CHAPTER-2

REVIEW OF LITERATURE
2.1 Review of Literature

This literature review deals with the research project work carried out by researchers in developing the high performance concrete. **Limbachiya et. al (2000,2003,2004,2010)** Found that recycled concrete aggregate had 7 to 9% lower relative density and 2 times higher water absorption than natural aggregate. According to their test results, it shown that there was no effect with the replacement of 30% coarse recycled concrete aggregate used on the ceiling strength of concrete. It also mentioned that recycled concrete aggregate could be used in high strength concrete mixes with the recycled concrete aggregate content in the concrete.

According to him there was no effect by using up to 30% of coarse recycled concrete aggregate on the standard 100 mm concrete cube compressive strength. But when the percentage of recycled concrete aggregate used increased, the compressive strength was reduced. There must be some influences that cause the reducing of compressive strength of recycled aggregate.

Construction demolition waste has become a global concern that requires sustainable solution. It was recognized that the recycling and reuse of demolition waste may not always be economical or practical and in some cases may be impacted by the external issues such as regulatory and planning controls. **(71, 72, 73, 74, 75)**

**Chen How-Ji et. al (2002)** stated that using unwashed recycled aggregate in concrete will affect its strength. The effect would be more obvious at lower water/cement ratios. At a water/cement ratio of 0.38, the compressive strength of recycled concrete remained only 60% that of normal concrete. The strength ratio could be increased to more than 75% when the water/cement ratio was greater than 0.60. **(27)**

**Stahl Douglas C. et. al (2002)** Stated that the best results were obtained with a simple mix based on replacing a conventional mix’s volume of coarse aggregate with wood aggregate, and a mix that used some stone aggregate in addition to the wood aggregate, along with a sodium silicate treatment for the wood. **(126)**

**Poon et. al (2002,2007)** reported that there were not much effect of the compressive strength of brick specimens with the replacement of 25% and 50% of recycled aggregate. But when the percentage of recycled aggregate replacement increased, the compressive strength of the specimens was reducing.
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The replacement of cement by 25% fly ash increased the slump of concrete mixtures with and without recycled aggregates. (108,109)

Bodin and Zaharieva et. al (2002) They stated that decreasing of the strength of recycled concrete specimen was due to the increase of water/cement ratio that required by the preservation of workability. Some precautions must be taken while using recycled aggregate in the concrete mixing. As there were some pathological reactions such as alkali–aggregate reaction and sulphate reaction may be include in the performed characterization of industrially produced recycled aggregate. They also mentioned that the mix proportioning of recycled aggregate concrete must be suited when both fine and coarse recycled aggregate were substituted for natural aggregate. (20)

Gorkce A. et. al (2003) Sandstone coarse aggregate particles reduced in size and amount could not propagate micro cracking within sound recycled coarse aggregate and into the other constituents of the recycled aggregate concrete subjected to freezing and thawing action. (45)

Otsuki Nobuaki et.al (2003) The strength of recycled aggregate concrete was lower than that of normal aggregate concrete. The chloride penetration and carbonation resistances of recycled aggregate concrete are slightly inferior to those of normal aggregate concrete. Improvement in strength, chloride penetration, and carbonation resistances of recycled aggregate concrete can be achieved by using the double mixing method in the case of high water-binder ratio concrete. (97)

Katz Amnon et .al (2003) Stated that Scanning electron microscopy of recycled aggregates derived from the crushing of old concrete showed extensive cracking of the old cement paste that remained adhered to the natural aggregate. In addition, contamination of the surface of the crushed concrete by small particles that were loosely connected to the aggregate was observed. Two treatments were evaluated, with the purpose of improving the surface properties of the R-aggregate: (1) Impregnation of the recycled aggregate with a 10% by weight silica fumes solution; and (2) ultrasonic cleaning of the R-aggregate to remove loose particles from its surface. (56)

Etxeberria M. et.al (2007) The mechanical properties of concrete produced with 25% of recycled aggregates are similar to conventional concrete. (38)

Badur Smita et.al (2008) said that the mixed concrete was safe enough to be used in environmental applications, like roadbeds, filling materials, etc. Thus, due to the beneficial use of the immobilized material, this type of industrial wastes and by-products usability should be appeared to offer a promising way to improve sustainable environment in developing countries. (13)
Business Magazine (2009) wrote that how times have changed in recent years for the demolition and construction industry. Companies have had to adapt to meet challenging environmental requirements. As with almost any industry, new regulations and legislation dictate the standards to which your business must aspire, if it is to be successful. (1)

