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RESEARCH ARTICLE

SELF-COMPACTING CONCRETE USING RECYCLED COARSE AGGREGATE- A FEASIBLE SOLUTION FOR WASTE DEMOLISHED CONCRETE

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Abstract

Concrete is mainly used construction material around the world. Different types of concrete have been developed. In case of heavy reinforcement it is very difficult to make sure that whether formwork gets completely filled, compacted. This problem can be sort out with Self Compacting Concrete(SCC) Self Compacting Concrete is the kind of concrete which does not require vibration at the time of placing, also it is having the capacity to flow in congested reinforcement under its own weight. This study gives an experimental investigation of fresh and hardened state properties of Self Compacting Concrete made with recycled coarse aggregate. In this study tests on coarse aggregates are performed and after that M30 grade of concrete is prepared. Five trial mixes with replacement of natural coarse aggregate with replacement of recycled coarse aggregate in percentage replacement of 0%,25%,50%,75% and 100% are prepared. The effect of recycled aggregate on fresh properties, compressive strength properties of SCC is studied in this research. All the tests gives satisfactory results. It is observed that recycled aggregate can be used in the production of Self Compacting Concrete (SCC) without any significant reduction in its properties.

Introduction:-

Self -Compacting Concrete is a type of concrete for which vibration does not require at the time of placing and compaction, also it is having the capacity to flow in congested reinforcement under its own weight[6].It is also known as Self-Leveling concrete, Self- Consolidating Concrete and High Fluidity Concrete.The history and development of self- compacting concrete is divided in two stages. Initial development was in Japan in the late 1980's and its sequent introduction into Europe through Sweden in the mid-to-late 1990's[4]In the beginning of 1983,there was a problem of durability of concrete structure in Japan. For making durable concrete, concrete requires compaction but due to gradual decrease of skilled labours in Japan's construction industry there was a major issue of concrete durability and with that quality of construction reduced. Then they got solution for durable concrete as Self compacting concrete, without vibration it can be compacted by its own weight. In 1986,Okamura proposed the need of Self Compacting Concrete.[5] SCC was first created in Japan in the year 1988 to accomplish more durable concrete structures by progressing quality obtained in construction process.[4]The studies to create self-compacting concrete with fundamental study on workability was done by Ozawa &Maekawa at University of Tokyo(Ozawa 1989,Okamura 1993 and Maekawa 1999).[8]Self Compacting Concrete was developed from

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underwater concretes and high workability concretes where the additional cohesiveness is required.The First research studies in Japan on Self Compacting concrete was concentrated on super-workable and high performance concretes with their fresh properties like filling ability,flowing ability and segregation resistance.[4]

Fast infrastructure development requires a large quantity of construction materials, land requirements & the site. Use of natural resources in construction affects the cost of project. Also Environment protection is a main factor which is directly connected with the survival of the human.Various contents like environmental consciousness, protection of natural resources, sustainable development play vital role in modern requirements of construction works. Due to modernization, demolished materials are dumped on land & not utilized for any purpose. Such situations affect fertility of land. So in such a situation if we use recycled materials that will help to lower the budget of construction in some extent and also it is beneficial to environment protection point of view.There may be deficiency of natural aggregates in coming years so it will affect concrete construction. Waste concrete can be recycled by a very simple process as breaking, removing and crushing to desired size and quality. So recycled aggregates have added benefit of decreasing landfill disposal, while conserving primary natural resources and lessening transportation costs, help to promote sustainable development in protection of natural resources

Case Studies:
Various cases studies on SCC using by varying water cement ratio, using different kind of ingredients like recycled aggregate, waste materials like demolished concrete ,nano materials, and behavior and properties of SCC are briefly discussed subsequently.

