximum resistance to heat was developed at 30% sand replacement. From the above test results it was concluded that quarry dust and fly ash may be used as replacement materials in concrete.

Mithanthaya and Jeyaprakash Narayan (2002) have conducted experiments to find the suitability of quarry dust as fine aggregate for plastering and pavement design. Test was conducted for the mix proportion of
cement and quarry dust in 1:3, 1:4, 1:5, 1:6 and 1:7. Tests were conducted and the values obtained were compared with control mortar containing cement and sand. From test results it was observed that voids present in the quarry dust mortar was lesser as compared to that of sand, hence high compressive strength. No cracks were found after 28 days of curing. Cement quarry dust mortar 1:4 mix was used to plaster inside the water tank and found that it was free from leakage. Based on the test results it was concluded that quarry dust can be utilized for plastering instead of sand and with proper investigation it may be utilized in the preparation of concrete also.

Selvakoodalingam and Palanikumar (2002) have analysed through experimental study the use of quarry dust as fine aggregate in cement concrete. M15 mix was considered with three proportions say 100% sand, 50% sand and 100% quarry dust. Workability and compressive strength tests were conducted. From the test results it was observed that the 28 day compressive strength was maximum at 50% sand replacement. Compared with sand, quarry dust was more workable. It was concluded that quarry dust can be utilized as replacement material in place of sand with higher strength at 50% replacement.

Naidu et al (2003) have conducted experiments to investigate the influence of partial replacement of sand with quarry dust in the compressive strength and pull out force concrete. Four types of concrete using OPC were prepared using M20 mix with 20% sand replacement in w/c ratios 0.4 and 0.45. The specimens were cast and tested at the age of 7, 14, 28 and 56 days. From the test results it was observed that for all the ages at this replacement the compressive strength was lower than normal concrete. It is concluded that the inclusion of quarry dust in to concrete resulted in a reduction in compressive strength and this may be compensated by adding admixture. Reduction in compressive strength might be caused by the particle shape of
quarry dust which was flaky and angular. Aggregates which were flaky tends to be oriented in one plane with water and air voids forming underneath and thereby result in a reduction in compressive strength. Insufficient cement paste to coat all the coarse and fine aggregate particles in quarry dust due to its higher content might have contributed to the reduction in compressive strength.

Sahu et al (2003) have investigated the suitability of using crushed stone dust waste as fine aggregate for concrete. Two design mixes were chosen for natural sand to achieve M20 and M30 grades concrete using OPC with percentage of replacement 0, 20 and 40. The equivalent mixes replaced natural sand by stone dust partially and fully. A superplasticiser was added with dosages 0.5, 1, 2 and 3 percent by weight of cement. Tests were conducted on workability, compressive strength, modulus of rupture and split tensile strength. From the test results he observed that the addition of stone dust decreases workability, the workability can be increased by adding superplasticiser and there will be a significant increase in compressive strength, tensile strength and modulus of rupture. He concluded that 40% sand replaced by stone dust in concrete reduce the cost and save a large quantity of natural sand and so, stone dust can be used effectively to replace natural sand in concrete.

Chandrasekhara Reddy (2003) has conducted experiments to study the performance of concrete using stone dust as a replacement to sand. Sand was replaced by quarry dust from 0 to 100% at increment of 25%. Compressive strength and tensile strength tests were conducted using 43 grade OPC in M20 concrete. Compressive strength was computed at the age of 7 days, 28 days and 60 days. From the test results he observed that all the mixes except 50% replacement achieved the target strength. The stone dust decreases workability of concrete due to the larger portions of fine particles.
At 75% of sand replacement, the percentage of increase in compressive and tensile strength were 40 and 28 compared with reference mix respectively. The unit weight increases with increase in percentage of replacement of sand. He concluded that sand can be replaced by stone dust available locally without affecting strength of concrete.

Vasumathi (2003) has experimentally investigated the properties of concrete when cement is replaced by fly ash and sand by quarry dust separately and simultaneously. Tests were conducted on workability at fresh state and compressive strength at hardened state at the age of 7, 14 and 28 days. The sand was replaced from 0 to 25% at increment of 5%. From the test results it was observed that workability was decreased due to addition of quarry dust. Better result on 28 days compressive strength was obtained on replacement of fly ash, quarry dust, fly ash and quarry dust at 5%, 15% and 10% respectively. It was concluded that replacement of cement with fly ash and sand with quarry dust resulted economical construction and also a solution for reducing the environmental pollution.