C. R. Sri Ravindrajah et. al (2009) The compressive strength of concrete was determined at various ages up to 90 days using 100mm cubes. Based on the results, they concluded that for a given water cement ratio, the recycled-aggregate concrete showed a lower strength than that for the natural aggregate concrete. The results also showed that the relationship between the strength and water-cement ratio at both ages follows a similar trend for the recycled-aggregate concrete as well as the natural aggregate concrete. (116)

Fathifazl G. et. al (2009) Using supplementary cementations materials i.e. fly ash, the cement content of a RCA concrete mix can be further reduced without adversely affecting its properties, except the use of fly ash may reduce the short-term compressive strength. (40)

According to Mohammed Tarek Uddin et. al (2009) The global consumption of concrete was estimated at 12 billion tons (@ 2 tons /capita/year). To make this huge volume of concrete, 1.5 billion tons of cement, 9.3 billion tons of aggregate, and 1.2 billion tons of water were necessary. The global production of demolished concrete was estimated at 2–3 billion tons per year. In next ten years, the global production of demolished concrete will rise to 7.5–12.5 billion tons. If it was possible to recycle the total amount of demolished concrete, there would be no need to produce new aggregates by destroying mountains or burning clay. Therefore, an attempt was made to determine possible ways to recycle demolished concrete for new construction as coarse aggregates. (84)

Michal Boltryk et. al (2009) depicted Compressive strength of recycled aggregate concrete in which natural gravel 2/16 was replaced by recycled aggregate in the range from 25% to 100 % was comparable with strength of NAC. Water absorbability of RAC is higher up to 24% compared with NAC. (82)

Song Gu et al (2009) The research had been concluded that, Because of old mortars adhered on the surface of the aggregate the water absorption rate of recycled aggregate was far more than natural aggregates, the slump and strength will decrease while the replacement rate of RCA increased and Fly ash can enhance the workability of recycled concrete effectively. While the replacement rate of Fly ash to cement was no more than 30%, the strength of concrete will not decrease obviously. (125)
Domono Peter et. al (2009) Water absorption typically increased by 40-60% with full coarse RCA replacement, but up to 180% increase with fine RCA replacement, Purity of RCA also very important for absorption performance (106)

PilarAlaejos Gutiérrez et. al (2010) stated that utilization of recycled aggregate in structural concrete required the development of technical guidelines or standards for recycled aggregate, in order to guarantee a safe use. Due to the high water absorption of all recycled aggregates tested, it would be necessary to use a blend with a replacement up to 20% of natural aggregate with coarse recycled aggregate. (107)

Mirza F. A. et. al (2010) concluded that concrete properties were usually worsened by the use of high percentages of recycled aggregates of concrete. Recycled aggregate concrete was successfully produced of grade 40/50 MPa using local recycled aggregate. The compressive strength and tensile splitting strength varied according to the quality of RCA and its crushing process. 5% Silica Fume, as a partial replacement and 100% recycled aggregate content give best combination for RAC as compressive and splitting tensile strengths values was observed at all ages. At the same recycled aggregate replacement level, the use of silica as a partial replacement of cement was able to enhance concrete strength as a result of the greater long term strength development due to the pozzolanic reaction of silica fume. (83)

Hani Suraya et. al (2010) The relationship of w/c ratio and compressive strength of RAC was inversely proportional. (128)

Ashiquzzaman M. et. al (2010) stated that the recycled stone aggregate could be the partial replacement of virgin stone aggregate and full alternative for both recycled and virgin brick aggregate. Based on this research, it was clearly seen that recycled coarse aggregates (stone and brick) had a bright future for the construction in Bangladesh (12)

According to Ahmad Ruslan Mohd Ridzuan et. al (2011) Sustainable industrial development pose serious problems of construction and demolition waste disposal. While on the one hand, there was a critical shortage of natural aggregate (NA) for the production of new concrete, the other the amount of the demolished concrete produced from deteriorated and dilapidated structures create severe ecological and environmental problems. (7)