Shamsad Ahmad, Abul Kalam Azad and Mohammad Abdul Hammed (2008)[21] studied the use of marginal aggregates for producing SCC.As Self compacting concrete was not introduced in Saudi Arabia's construction industry. So they have studied SCC with aggregates which are locally available. In eastern locale of Saudi Arabia most of the coarse aggregates are smashed tertiary stage weaker dolomitic limestone. That aggregates are having the properties like porous, highly absorptive, soft and excessive dusty are considered as "Marginal". They have utilized aeolian dune sands which are found in coastal regions as source of fine aggregate. They have studied wet-dry and heat-cool cyclic exposures on hardened properties of SCC. Heat cool cyclic exposure means heating the specimen in oven at 40^0C. for 2days and then cooling them at room temperature for 2 days. Wet-dry cyclic exposure means wetting the specimen with water for 2 days and then drying them in an oven at 30^0C for 2days.The reason behind cyclic exposure procedure is to examined damaging impact of heat cool and wet dry cycles on SCC. After completion of cyclic exposures specimens were tested for properties like water absorption, compressive strength, rapid chloride permeability, water penetration depth, water permeability and drying shrinkage.Compressive strength, rapid chloride permeability, water absorption, depth of water penetration and water permeability test were carried out after around four months of presentation. Specimens were damp cured for 28 days to begin with at that point subjected to ordinary wet dry and heat cool cycles.The results were obtained as compared to compressive strength of specimens exposed to normal conditions, the compressive strength of specimen exposed to wet dry and heat cool conditions were higher by about 6% and 14%respectively. The water absorption and water penetration in the samples uncovered to wet dry conditions is less and heat cool conditions is more than that of specimen exposed to normal conditions. According to depth of water penetration measured the specimens exposed wet dry conditions corresponds to low permeability and specimen exposed to heat-cool and normal conditions corresponds to moderate permeability. According to criteria to set by concrete society water permeability found lesser as compared to maximum permissible limit of water permeability coefficient for conventional concrete. The chloride permeability for all examples found to be exceptionally low concurring to ASTM C1202 criteria.

S.Salkhordeh,P Golbazi,H Amini(2011)[19]studied improvement in compressive strength by adding Nano silica in the mixture of SCC with varying percentage of recycled aggregate .In this study two series of mixes were prepared with different percentage of fine recycled aggregate and different water binder ratio with 100% coarse recycled aggregates. In series I,0.50 water binder ratio, and recycled fine aggregate were replaced with river sand in the percentage of 0%,20%,40%,60%,80% and 100%and no fly ash were added. In series II,0.45 water binder ratio were used, fly ash were added. Also 10% Nano silica was added in replacement with cement weight. As like series I fine recycled aggregate are added in the replacement percentage of 0%,20%,40%,60%,80% and 100% with river sand. In series I compressive strength results were obtained as by adding Nano silica the compressive strength increased. The most noteworthy compressive strength were gotten by 20% substitution of fine aggregate and in series II compressive strength comes about appears that tests of 20% and 40% fine aggregate substitution gives higher

compressive strength. So less percentage of fine recycled aggregate and by adding Nano silica increases the compressive strength.

O.Gencel, C Ozel, W Brostow, G Martinez-Barera(2011)[16]In this study **,** mechanical and workability properties of Self Compacting Concrete with fly ash with monofilament polypropylene fibres were examined. For investigation of fresh state properties of SCC like Slump flow, J-ring, air content and V funnel test were conducted and for hardened properties unit weight, compressive strength, splitting tensile strength, flexural strength, pulse velocity and elasticity modulus of concrete were carried out. For this study, two different cement contents at 350kg/m^3 and 450 kg/m^3 were taken and four different fibre contents at 3,6,9 and 12 kg/m^3 were used. Result shows that increasing content of fibres air content gets increased. Up to 9 kg/m^3 fibre inclusion has provided satisfactory results. Fibres in this study have very flow and workability in all mixtures. With addition of polypropylene fibres unit weight and pulse velocity of concrete decreases and elasticity modulus, split tensile ,compressive and flexural strength have been increased.

Mehtab Alam, Gaurav Singh, BeshBahaa,MohammadNasimSahar(2013)[13]studied comparison of fresh and hardened concrete with natural aggregate and SCC with 100% substitution of natural aggregate with recycled aggregate. Two sorts of concrete mixes were made one totally with fresh coarse and fine aggregate and other with 100% substitution of coarse and fine aggregate with Recycled Aggregate Concrete(RAC).For expanding strength Recycled Aggregate Concrete (RAC) distinctive amounts of GGBS were included. To discover fresh properties Slump flow ,J ring, U box, L box and V funnel test were conducted. Also along with fresh concrete tests compressive strength test , non-destructive testing like Ultrasonic pulse velocity meter, rebound hammer were conducted. As per obtained test results it is shown that the recycled aggregate concrete is stronger than fresh aggregate concrete. With increasing amount of GGBS the values of rebound hammer and ultrasonic pulse velocity increased.