Ilangovan and Nagamani (2004) have conducted tests on cubes to study the strength of concrete made of crushed rock material and the results were compared with the natural sand concrete. Compressive strength was determined at 7 days and 28 days using M20 and M30 grade concrete with and without using quarry dust. From the test results it was found that the compressive strength concrete made of crushed rock material is nearly 13% more than the conventional concrete.

Binu Sukumar et al (2005) have investigated about the mix optimization method to develop a suitable mix proportion for self compacting concrete (SCC) with different percentage of replacement of river sand by crusher dust. They studied about the compressive strength, split tensile strength and flexural strength of OPC used concrete. They reported from their
results that higher percentage replacement of crusher dust reduces the flow characteristics of SCC and hardened properties of SCC with crusher dust replacement were improved. Replacement beyond 20% greatly reduces the workability which needs addition of a super plasticizer. Mix using only stone crusher dust as fine aggregate developed higher strength than control concrete. This was due to better bonding characteristics of crusher dust compared to the rounded particles of river sand. It was concluded that use of crusher dust in place of sand may be possible to get better strength.

Raman et al (2005) have reported in their experimental study about the investigation of some properties of quarry dust and discuss the suitability of those properties to enable its usage as a replacement material for sand in concrete. Sand was replaced by quarry dust in 0%, 20% and 40% where the cement was replaced by silica fume and fly ash. Super plasticizer was used to get desired workability. In addition to physical properties the compressive strength of concrete at the age of 28 days was determined. From the test results it was observed that partial replacement of sand with quarry dust resulted in a reduced compressive strength compared with control concrete. This was compensated by the inclusion of mineral admixtures. It was concluded that quarry dust can be utilized as a partial replacement material to sand.

Prachoom Khamput (2006) has conducted experiments to study the compressive strength of concrete using quarry dust as fine aggregate instead of sand. The mix used was 1: 2: 4 (by weight) with water-cement ratio 0.45. In addition to normal concrete( 0% quarry dust ) 70%, 90% and 100% sand replaced concrete was prepared , specimen were cast to conduct compressive strength test at an age of 7, 14, 21 and 28 days with and without admixture. From the test results it was observed that maximum compressive strength of concrete was obtained at 70% sand replacement both at 7 and 28
days. Concrete with admixture was more workable than concrete without admixture. However, the compressive strength of concrete with admixture was higher than without admixture concrete in every mix ratio of quarry dust and sand. He concluded that quarry dust could be used to replace sand in general concrete structures.

Safiuddin et al (2007) have conducted experiments on fresh and hardened concrete with quarry waste as fine aggregate except control concrete. Four different types of concrete were prepared using water binder ratio 0.4. The percentage of replacement of quarry waste was 20 with pit sand. Cube specimens were prepared to find compressive strength at an age of 28 and 56 days. From test results, it was observed that quarry waste fine aggregate decreased the compressive strength of concrete due to deficient grading and excessive flakiness. Quarry waste fine aggregate decreases concrete’s resistance to water penetration. Due to addition of quarry dust, the slump value increases due to deviation in graduation of quarry waste fine aggregate. They concluded that quarry waste fine aggregate can be utilized in concrete mixture as a good substitute for natural sand.

Raman et al (2007) have conducted experiments for the non-destructive properties such as dynamic modulus of elasticity, ultra sonic pulse velocity and initial surface absorption for both control specimens and quarry dust concrete specimens. The slump, slump flow, V-funnel flow, air content and compressive strength of concrete were also determined. They prepared specimens by using 20% partial replacement of sand with quarry waste and 10% of cement was partially replaced by fly ash and silica fume. They reported by their test results that the quarry waste did not affect the flow ability of the concrete. Quarry waste caused slight reduction in compressive strength due to excessive flakiness, greater weakness to crushing and lack in gradation. Quarry waste resulted in higher initial surface absorption mostly
due to increased porosity in cover concrete. It was concluded that quarry waste did not affect the physical properties of concrete.