Abdelfatah Akmal S. et. al (2011) Real-life applications of using recycled construction waste were still in their infancy and need some major efforts to attract investors to this industry. There were limited legislations and policies to encourage recycling and use of demolition waste in the Gulf Cooperation Council (GCC). No governmental standards and
specifications for processing and use of recycled aggregate are currently available in the region. (3)

**Gupta Arundeb et. al (2011)**  This study said Recycled aggregate concrete with 10% fly ash gives higher compressive strength, split tensile and flexural strength over Recycled aggregate concrete. Pore structure of recycled aggregate concrete could be improved by addition of fly ash with respect of total pore volume as well as pore diameter. (47)

**Parekh D. N. et.al (2011, 2012)**  The presence of chloride ions in RAC may promote corrosion of reinforcement and thus affect the durability of structure. Use of recycled concrete decreased workability of fresh concrete at given water content, increased water requirements for giving consistency, increased drying shrinkage at given water content, and reduced the modulus of elasticity at given water-cement ratio. The effects were greatest when the recycled concrete was used as both coarse and fine aggregate. They also reported that Water absorption and specific gravity were very important property for RCA. Hence water absorption was checked for different time intervals. All mechanical properties of the NCA and RCA were determined and compared with IS requirements. At the fresh state, the slump loss and fresh density for various concrete mixes were determined. Water absorption of RCA was 5 to 9 times higher and specific gravity of was 15% to 20% lower than the NCA. Furthermore, RCA had 9 to 11% lower density. Attached cement mortar and voids in that are the basic reason behind such behaviour. These aggregates were used without any type of treatment, i.e. without washi treatment. Elongation and flakiness index were observed little higher for RCA. All other properties of aggregates (i.e aggregate crushing value, aggregate impact value, aggregate abrasion value etc) were showing values within IS limit for all source of recycled aggregates. 7% addition of silica fume to 100% RA concrete gave the same result as that of 100% NA concrete. It was observed that the presence of recycled aggregates seemed to produce lower performance levels in terms of sustain. However, the addition of silica fume was also seen to have a beneficial effect on controlling this performance. (99,101,102,103)

**Hong Kong Housing Authority (2011)**  The study concluded that RAC could generally be used in building works as a sustainable construction material besides technical consideration, there were other considerations affecting the general acceptance of its wider use, which include public confidence, costs and liability. (52)

**Corinaldesi Valeria et. al (2011)**  The study gave correlation between elastic modulus and compressive strength of recycled-aggregate concrete was found showing that, in general, 16% lower elastic modulus is achieved by using 30% coarse recycled aggregates, whatever the recycled aggregate grain size distribution. (29)
Utilization of Recycled Aggregate in concrete has been employed due to awareness of society in natural resources protection. MBS (Micronised Biomass Silica) could improve the performance of RAC in terms of compressive strength and water permeability. (129)

This study recommended the recycling of waste concrete as an aggregate material in production of new concrete, provided the labour cost incurred in the extraction of waste aggregates from demolished buildings and also the cost incurred in using admixture to increase the strength of waste aggregates did not exceed the cost of fresh aggregates. The recycling of waste concrete could help us to conserve the natural aggregates and use them for more important constructional works. Also, the waste aggregates obtained from demolition of buildings and destruction of buildings by earthquakes creates disposal problems. (46)

The results of these papers showed that the contributions of the mineral admixtures (silica fume, fly ash, metakaolin, ground granular blast slag) to performance improvement of the recycled aggregate concrete are higher than that to the natural aggregate concrete. The compressive strength decreased as the recycled aggregate content increased. The absorption test results clearly confirm that the higher the decrease of recycled concrete strength, the higher its porosity was significant; especially more its large capillaries were of significant diameter. The use of fly ash as a partial replacement of cement and an addition of cement significant decreased the water absorption of recycled aggregate concrete. Although the use of fly ash as both a partial replacement and an addition of cement could improve the durability properties of recycled aggregate concrete, from an economic and environmental point of view, the use of fly ash as a partial replacement of cement in the concrete mixture was the least expensive and the more environmentally friendly. (66, 67)