Murat Tuyan,Ali Mardani-Aghabaglou,Kambiz Ramyar(2014)[14] examined impact of recycled coarse concrete aggregate on mechanical performance, freeze thaw resistance, and transport properties of Self compacting Concrete (SCC).In this research coarse crushed limestone aggregate replaced in the percentage of 0%,20%,40% and 60% with RCA. For that twelve different samples were prepared with three different w/b ratio and their properties like mechanical, freeze- thaw resistance and transport properties were examined. For testing fresh properties slump flow test ,T50 cm flow time, V funnel flow time,5 min delayed V funnel flow time, L box passing ratio and L box flow time tests were performed and for hardened concrete properties compressive strength, Splitting tensile strength and ultrasonic pulse velocity test were performed on 28 day old specimens. Also to determine durability properties sorptivity test, chloride ion penetration, freeze thaw resistance conducted. Slump flow test values got as per EFNARC guidelines. The result shows that dosage of super plasticizer increased slightly with an increase in RCA content. The flow time measured by T50cm,V funnel and L box test method are related to viscosity of mixture. With increase in RCA content viscosity of mixture increased. By L-box test passing ability of SCC can be determined. The passing ability decreased by decreasing super plasticizer dosage .With decreasing w/b ratio compressive strength get decreased. The compressive strength values increased upto 40% replacement of RCA. With increase in RCA content splitting tensile got decreased. Also ultrasonic pulse velocity(UPV) test values slightly decreased with increasing amount of RCA and w/b ratio. The water absorption rate increased with increasing amount of RCA content and increased with increasing w/b ratio.With increasing w/b ratio chloride ion penetration increased.

L.A Pereira-de-oliveira,M C S Nepomuceno,J P Castro-Gomes,M.F.C.Vila(2014) [12] investigated durability properties of self compacting concrete with 20%,40% and 100% replacement of natural aggregate with recycled aggregate. Slump flow test and V funnel test were conducted to determine rheological properties in fresh SCC. The mechanical properties of hardened concrete were evaluated by density, compressive strength and ultrasonic pulse velocity test at 7 and 28 days. Durability properties of SCC were determined by capillary water absorption ,water and air permeability at 28 days. In fresh properties testing it is noted that as amount of recycled aggregate increases there should be need to add more amount of super plasticizer. There was a small loss of densities as amount of recycled aggregate increased. Modulus of elasticity and Compressive strength got decreased with increasing addition of recycled aggregate.

V. SaiKrishnamohan Chowdary (2015)[24]studied flexural bond strength of Fibre Reinforced Self Compacting Concrete with substitution of normal aggregate with recycled aggregate. In this study replacement of normal

aggregate with replacement of RCA in range of 25% to 60% with an increment of 5% were conducted. The material used for this study are cement, fine and coarse aggregate, water, super plasticizer, mineral admixtures like fly ash and blast furnace slag , steel fibres of diameter 0.92mm,recycled concrete aggregate(RCA) obtained from destruction of aged and deteriorated construction. Slump Flow,T50cm slump flow, V funnel , t5min V-funnel and L-box test were conducted to evaluate fresh properties of SCC. For hardened concrete, Tensile, flexural and compressive Strength test were conducted. Optimum strength gained after curing period of 7,28 days is at 35% replacement and lowest strength is at 60% replacement of RCA.

Aswathy P. U., Mathews M Paul (2015) [2]this paper represents behaviour of SCC with increment of bottom coal ash partially substitutes with fine aggregate. The replacement percentage of coal ash to fine aggregate is 0% to 30% with increment of 5%.Fresh properties like slump flow,T500,V-funnel test and hardened properties like split tensile, flexural and compressive strength also modulus of elasticity were investigated. Fresh state properties achieved satisfactory results as per EFNARC with increased addition of coal ash modulus of elasticity, compressive , flexural and tensile strength gets decreased.

V Karthik, Dr G Baskar(2015) [23]In this study by product obtained from manufacturing of copper metal means copper slag was partially replaced with fine aggregate in self compacting concrete to check its workability and durability. The percentage substitution of fine aggregate with copper slag of 20%,40%,60% and 80%.For conducting workability investigation tests like Slump flow,T50,V-funnel, J-ring and L-box test were carried out and durability properties with sulphate attack acid and corrosion resistance. From the investigation it is clear that copper slag at 60% replacement with fine aggregate gives optimum result. Due to attack of sulphuric acid these will be more reduction in strength than sulphate.