Chaturanga Lakshmi Kapugamage et al (2008) have reported about the use of fly ash and quarry dust as partially replacement materials for cement and sand in concrete. Sand was replaced by quarry dust from 0 to 45% at increment of 15%. Cement was replaced by fly ash at 0%, 15% and 30%. Using M30 mix with OPC the strength was determined at the age of 3, 7 and 28 days. From the test results it was observed that the use of 15% fly ash leads to a reduction in early strength of concrete. This effect was eliminated by addition of 30% quarry dust. Using of quarry dust leads to the reduction in the workability of concrete. Therefore, the concurrent use of crushed rock material and fly ash in concrete will lead to the benefits.

Ilangovan et al (2008) have conducted tests to study the feasibility of the usage of quarry rock dust as hundred percent substitute for natural sand in concrete. Mix design has developed for M20, M30 and M40 grades for both conventional concrete and quarry dust concrete. Tests were conducted on cubes and beams to study the strength and durability of concrete made of quarry rock dust and the results were compared with natural sand concrete. From the test results they reported that permeability of quarry rock dust concrete was less compared to controlled concrete. The quarry dust concrete have comparatively 10-15% more strength than the ordinary concrete. Quarry dust concrete has better durability, little drying shrinkage value and higher water absorption. They concluded that the replacement of natural sand with quark rock dust as full replacement in concrete is possible.

Chitlange et al (2008) have reported about the feasibility of the usage of artificial sand obtained by crushing basalt over natural sand considering technical, environmental and commercial factors. For the purpose of experimentation concrete mixes using OPC were designed as M20, M30
and M40 grades by 100% replacement of natural sand to artificial sand with water cement ratio 0.5. Compressive and flexural tests were conducted to study the strength of concrete at 7 and 28 days using artificial sand and the results were compared with that of natural sand concrete. From the test results it was observed that the 28 day compressive strength was 5.08%, 4.56% and 3.78% higher than conventional concrete for M20, M30 and M40 grade respectively. The percentage of increase in flexural strength of concrete was 6.52, 7.52 and 8.13 for M20, M30 and M40 grades respectively. Admixture was added to keep constant w/c ratio 0.5. Due to sharp edges of artificial sand particles it provides better bond with cement than the rounded particles of natural sand resulting high strength. They concluded that the concrete prepared by using artificial sand have more strength compared to ordinary concrete.

Shahul Hameed et al (2009) have conducted experiments to study the feasibility of the usage of quarry rock dust and marble sludge powder as hundred percent substitutes for natural sand in concrete. Two M20 mixes were prepared using 43 grade OPC, one with purely river sand and another with quarry dust and marble sludge powder combination. Tests were conducted on compressive strength, tensile strength, water absorption, permeability and resistance to sulphate attack. From the test results it was observed that the water absorption was slightly more. The compressive strength was 14% more for quarry dust and marble sludge powder combination. It has high workability, less permeability compared with control concrete. It exhibit excellent performance due to efficient micro filling ability and pozzolana activity. It was concluded that quarry dust and marble sludge powder combination as fine aggregate in concrete was recommended.

Manasseh Joel (2010) have studied the suitability of using the crushed granite fine(CGF) to replace river sand in concrete. Slump,
compressive and indirect tensile strength tests were performed on fresh and hardened concrete using M35 grade mix with replacement of sand from 0 to 100% at increments of 10%. The cubes were tested at the age of 7, 14 and 28 days whereas cylinder specimens tested at 28 days. From the test results it was observed that w/c ratio and slump value increased with the replacement of sand with crushed granite fine. Maximum compressive and tensile strength was obtained at 20% sand replacement. Based on economic analysis and results of tests, he recommended that river sand replaced with 20% CGF can be used in the production of concrete for use in the rigid pavement.

Venu Malagavelli and Rao (2010) have studied about the characteristics of M30 concrete with partial replacement of cement with Ground granulated blast furnace slag (GGBS) and sand with the ROBO sand (crusher dust). 43 grade OPC was used to prepare concrete mix. Sand was replaced by crusher dust from 0-30% at increment of 5% and cement by GGBS 40-60%. The cubes and cylinders were cast and tested for both compressive and tensile strength. Admixture also added to enhance the required workability. The w/c ratio was fixed as 0.42. From the test results it was found that if sand only replaced by crusher dust then maximum compressive and tensile strength was obtained at 30% replacement. For GGBS in place of cement and crusher dust for sand used simultaneously then maximum strength was obtained at 50% and 25% materials respectively. It was concluded that GGBS and ROBO sand can be utilized as partial replacement materials.