According to M. Chakradhara Rao et al (2010, 2011) Recycling of construction and demolition waste has been considered from two main environmental aspects point of view: solving the increasing waste disposal crisis and save the depletion of natural resources. Overall the strength gain rate for recycled aggregate concrete was slower than concrete with natural aggregates in first 28 days. Density of RAC was less than that of concrete with natural aggregates. This may be an advantage in the design of structures where the light weight concrete is preferred. (24, 25)

Beleń González et. al (2011) concluded that due to the mortar adhered to the recycled aggregates; recycled concretes (with pre-wetted recycled aggregate) have a lower
hardened density and a higher absorption coefficient than conventional concretes. Similarly, this caused a decrease in the compressive strength and in the longitudinal and transverse modulus of elasticity. The tensile splitting strength was slight affected by the replacement of natural coarse aggregate with recycled coarse aggregate. (16)

Sekar T. et. al (2011) Based on the study it can be stated that waste ceramic tiles can be used as an alternate construction material to coarse aggregate in concrete. Besides economical and strength criteria, concrete made from waste materials as aggregates, solves the disposal problem of these waste materials. (121)

Bhikshma V. et. al (2010, 2012) Conservation of natural resources and rapid urbanization has prompted growing demand for natural aggregate by construction industry. The influence of replacement ratio, (Rr) the ratio of recycled coarse aggregate to total coarse aggregate (Rr=RCA/TCA) on mechanical properties of recycled aggregate concrete was studied. Saenz mathematical model was successfully evaluated and validated for all recycled aggregate concrete mix cases considered in the investigation programme. Stress strain values for various grades and percentages of recycled coarse aggregates were developed exclusively for recycled aggregate concrete mixtures, and they were validated for all concrete mixtures considered in the investigation programme. The mechanical properties like compressive strength, split tensile strength, flexural strength will be increased 22%, 36% and 26% after 28 days respectively for M20 and M30 grade concrete with the addition of 1.5% steel fibres by volume of concrete. (19, 18)

P. Saravana Kumaret.al (2012) In this work, a comparison was made between the results of a laboratory investigation on various properties of concrete made with recycled aggregate concrete with fresh aggregate concrete and found that the results were encouraging to use concrete with RA for M25 grade of concrete for three different periods of curing of 7, 14, and 28 days. (120)

Wai Hoe Kwan et.al (2012) The replacement level of the natural coarse aggregate with the RCA would reduce the compressive strength of the concrete. However, the replacement up to 80% was still acceptable to achieve the target strength. The water absorption value was directly proportional to the level of the RCA replacement. (70)

JianZhuang Xiao et. al (2012) The influences of the RCA on the strength and deformation characteristics of concrete, the statistical characteristics for the strength of RAC, fracture energy, stress-strain relationships under uniaxial compression, uniaxial tension as well as pure shear, and the residual strength of RAC after exposure to high temperatures, the bond between RAC and different kinds of steel rebar were reviewed. (145)
Medina C. et. al (2012) said that the generation and management of wastes from different productive activities constitute a serious environmental issue in modern society. (81)

Praveen Kumar et. al (2012) The physical, chemical and strength characteristics of various waste materials like building construction and debris (Recycled aggregates), Fly ash, Steel & Blast furnace slag and Rice husk ash were tested in laboratory and the results were found to be within the specified limits as per MOSRT&H. Recycled aggregates found to be relatively soft compared with conventional aggregate and can be used as a sub-base material but not in base course and wearing course. Water absorption of waste material was found to be high compared with conventional aggregate. The results of recycle aggregate were found to be within the limits as per MOSRT&H specifications. (110)

Md Shakir Ahmed et. al (2013) concluded that water absorption of RCA was more which decrease the strength. The strength of concrete decreases as the percentage of RCA increases and to achieve target mean strength extra quantity of cement is to be added in the concrete mix. There was considerable reduction in split tensile strength and flexural strength of concrete with recycled aggregates, the loss in strength should be considered while designing members using recycled aggregate concrete. (86)

Belagraa Larbi et. al (2013) In light of this study, there was an improvement of recycled aggregate concrete strength when combined with admixtures (Medaplast 120) compared to normal concrete without admixture incorporation. (17)

Sonawane Tushar R et. al (2013), conclude that use of recycled aggregate up to 30% did not affect the functional requirements of the structure as per the findings of the test results. Due to use of recycled aggregate in construction, energy and cost of transportation of natural resources and excavation is significantly saved. This in turn directly reduces the impact of waste material on environment. (123, 124)