N Singh, S P Singh(2016) [15]investigated carbonation resistance, compressive strength and ultrasonic pulse velocity values of SCC with recycled aggregate. For conducting tests five trial mixes of 0%,25%,50%,75% and 100% replacement of natural coarse aggregate with recycled coarse aggregate were prepared. Based on the results, noticed that compressive strength of all mixes decreased with increasing amount of RCA. Also ultrasonic pulse velocity test values reduces with increment in RCA content.

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G.C.Behrera, R.K.Behera (2016) [7]In this study, fresh properties and hardened state properties of SCC with replacement of natural aggregate with aggregate obtained from blast furnace slag in the percentage of 0%, 10%, 20%,40% and 60%. Fresh properties tests like slump flow,T50cm, V funnel, T5 min, L box test and for hardened properties, compressive strength split tensile strength & flexural strength were carried out. Fresh properties report gives satisfactory results. Also with increase in slag aggregate content compressive strength,Split tensile strength, flexural strength increased. For all the mixes about 60% replacement gives satisfactory results.

Ramesh, Seetharaman Munnur(2017) [18]Robosand is a product of crushed stone and cinder is a naturally obtained light weight rock which is of igneous origin. In this paper self- compacting concrete is prepared with substitution of robosand in place of natural sand with the percentage of 25% and 30% and coarse aggregates were replaced in the percentage of 0%,10%,20%,30%,40% and 50% with Cinder. Seventy Eight cubes ,cylinder and prisms were tested for split tensile, compressive and flexural strength of Self compacting concrete. Result shows that 40% substitution of cinder in place of coarse aggregate and 25% substitution of robosand in place of natural sand gives maximum strength which is more than normal SCC. Also 30% substitution of coarse aggregate by cinder and natural sand by robosand gives maximum compressive strength which is also more than normal SCC. The Split tensile strength of SCC with substitution of 30% robosand and 40% coarse aggregate by cinder gives good strength than normal SCC. With replacement of 30% natural sand by robosand and 50% replacement of coarse aggregate with cinder gives increased compressive strength with the comparison of normal SCC.

Jagadeesh M,Bhuvaneswari R,Prithwini B (2017) [10]In this study M-sand and clay roof tile which is recycled were taken as replacement percentage of 0%,10%,20%,30% with natural sand and aggregate.Fresh properties like slump flow,T50,V-funnel and t5min,J-ring,L-box and U-box tests and hardened properties like compressive strength and split tensile strength were examined.30% replacement of recycled clay roof tile and natural sand given better results in each tests.

Srikanthan L, Ramya B.L, Kalaivani M, Maheswari.S, Iyyappan A P (2017)[22]In this study rice husk was used in the substitution of fine aggregate in the percentage of 0%,10%,20% and 30% SCC tests like Slump flow test,L-box test

and V funnel test and hardened concrete tests like compressive, split tensile strength tests were performed. High performance superplasticizer Structuro 203 were used for preparation of SCC mixes.Only normal SCC mix with 0% rice husk gives favourable result and 10%,20% and 30% replacement of natural aggregate with rice husk are not achieved SCC conditions on fresh concrete.0% rice husk gives higher compressive strength, split tensile strength than other SCC mixes with rice husk. Use of husk of rice as with partial substituttion of fine aggregate did not gives satisfactory results in both state.

Khaled M Heiza, Fatma M.Eid, Taha Masoud (2017) [11]In this study coarse light weight aggregate used. This aggregate was created by the process expanding selected clay and vitrifying that clay in rotary kiln. This research work were performed in two phases. In phase I, experimental investigation of fresh properties and hardened state properties of concrete were conducted and based on that the best mix which achieve the properties of light weight concrete and self compacting concrete selected for further investigation. In further investigation with selected mix studies the effect of different reinforcement ratio of two way slab reinforced by welded wire mesh with
different diameter of wire. In phase I, fresh properties like V-funnel flow time, Slump flow, J ring flow diameter/height difference and hardened properties like unit weight and compressive strength were evaluated. Six mixes C1, C2, C3, C4, C5,C6 were design with different w/c ratio 0.28, 0.3, 0.32, 0.35. The results of fresh state properties found that, slump flow values increase with increase in percentage of water cement ratio, with increase in water cement ratio V funnel flow time values decreased and with decrease in w/c ratio compressive strength get increased and all mixtures unit weight have given satisfactory result. After phase I investigation the best mixture with best strength No. C4 means with 0.3 w/c ratio mix were taken for further investigation. For phase II three slabs (A1,A2&A3) casted using wooden mould with same thickness with different thickness of wire mesh (3mm, 4mm, & 5mm).Four point loading system were adopted for conducting test, flexural loads & deflection were analysed and concluded that increase in thickness of wire mesh, the performance of slab increases.