Anupama et al (2010) have conducted experiments on the use of metakaolin in cement mortar as a partial replacement for cement with quarry dust as fine aggregate. 43 grade OPC was used to prepare cement mortar 1:3 mix. They cast specimens using metakaolin as partial replacement of cement by 5 to 15% and quarry dust as fine aggregate. The specimens were tested at
the age of 3, 7, 28, 56 and 90 days. From the test results it was observed that the compressive strength was decreased with increase in metakaolin content for a given water binder ratio. The drop in compressive strength was disappeared in mixes made of higher water binder ratio. Mix with 15% metakaolin was superior in all water/binder ratios investigated.

Mahendra et al (2010) have conducted experiments on steel fibre reinforced concrete with natural sand as fine aggregate (SFRNSC) and also the artificial sand the quarry dust as fine aggregate (SFRASC). Three grades M20, M30 and M40 were prepared with steel fibres. The specimens were cast and tested for compressive strength, split tensile strength and flexural strength. From the test results it was observed that SFRASC has more strength than SFRNSC. The percentage of increase in strength was less for higher grades of concrete. The increase in strength was due to sharp edges of the particles in artificial sand provides better bond with cement than the rounded particles of natural sand resulting in higher strength. It was concluded that the full replacement of natural sand by artificial sand considering technical, environmental and commercial factors.

Radhikesh Nanda et al (2010) have conducted experiments on cement concrete paving block replacing sand by stone crusher dust as fine aggregate. Paving block of size 0.25x0.20x0.05 m was cast with mix M20 by weight with water cement ratio 0.6. Compressive, flexural and split tensile tests were conducted by replacing sand by crusher dust from 0-100% at increments of 25%. From the test results it was observed that the compressive strength was decreased if the addition of crusher dust increases. Similarly flexural and tensile strength also decreases due to increase in crusher dust percentage. Slump value decreases if the crusher dust percentage increases. It was concluded that crusher dust may be used instead of sand up to 50% in the place where sand availability was less and crusher dust is in plenty.
Rajendra Prasad et al (2011) have conducted experimental works to study the effect of crushed rock powder (CRP) as fine aggregate and partial replacement of cement with admixtures subjected to different curing methods. Sand was replaced by CRP in 0%, 10%, 20%, 40%, 60%, 80% and 100% and cement replaced by 10% Rice husk ash (RHA). 53 grade OPC was used to prepare M30 concrete with water cement ratio 0.45. From the test results it was observed that 10% RHA with 20% quarry dust replacement combination gave better compressive strength. Other than 20% replacement obtained lesser compressive strength compared with control concrete. This was due to the voids present in the concrete mixes with higher amount of CRP. It was concluded that quarry dust can be utilized in concrete replacing sand.

Mohanraj et al (2011) have reported about the use of fly ash, granite and quarry dust based concrete, material and the mixture proportions, the manufacturing process, and the influence of various parameters on the properties of fresh and hardened concrete with plain concrete and partial replacement of fine aggregate by fly ash and quarry dust and coarse aggregate by granite and C & D debris concrete. The column specimens were tested under axial compression to investigate the effects of waste materials. They utilized the waste materials by effectively recycling and filling in steel tubular circular columns with recycled aggregate concrete instead of conventional concrete. They developed an empirical equation for calculating the design load carrying capacity of the composite column using the experimental results. The test results were compared with the international codes and new theoretical models were suggested for the design. In this paper, experimental and analytical investigations were carried out to study the strength and behaviour of CFST columns over the entire range of loading. The ultimate loads and behaviour of CFST were compared with those of the hollow steel tube columns. From these elaborative experimental and analytical investigations that were done, it is concluded that out of all the waste
materials used, the contribution of C & D debris and quarry dust are significant. The remaining materials that include fly-ash and granite are reasonably contributed in the performance enhancement under axial loading conditions. Finally, it is concluded that materials recovered from various waste stream are suitable to be used as secondary aggregates in concrete.