Nyok Yong Ho et. al (2013) The compressive strength of all the concrete mixes with up to 40% RCA replacement level showed higher strength than that of the control mix. (93)

According to Mohd Monish1 et.al (2013) Huge quantities of construction and demolition wastes are generated every year in developing countries like India. Recycled aggregate concrete may be an alternative to the conventional concrete. Water required producing the same workability increased with the increase in the percentage of demolished waste. Up to 30% of coarse aggregate replaced by demolished waste gave strength closer to the strength of plain concrete cubes and strength retention is in the range of 86.84-94.74% as compared to conventional concrete. (85)
Bulbul Ahmed et. al (2013) said that one way to achieving this objectives is to use recycled concrete aggregate (RCA) for base course and other purposes. RCA is not widely used in new concrete mixtures, however, largely because RCA concrete has been reported to be of inferior quality to concretes produced with virgin aggregates (5).

Puri Nitish et. al (2013) concluded that use of waste materials results in the formation of lightweight concrete. Maximum strength was shown by concrete mix having 25% recycled debris aggregates and 75% natural aggregates. Except leather waste other materials like construction debris and PVC scrap performed well as full or partial replacer of concrete aggregates and can find suitable application in construction industry as alternative to conventional materials. (111)

Patil Sudhir P. et. al (2013) stated that the amount of construction waste has been dramatically increased in the last decade, and social and environmental concerns on the recycling of the waste have consequently been increased. The slump of the normal concrete was observed to be less than the recycled one. The strength of concrete was high during initial stages but gradually reduced during later stages. Water absorption of RCA was higher than natural aggregate. Due to lack of treatment process for RCA adequate strength was not achieved but by applying more advanced and sophisticated treatment process the strength could be improved. The usage of RCA in concrete mixture was found to have strength in close proximity to that of natural aggregate and could be used effectively as a full value component of new concrete. (105)

Husain Asif et. al (2013) stated that in recent years demolished concrete waste handling and management is the new primary challenging issue faced by the countries all over the world. Study shows that dismantled concrete is not solid waste but useful material to be recycled to prepare fresh concrete, which saves the cement and make the concrete economical. (53)

Nixon P. J. et. al (1978) The present state of knowledge on the use of recycled concrete as an aggregate in new concrete was reviewed and suggestions made as to what further work is necessary before a proper assessment of the material can be made. Where crushed uncontaminated concrete was used the properties of the material as an aggregate and the basic engineering characteristics of the concrete made with it were well established. Much less was known about the type and quantity of impurities which could occur in crushed concrete from general building rubble and the effect these would have on concrete made using such crushed concrete as aggregate. (91)

Tavakoli (1996) said that the strength characteristics of recycled aggregate concrete were influenced by the strength of the original concrete, the ratio of coarse aggregate to fine
aggregate in the original concrete, and the ratio of top size of the aggregate in the original concrete in the recycled aggregate. He also mentioned that water absorption and Los Angeles abrasion loss will influence the water cement ratio and top size ratio for the strength characteristic of recycled aggregate. (133)

**Tom Wilmot and George Vorobieff** (1997) stated that both the use of pavement materials and their performance, and the wider implications to the community continue on very limited budgets. A small annual contribution from all local government road maintenance budgets would assist in continued research and usable outcomes to benefit the community. (141)

**Vorobieff George** (1998) Stated that the Road Rehabilitation by Recycling project broke new ground by developing a test method to provide more reliable predictions of the stabilized layer modulus in order to give more accurate material fatigue prediction models. In addition, the field trials outlined the methods that may be employed to monitor the performance of stabilized pavements. With the recent use of various slow setting cementsations binders for deep lift construction which are now being specified for local government projects, the construction and design decisions must be complemented to allow the pavement to perform as intended. (140)

**YangKeun-Hyeok et. al (2008)** The initial slump of recycled aggregate concrete was slightly affected by the relative water absorption of aggregates, whereas the rate of slump loss increased with the increase of the relative water absorption of aggregates. The normalized splitting tensile strength and moduli of rupture and elasticity of recycled aggregate concrete decreased with the increase of the relative water absorption of aggregates. (147)