Yasser Khodair, Sameed Ahmed Osman, Ahmed Towfeequllah Siddiqui (2017) [25]In this study recycled asphalt pavement (RAP) and supplementary cementations materials like fly ash, ground granulated blast furnace slag. Fresh properties like slump flow, T50, J ring seggregation index. Hardened properties like compressive strength ,tensile strength and durability properties like unrestrained shrinkage test, rapid chloride permeability test Sixteen mixtures divided into four groups with replacing recycled asphalt pavement in the percentage replacement of 0%,15%,30% and 55% and replacing cement with 60% fly ash with 60% GGBS and combined 30% fly ash and 30% GGBS with constant w/c ratio of 0.4 for all mixes. Result shows that with adding amount of RAP, compressive strength & tensile strength decreases and increases permeability resistance. This study concluded that RAP can be utilized as an replacement for coarse aggregate & it is cost effective solution.

Athulya Sugathan(2017) [3],Study was performed to investigate fresh properties and hardened state properties of self compacting concrete reinforced with sisal fibers. In that study author used different percentage of Sisal Fibres which are obtained from sisal plant having properties like strength, durability, ability to stretch, resistance to deterioration in salt water etc. With water cement ratio 0.31.M40 grade of concrete were used. Specimens were examined for compressive and tensile strength for 7 days , 28 days of curing and for analyzing fresh propertiesT500 and slump flow test, , V funnel test, L box test were performed. Different percentage of super plasticizer were also used for conducting test. Sisal fibers were added in the percentage of 0.5%,1%,1.5% and 2% and super plasticizer added in the percentage of 0.15%,0.2%,1% and 2% .Result obtained as ate 1.5% of adding fibres in specimen gave maximum tensile strength and compressive strength after that there will be decrease in strength. Optimum percentage of super plasticizer was obtained to be 1%.Also addition to some quantity of sisal fibre found not to affect workability.

Prabhat Singh, Mohd Oswan, Awdhesh Chandramauli, Dinesh Kumar (2018)[17].Fresh properties and hardened properties of self compacting concrete with three different samples. Sample A is conventional concrete, sample B,concrete with replacement of cement by 15% fly ash and sample C is substitution of cement with 10% silica fume and water cement ratio is 0.53.Fresh concrete tests like T50,V-funnel,L-box,U-box,slump were conducted and result shows that all the three sample given satisfactory result and hardened properties like compressive strength for 7days and 28 days were investigated and three sample gives good.

Ankur Tayal, Sabin Shaji, Pratibha, Kartik Khosla, Keshav Kumar(2018) [1]In this study Four distinctive samples of SCC were prepared with different percentage of coarse aggregate. Cubes were casted at 0%,15%, 30%, 50% of RAP and compressive strength were tested for 7,14 , 28 days of curing. M30 grade of concrete were. used, Result shows

that with increase in the percentage of asphalt recycled pavement aggregate, compressive strength gets decreased and for obtaining adequate strength maximum 30% replacement can be done.

Idowu H, Adebakin, K.Gunasekaran&R.Annadurai (2018) [9]in this research durability and mechanical properties of Self Compacting Concrete by using discarded shell of coconut as coarse aggregate and ordinary Portland cement is partially in replacement by fly ash is carried out. For mechanical properties, tests like elastic modulus, density , splitting tensile strength, compressive and flexural strength were conducted and for durability properties, tests like sorptivity,water absorption, rapid chloride penetration tests and volume of permeable voids test were conducted. All the results has given satisfactory results. Research concluded that shell of coconut can be utilized as coarse aggregate. So that coarse can be reduced as well as it will promote for creating cleaner environment.