Ramaraju et al (2011) have conducted experiments on self compacting concrete with partial replacement of quarry dust in place of sand and fly ash in place of cement. 53 grade OPC was used to prepare M30 mix. Sand was replaced by quarry dust from 0-100% at increments of 25%. Cement was replaced by fly ash by 0%, 15%, 25%, 30% and 35%. From the test results it was found that maximum compressive strength was obtained at 100% sand replacement without cement replacement. If fly ash used in place of cement then maximum compressive strength was obtained at 30% replacement. It was concluded that quarry dust can be a very good replacement for river sand fully.

Nagabhushana and Sharada bai (2011) have conducted experiments on concrete using crushed rock powder as a partial replacement material for natural sand. The percentage of replacement was 20, 30 and 40. Three grades of concrete of M20, M30 and M40 were taken for study using 53 grade OPC. Tests were conducted on compressive, flexural and split tensile strength at the age of 7 and 28 days. The w/c ratio was fixed as 0.5, 0.39 and 0.31 for M20, M30 and M40 mixes respectively. For M40 mix in addition to the water quantity as per w/c ratio a super plasticizer was added to keep slump of 70mm. From the test results it was observed that the compressive, flexural and split tensile strength was increased and maximum at 40% sand replacement. The percentage of increase will be inversely proportional to the mix ratio. It was concluded that the compressive, flexural
and split tensile strength of concrete were not affected with the replacement of sand by crushed rock powder as fine aggregate up to 40%.

Shaikh and Daimi (2011) have conducted experiments to study the strength and durability performance of concrete made with natural sand and artificial sand with dust. The durability properties were investigated through microstructure related properties of concrete such as permeability, water absorption, chloride diffusion and chemical attack. 43 grade OPC was used to prepare concrete mix. The cubes were cast and tested at the age of 28, 90 and 180 days. From the test results it was found that the mix with artificial sand with dust as fine aggregate gives higher strength than mix with natural sand. This was due to sharp edges of particles in artificial sand provides better bond with cement than the rounded particles of natural sand. The weight loss of artificial sand was same as natural sand. Low water absorption, moderate chloride permeability was the properties of both the artificial sand and natural sand used concrete. It was concluded that the full replacement of natural sand by artificial sand with dust considering the technical, environmental and commercial factor.

Raman et al (2011) have conducted experimental work to evaluate the suitability of quarry dust as a partial substitute for sand in high-strength concrete (HSC) containing rice husk ash (RHA). Two grades of HSC mixes, to achieve 60 MPa and 70 MPa at 28 days, were designed with and without the incorporation of RHA. Quarry dust was then used in the mixes containing RHA as a partial substitute for sand, in quantities ranging from 10% to 40%. The slump of the fresh concrete and the compressive strength development were monitored up to 28 days. Based on the results obtained, they reported that the inclusion of quarry dust as a partial replacement material for sand resulted in a decrease in workability and compressive strength. Mix containing 20% quarry dust and 10% RHA results optimum compressive
strength. It was concluded that negative impacts in workability of fresh concrete due to addition of quarry dust can be compensated by use of super plasticizer. The findings of the research assert that quarry dust can be used as a viable replacement material to sand to produce high strength RHA concrete.

Devi and Kannan (2011) have conducted experiments to investigate the use of crushed rock material as fine aggregate in concrete. Corrosion of steel reinforcement is one of the main durability problems which the reinforced concrete structures face worldwide. They studied the strength and corrosion resisting properties of concrete containing crushed rock material as fine aggregate along with an organic inhibitor. The inhibitor used was Triethanolamine at 1%, 2%, 3%, and 4% by weight of cement. Strength tests, water absorption test and the durability tests were conducted and the results were compared with the natural sand concrete. The resistance to corrosion is evaluated based on the performance of the concrete for the penetration of chloride ions by means of impressed current method. From the results obtained it was found that replacement of sand by crushed rock material increases the strength of the concrete, with addition of inhibitor. It offers very good resistance against chemical attack and increases corrosion resistance in addition to the overall properties of concrete. It was concluded that 100% sand replacement with 2% Triethanolamine can be effectively used in reinforced concrete structures for delaying corrosion and to increase other strength and durability characteristics.