**Forster S. W. et. al (2008)** concluded that the recycled coarse aggregate had invariably lower specific gravity and higher absorption than the original aggregate, due to the presence of cement paste in the recycled aggregate. Required compressive strengths could easily be met using recycled coarse aggregates. Some recycled mixes had higher flexural strength than the original mixes. As with compressive strength, both were well above required levels. Split tensile test results indicate that the recycled mixes give lower results, in general, than the original mixes. Those mixes with 100 percent recycled coarse aggregate were generally lower than those with 50 percent virgin aggregate and 50 percent recycled aggregate. (43)

**Ayed Ahmad Zuhud et. al (2008)** The workability of recycled aggregate concrete mix was lower than natural aggregate, concrete mix with 30% recycled aggregate concrete has satisfied workable concrete. The super plasticiser was considered necessary for achieving
the required workability of concrete using more than 30% recycled aggregate. Recycled concrete aggregate could be used as aggregate for new concrete, there was a need to obtain long-term in-service performance and life cycle cost data for concrete made with recycled aggregate concrete to assess its durability and performance. (6)

According to **Yadav S. R. et. al (2009)** India is presently generating construction and demolition (C &D) waste to the tune of 23.75 million tonnes annually and these figures are likely to double fold in the next 7 years. C&D waste and specifically concrete have been seen as a resource in developed countries. Works on recycling have emphasized that if old concrete has to be used in second generation concrete, the product should adhere to the required compressive strength. Research work has concluded that a 25- 30% recycled may not have a significant effect on concrete properties, but if these aggregates contain more than 65% of adhered mortar its impact on concrete properties have not been evaluated. The work would simplify the work for contractors who would be interested in using demolished concrete and give a simple procedure of using recycled by considering % adhered mortar and evaluating the mix proportions for attaining a comparable strength for high grade applications. (146)

**Kishore R. et. al (2009)** said that conservation of natural resources and protection of environment is the key to sustainable development.. The research work on flexural behaviour of recycled aggregate concrete beams presented to establish performance of recycle aggregate concrete (RAC) as structural grade concrete. In all 8 beams of RAC and 8 beams of NAC were tested for flexure under two point loading. The investigations indicated encouraging results for RAC beams in all respects, thus, pointing to recycled aggregate as potential alternative source of aggregate of the 21st Century. (65)

**D. Yong P.C. et. al (2009)** Recycled concrete aggregates (RCA) from site-tested concrete specimens were used. The main aim of this research project was to utilize recycled concrete as coarse aggregate for the production of concrete. The compressive strength of concrete with 100% replacement of RCA has the highest 7-day and 28- day strength which reaches 40.24 MPa and 57.99 Mpa respectively. The compressive strength of recycled concrete with 50% replacement of RCA is in close proximity with that of the control concrete The split tensile strength of recycled concrete with replacement of 100% RCA and 100% SSD RCA are both higher than split tensile strength of control concrete. From the results, the 3-day flexural strength of control concrete is lowest compared to 3-day flexural strength of RAC. The 28-day flexural strength of control concrete is highest compared to 28-day flexural strength of RAC. (148)
Ismail Abdul Rahman et al (2009) concluded that the 28-day target compressive strength for all six mixes was achieved to 25 MPa even though the RAC strength was lower than NAC. The compressive strength for RAC was within the same range compared to NAC and reached up to 25MPa at day 28 of curing. The size of RA was affected the strength in compressive strength, the results showed the 10mm and 14mm size of RA was better than 20mm size. The workability (slump test) of RAC was lower than NAC because the rate absorption of RA was higher than NA. (54)

Gupta Y P et. Al (2009) stated that disposal of Demolition Waste / Garbage becomes easier. With use of recycled aggregate it could be possible to make concrete blocks, it could be used in reinforced concrete or Plain Concrete in foundation, Retaining walls, Panel walls, in highways dry lean concrete (DLC), Shoulder, and paving blocks and in side drains, finer material could go back to river beds in the same trucks which bring sand from river. It will save the natural resources like Hillocks, River Pebbles etc from extinction. Stone queries or Hillocks will not be affected and hence environment can be preserved. Resulting floods and droughts will be minimized & thus less Deforestation of hilly areas. It can keep the roads and streets clean by not dumping Demolition Waste on the road side as in India. This will also minimize Road accidents because of fewer obstructions. It can generate work for unemployed people like collecting malwa by Rag pickers and deposit it at Ready Mixed Concrete Plants who will get some Aggregate. For enforcing the use of Recycled Aggregate in Construction, studies on long term properties of the Recycled Aggregate should be done for their properties. Based on such studies, Formulation of Specifications and Codal provisions be done. (48)