Saif I Mohammed, Khalid B Najim (2020)[20]in this research three contents such as recycled aggregate(Coarse and fine aggregate) and super plasticizer were examined withdifferent percentage replacement. The aim of this research is to investigate the use of recycled aggregate which are produced from tested concrete specimens. Also structural behavior with different percentage of recycled aggregate content and toughness and flexural stiffness of RC beams were studied. Test result shows that increased in recycled concrete aggregate content decreases compressive strength, splitting and flexural strength also modulus of elasticity slightly decreases. In comparison with normal SCC beams, SCC beams with recycled concrete aggregate content noted to be deteriorated.

Methodology Adopted:

The materials utilized in the present study are cement, fly ash, sand, natural coarse aggregate and recycled coarse aggregate. All these materials are tested within research facility to investigate their physical and mechanical properties as per the Indian Standards specification. Different characteristics of the materials like surface texture and shape, water absorption, particle size distribution, specific gravity, impact value, bulk density of aggregates have been tested. Concrete Mix Design was carried out for M30 grade concrete according to European countries founded European Federation of National Associations Representing for Concrete (EFNARC) design guidelines. The fresh and hardened properties of SCC such as Slum Flow test,T50cm slump flow,V-funnel Test and V funnel test at T5 min,L box test, compressive strength of concrete using recycled coarse aggregate were studied.

Preparation of Fresh Self Compacting Concrete In The Laboratory:

The methods of batching, mixing of concrete in the laboratory. Batch is the quantity of concrete mixed in one cycle of operations of a mixer.

Batching:

The quantity of concrete in each batch shall be at least 10% more than that required for the test. For each batch, cement, fly ash, fine aggregate, coarse aggregate, super plasticizer and water shall be weighed as per design.

Mixing:

All the aggregate including recycled aggregate are soaked in water before use .Before using the mixer any fresh concrete remaining from a previous batch is cleaned out. No free water remain in the mixer. If the mixer is dry then it should be wiped with damp cloth before use. The mixer is charged with one half of the coarse aggregate, then with the fine aggregate, then cement, fly ash and finally with the remaining coarse aggregate. All the water is added during the first 30seconds of mixing. Mixing continues after all the materials and admixture have been added for at least two minutes until the concrete appears to be uniform and homogenous.

Testing of Fresh Concrete:

After mixing of concrete it is checked for its characteristics like passing ability, filling ability and segregation resistance. Slump Flow Test and T50cm test are used to assess filling ability and segregation resistance. V-funnel Test and V funnel test at T5 min test carry out to determine the filing ability or flow ability of concrete. L box test is performed to examine the flow of concrete and also extent to which the concrete is subjected to blocking by reinforcement.

Strength Investigation:

After testing of fresh concrete it is filled in mould for casting. For each mix three different cubes were casted for 7 and 28 days to determine compressive strength.

Test Results:

The results are focused on the properties of coarse aggregate and performance of self compacting concrete with recycled coarse aggregate. The results presented here in Table 1 and fig 1a,1b,1c,1d,1e are regarding the properties like fineness modulus , specific gravity, water absorption, bulk density , impact value of normal and recycled aggregate.

Table 1:- Properties of Coarse Aggregate

Particulars	Noramal/Natural Aggregate	Recycled Aggregate
Fineness Modulus	2.63	1.36
Specific Gravity	3.08	2.35
Water Absorption	0.7%	5.96%
Bulk Density	1334.8kg/m3	1196 kg/m3
Aggregate Impact Value	17.58%	24.79%