Sivakumar et al (2011) have studied the hardened and durable properties of concrete using quarry dust. Three mixes were used with water cement ratio 0.32 and fine to coarse aggregate ratio was 0.6, 0.7 and 0.8. The performance of concrete with quarry dust compared with concrete with sand only. A naphthalene based superplasticizer was used with dosage not exceeding 1% by weight of cement. Workability, compressive and tensile
Tests were conducted using three different binders. From the test results it was observed that for constant w/c ratio the workability decreases if fine to coarse ratio increases. This was compensated by addition of superplasticizer. The compressive strength at 28 days decreased if fine to coarse ratio increases. Maximum compressive and tensile strength were obtained for fine to coarse ratio 0.6. From the above test results it was concluded that quarry dust may be used as an effective replacement material for natural river sand.

Abdullah Demir (2011) has prepared concrete specimens by CT (crushed tiles) replacing 16–31.5 mm coarse aggregate at the ratios of 0%, 10%, 25%, 50%, 75% and 100%. Concrete specimens are exposed to 20, 150, 300, 400, 600, 900 and 1200° C high temperatures corresponding TS EN 1363-1 after an initial 28 day curing period. After heating, the specimens were slowly air-cooled to the room temperature and then Ed and fc of concretes were determined. Experimental results are also predicted by constructing models in ANN and FL methods. In the models, the training and testing results have shown that ANN and FL methods have strong potential for predicting the fc and Ed of crushed tile concretes exposed to elevated temperatures.

Djaknoun et al (2012) have conducted experiments to evaluate the performance of mortar mixed with silica fume (SF) when exposed to high temperatures. A three-point bending test apparatus was developed to test concrete-like materials at high temperatures. Notched specimens were first heated at a rate of 3.3°C/min to various target temperatures from room temperature to 900°C and then maintained under constant temperature during 2 hours. They were then subjected to a three-point bending test while the temperature was held constant. The maximum peak load occurred at 300°C and decreased sharply at higher temperatures. The experimental results demonstrated a noticeable influence of the temperature on the fracture
resistance of the high-performance mortar. The toughness parameters, such as intensity factor or fracture energy, evolved nonlinearly with the target temperature, and reached their maximum value at 300 °C; at higher temperature, their values decreased considerably.

Alaa et al (2012) have conducted experiments to study of the possibility of using quartz powder (QP) as mineral admixture substituting Portland cement (PC) to resist elevated temperature and thermal shock. They prepared concrete by using 0, 5, 10, 15 and 20 % QP by weight replacing PC. The various hardened pastes were exposed to elevated temperatures of 200, 400, 600, 800 and 1000° C for 2 hours. The residual strengths of these specimens were determined after gradually cooling and compared with their original before exposing to elevated temperature. Further, water quench test was applied to determine the thermal shock resistance of various hardened cement pastes. The results are discussed using material characterization experiments namely, X-ray diffraction (XRD) analysis, derivative thermo gravimetric (DTG) analysis and scanning electron microscopy (SEM). The experimental results show that the QP enhances both elevated temperature and thermal shock resistance of the cement pastes. They concluded that the loss in structure quality of concrete due to a rise of temperature is influenced by its degradation through change induced in basic processes of cement hydration and hardening of the binding system in the cement paste of concrete.

Arundeb Gupta (2012) has conducted experiments to study the mechanical as well as micro structural properties of recycled aggregate concrete (RAC) exposed to elevated temperature. Fly ash (as replacement of cement) was added while making concrete. Recycled aggregates are mixed with natural aggregates also to prepare concrete. Cubes and cylinder test specimens were prepared and cured under water for 28 days. Test specimens
were exposed to different levels of temperature (200°C, 400°C, 600°C, 800°C, 1000°C) for a period of 6 hours in the furnace. The reduction in compressive strength observed were in the ranges from 21% to as high as 61% when exposed to elevated temperature. Modulus of elasticity reduces appreciably also with the increase of exposure temperature. MIP (Mercury intrusion porosimetry) test was conducted to estimate the percentage of voids and also to appreciate the change of micro voids due to change of exposure temperature. Microscopic study was made to note the change of surface texture. They developed empirical formulae involving major parameters such as fly ash content, exposure temperature etc. to predict modulus of elasticity of recycled aggregate concrete. He concluded that maximum compressive strength at lower temperature was due to stronger interfacial bonding between matrix and aggregates. Strength loss at elevated temperature due to the texture of the sample becomes coarse and several micro cracks appeared, which gradually worsen the strength character of the sample. Due to pore volume increases after heating leads to higher strain in concrete results lower compressive strength.