Jagannadha Rao K. et al (2009) determined the suitability of glass fibers for use in structural recycled aggregate concrete of high strength. The fresh and hardened state properties of partially replaced recycled aggregate concrete, with varying percentages of glass fibers, were compared with the corresponding conventional aggregate concrete. The compressive, split tensile and flexural strengths of M50 grade concrete with 0% RCA and 50% RCA have increased as the fiber content increased. The maximum values of all these strengths were obtained at 0.03% of fiber content. Large deflections of beams before failure indicated improved ductility with the addition of fibers. (55)

Kumutha R. et. al (2010) Investigated that the properties of concrete containing recycled aggregates. For strength characteristics, the results showed a gradual decrease in compressive strength, Splitting tensile strength, flexural strength and modulus of elasticity as the percentage of recycled aggregate used on the specimens increased. There was a possibility to use 100% crushed concrete coarse aggregates and 60% crushed brick fine
aggregate in compression elements like concrete blocks and concrete pavements since the target strength could be achieved. (69)

Mirjana Malešev et. al (2010) A comparative analysis of the experimental results of the properties of fresh and hardened concrete with different replacement ratios of natural with recycled coarse aggregate was presented in the paper. The way of preparing recycled aggregate for concrete mixtures influences the concrete workability. Concrete compressive strength mainly depends on the quality of recycled aggregate. If good quality aggregate (obtained by crushing higher strength class concrete as in this case) is used for the production of new concrete, the recycled aggregate has no influence on the compressive strength, regardless of the replacement ratio of natural coarse aggregate with recycled aggregate. The same conclusion is valid for concrete tensile strength (splitting and flexural). (76)

Brett Tempest et. al (2010) said that recycled aggregates produced from construction and demolition rubble can successfully be used in concrete mixtures that exhibit acceptable laboratory performance, impediments to widespread usage were still readily apparent from a market perspective. Concrete that includes recycled aggregates has been shown to provide cost savings to producers. If the supply and consistency of demolition rubble increases, there should be improved market interest in RA. The remaining impediments will include equipment and operational cost barriers to market entry, and other economic issues such as tipping fees, hauling costs, and increased product development expenses. (134)

Akbari Y. V. et. al (2011) In the present work, an attempt has been made to study the effect of recycled aggregate on behaviour of normal strength concrete. The experimental program included variation in the water cement ratio and replacement of natural aggregates by recycled aggregates. Three different water ratios 0.60, 0.52 and 0.43 and aggregate replacement of 0%, 15%, 30%, 50% were accounted in the experimental program. Experimental results shows up to 25% reduction in compressive strength, 23% reduction in flexural strength, 26% reduction in Splitting tensile strength and a noticeable reduction in workability was observed with the increase in percentage of aggregate replacement.(8)

According to Deshpande Neela et.al (2011) Concrete industry, uses 12.6 billion tons of raw materials each year, is the largest user of natural resources in the world. The environmental impact of production of raw ingredients of concrete (such as cement and coarse and fine aggregates) is considerable. The scale of the problem makes it prudent to investigate other sources of raw materials in order to reduce the consumption of energy
and available natural resources. 28 days compressive strength of concrete with various percentage replacements by Recycled concrete aggregates could be achieved, even though the compressive strength of concrete with Recycled Concrete aggregate was less than that of Concrete with Conventional aggregates. The properties of Recycled Concrete Aggregates were governed by the Parent source. Due to higher water absorption of recycled aggregates, more was the water requirement for appropriate workability. The adjustments in water content could be done during designing which increases the water demand; however the appropriate percentage of admixture could be used to increase the workability. Using Recycled fine aggregates in concrete could prove to be better however in less quantity and could be recommended for lower grade applications. (32)