Neelam et al (2012) have studied the properties of self-compacting concrete (SCC) such as compressive strength, splitting tensile strength, rapid chloride permeability, porosity and mass loss when exposed to elevated temperatures. They prepared mixes with three percentages of class F fly ash ranging from 30% to 50% and for comparison one controlled mixture without fly ash was also produced. The variables included were the temperature effects (20°C, 100°C, 200°C, and 300°C) using ordinary Portland cement. From their test results they reported that there was little improvement in compressive strength within temperature range of 200–300°C as compared to 20–200°C but there is little reduction in splitting tensile strength ranging from 20 to 300°C and with the increase in percentage of fly ash.
Sensil Yazıcı (2012) has studied the effect of elevated temperature on the compressive strength of mortars containing fly ash, silica fume and pumice. Thirteen mortar mixtures were produced by replacing 0%, 5%, 10%, 15% and 20% of cement with a fly ash, silica fume and pumice. Totally, 3900 cube (50 x 50 x 50 mm) mortar specimens were prepared from these mortar mixtures and cured at 7, 28 and 90 days. After standard curing period, specimens were dried in a room temperature for 7 days and then exposed to temperature of 20, 150, 300, 450, 600 and 750°C for 1 hour in ceramic furnace. Afterwards, the compressive strengths of the specimens were determined. It was concluded that, compressive strengths of mortars containing pozzolana were less affected at high temperature than that of control mortars.

Lohani et al (2012) have studied the property of the quarry dust and the suitability to use it as partial replacement material for sand in concrete. Design mix of M20 grade concrete was used with replacement of 0%, 20%, 30%, 40% and 50% of sand by quarry dust. They conducted slump test, compaction factor test, compressive strength (cube, cylindrical sample), split tensile strength, flexural strength, modulus of elasticity and water absorption test. The durability of concrete was studied by immersing the concrete cube in 5% solution of MgSO₄, 5% solution of NaCl and 2N solution of HCl for 28 and 91 days and results were compared with the standards to achieve the desired parameters. From the test results it was observed that the concrete does not give adequate workability with increase of quarry dust. It was due to the extra fineness of quarry dust. Increased finer requires greater amount of water for the mix ingredients to get closer packing results in decreased workability. Increase in dust content up to 30% increases compressive strength of concrete and if the dust content was more than 30% the compressive strength decreases gradually. But the compressive strength of quarry dust concrete continues to increase with age.
for all the percentage of quarry dust contents. Flexural and tensile strength was maximum at 20% sand replacement. From the above test results it was concluded that quarry dust can be utilized at 20% replacement.

Dehwah (2012) has conducted experiments to evaluate the mechanical properties of self-compacting concrete (SCC) prepared using quarry dust powder (QDP), silica fume (SF) plus QDP or only fly ash (FA). They conducted trails to assess the proportions of QDP, SF + QDP or FA required for producing SCC meeting the flow criteria. SCC specimens were prepared and tested for compressive strength, pulse velocity, split tensile strength and flexural strength. They reported that the mechanical properties of SCC incorporating QDP (8–10%) were equal to or better than those of SCC prepared with either SF plus QDP or FA alone. The use of QDP alone results in a significant cost saving in regions where SF and FA have to be imported from other countries.

Joseph et al (2012) have investigated about the structural characteristics of concrete using various combinations of lateritic sand and quarry dust as complete replacement for conventional river sand as fine aggregate. Laterite and quarry dust replaced sand fully in the proportion 0:100, 25:75, 50:50, 75:25 and 100:0. The mixes M15, M20 and M25 were prepared for workability and cube specimen were cast and tested for compressive strength at the age of 3, 7, 14, 21 and 28 days. From the test results it was observed that 25% of laterite with 75% of quarry dust produced greater compressive strength. It was concluded that quarry dust may be replaced in place of sand in concrete.

Joseph et al (2012) have investigated through experiment about flexural and tensile characteristics of concrete using combination of lateritic sand and quarry dust as complete replacement for conventional river sand fine aggregate. Specimen were cast in M20 mix with water cement ratio 0.65 and
tested at the age of 28 days. From the test results it was observed that the
tensile and flexural strength were decreased slightly while sand replaced by
quarry dust. It was concluded that the strengths were comparatively closer
with normal concrete and hence concrete with mixtures of lateritic sand and
quarry dust can be used for structural construction below 50% combination.

Priyanka A. Jagadev and Dilip K. Kulkarni (2012) have conducted
experiments on concrete to determine mechanical properties using
manufactured sand. Specimens were cast using M20 concrete with water
cement ratio 0.45, replacing sand from 0-100% at increments of 20%.
Workability test was carried out in fresh state. Hardened state tests like
compressive, flexural and split tensile strength were conducted at the age of
28 days. From the test results it was observed that the increase in percentage
of replacement of manufactured sand decreased the workability. The
manufactured sand consumes higher amount of water. The compressive,
flexural and split tensile strength of concrete with 60% sand replacement
attains higher strength as compared to reference mix. It was concluded that
manufactured sand has a potential to provide alternative to natural sand and
helps in maintaining the environment as well as economical balance.

Sachin Balakrishna Kandekar et al (2012) have conducted
experiments on concrete to study the mechanical properties with different fine
aggregates. They used grit the quarry dust, artificial sand and combination of
the above two as replacement material to sand. Mix M20 was adopted to
prepare concrete. Hardened state tests like compressive, flexural and split
tensile strength were conducted at the age of 28 days and compared with
control mix. From the test results it was observed that the concrete with grit
the quarry dust as fine aggregate achieved maximum strength. It was
concluded that the grit the quarry dust was more preferable than others.
Divakar et al (2012) have conducted experiments to study the behavior of concrete with the use of granite fines as fine aggregate. The percentage of replacement of sand by granite fines were 5, 15, 25, 35 and 50. Specimens were cast in M20 concrete using 53 grade OPC. Tests were conducted on compressive, flexural and split tensile strength at the age of 28 days. From the test results it was observed that the maximum compressive and split tensile strength were obtained at 35% sand replacement. The flexural strength was maximum at 25% sand replacement. Workability of concrete mixes decreased with the increase in granite fine percentage. For RCC beams the flexural strength was increased with increase of granite percentage. It was concluded that overall 35% of replacement as optimum to satisfy all properties.

Mukesh and charkha (2012) have conducted experiments on concrete to study the effect of the flexural and tensile strength with partial replacement of ingredients. 40% sand was replaced by crushed stone dust and cement was replaced by fly ash from 0-40% at increment of 10%. Flexure and split tensile tests were conducted in M20 mix using PPC. From the test results it was observed that the maximum flexure and split tensile strength were obtained 0% fly ash and 40% sand replacement. If the cement was replaced by fly ash then flexure and split tensile strength were reduced. So the optimum fly ash content was 0% for PPC cement. It was concluded that crushed stone dust can be partially used as fine aggregate with conventional river sand in concrete.

Kothai and Malathy (2012) have conducted experiments on self compacting concrete with manufactured sand as partial replacement material to natural sand. Using 43 grade OPC, the mixes M20, M25, M30, M35 and M40 were prepared with the sand replacement from 0-100% at increment of 10%. Tests were conducted to determine compressive, tensile and flexural
strength at the age of 28 days. From the test results it was found that maximum compressive strength, tensile strength and flexural strength were obtained at 30% of sand replacement. A relationship between compressive strength and split tensile strength was obtained as $0.1f_{ck}$. Similarly $0.657f_{ck}$, the relationship between compressive and flexural strength also derived. It was concluded that partial replacement of natural sand by manufactured sand permits a gain of compressive, tensile and flexural strength of concrete up to optimum value at 30% replacement.

2.3 SUMMARY OF REVIEW OF LITERATURE

Researchers presented various different suggestions and all are not unique in connection with the usage of quarry dust the crushed rock material as an alternative to natural sand. Most of them investigated normal mechanical properties like compressive, flexural and split tensile strength of quarry dust as fine aggregate in concrete. Due to higher strength than control concrete they suggested that the quarry dust may be utilized in place of sand upto some extent. Least number of investigations was carried out on concrete durability if sand was replaced by quarry dust. This research is planned to investigate in addition to normal mechanical properties, flexural strength of RCC beam, temperature effect, thermoshock effect and permeability with and without superplasticizer.