**Madan Mohan Reddy K. et. al (2012)** The performance of compressive strength produced by Recycled Aggregate Concrete (RAC) and results were compared with the Natural Coarse Aggregate Concrete (NAC). The studies were conducted with M20 mix with the selected w/c ratio of 0.5 and the development of compressive strength of the RAC and NAC at the age of 7 & 28 days were studied. The result showed the compressive strength of RAC was on average 87% of the NAC and the Slump of RAC was low and that could be improved by using Saturated Surface Dry (SSD) of RCA. Based on the obtained results they derived the conclusion that concrete could be successfully produced using RCA that have been produced from demolition and construction waste. The Recycled Aggregate Concrete still has a strength that would make it suitable for some applications. (77)

**Murali G. et. al (2012)** The test results showed that the flexural, compressive and the split tensile strength of the recycled aggregate concrete was found to be lower than the natural aggregate. The strength of recycled aggregate concrete could be improved by the water and acid treatments. Furthermore Recycled aggregate treated with nitric acid displayed the decent result compared to the hydrochloric and sulphuric acid and from economical point of view; water and acid treated recycled aggregates could be used in place of natural aggregates for temporary structures. (88)

**H. Sudarsana Rao et. al (2012)** said that Recycled coarse aggregate concrete (RCAC) can be recognised as a new kind of concrete, in which broken pieces of waste concrete were used as aggregate. The use of RCA was one such an attempt to solve some of the problems in the field of construction industry. The concept of using RCA was now gaining popularity and research in this field has gained some momentum. As the percentage replacement of natural coarse aggregate with recycled coarse aggregate increases the
compressive strength and split tensile strength increases. Up to 40% replacement of NCA with RCA there was a marginal decrement in compression and split tensile strength when compared with natural coarse aggregate concrete. (127)

Qasrawi Hisham et. al (2013) based on the study presented in this paper it can be concluded that the use of RCA as coarse aggregate is possible in normal concrete mixes. It is useful in reducing the environmental problems created by dumping these materials and also helps to maintain sustainability of the environment by reducing the new quarries needed for new concrete. The use of RCA as coarse aggregate in concrete mixes has adversely affected the properties of fresh concrete and hardened concrete. The workability of concrete was severely reduced. The use of plasticizers and super plasticizers would be beneficial in enhancing the workability. Regarding air content in fresh concrete, the use of RCA has an adverse effect on the air content in concrete especially for replacement ratios exceeding 25%. On the other hand, approximately no effect is observed at replacements up to 25%. Above this value, it has been observed that the air content is increased by a constant value, approximately 2%, for replacements exceeding 50%. A decrease in compressive and tensile strengths has been observed. This decrease depends on the replacement ratio and the grade of concrete. For the same replacement ratio, the percentage reduction in compressive strength is more than that in tensile strength when RCA is incorporated. The modulus of elasticity of concrete has been reduced when RCA is incorporated irrespective of the w/c ratio or the RCA replacement ratio. They noted that widespread use of RCA, it is important to provide specifications and standards that control the use of RCA in concrete. Each country can arrive at its own specification and standards. The Japanese and RILEM specifications could be bases for such issue. (112)

2.2 Major findings from Literature review

The Major findings from literature review are as follows:

1. A laboratory work done on experimental programme aimed at examining the performance of recycled aggregates, produced with known source of concrete and unknown source of concrete. (99)

2. When recycled aggregate is used at high percentages (e.g. 50% or higher), the concrete mixes were less cohesive (based on visual observations during mixing and casting) than those prepared with natural aggregates. (100, 101)

3. Workability for fresh concrete was decreasing with increase of incorporation of recycled aggregates. There is also no effect for known or unknown source of aggregates. (102)
4. Up to 30% coarse recycled coarse aggregate has no effect on concrete strength, but thereafter a gradual reduction with increasing recycled aggregate content occurs.

(103)

Literature in the area of industrial waste and by-product utilization along with various applications there merits and demerits in the field of construction Industrial development has been collected from available sources like conference, proceedings, National, International Journals, publications and Ph.D. Thesis, regress and critical study of the proposed area was done to arrive with following major finding and based on that the precast problem of studies or parts of more work has been identified.

The areas for proposed waste from recycled material, design development and construction needs to study carefully encourage the potential application of the recycled aggregate. The parameters in reference to a concrete application like workability, mechanical properties, and durability needs to study critically for sustainable construction technology with recycled aggregate utilization.