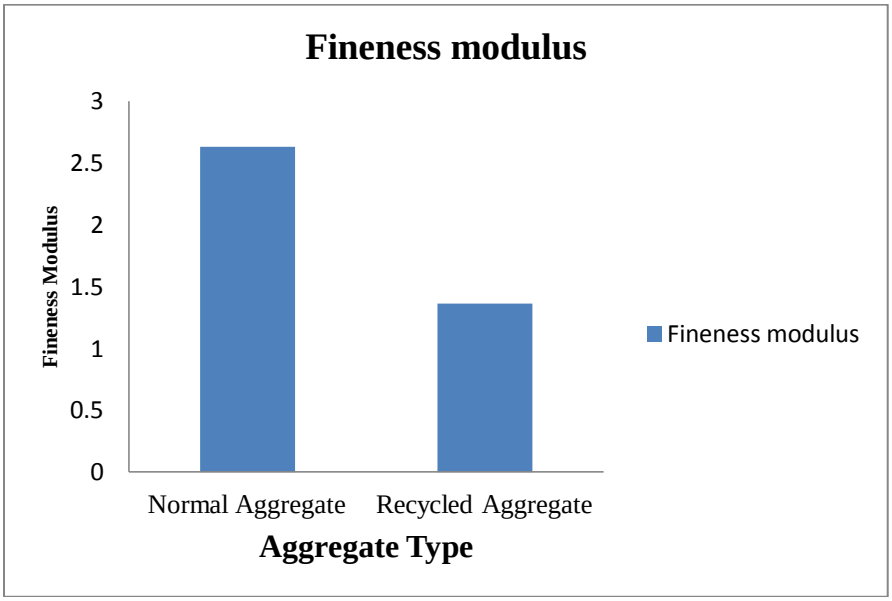

Fig 1a:- Fineness modulus of Normal and Recycled Aggregate.

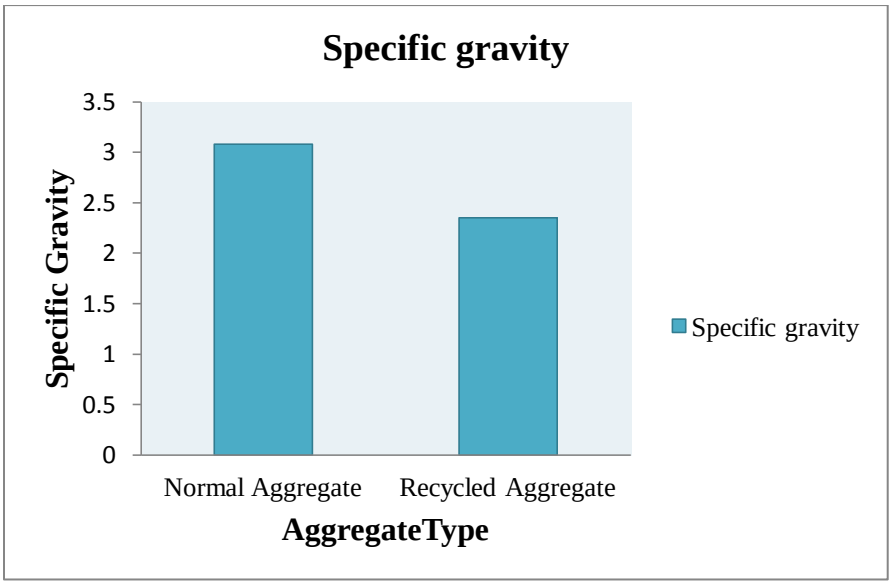

Fig 1b:- Specific gravity of Normal and Recycled Aggregate.

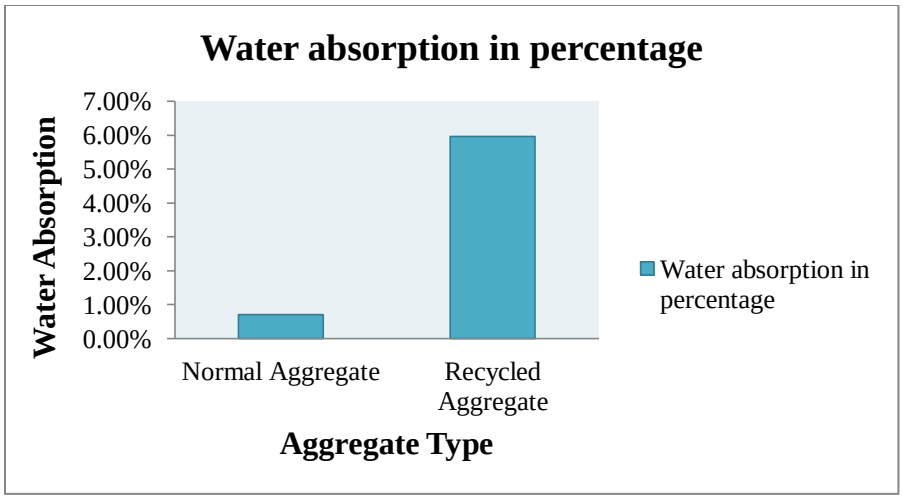

Fig 1c:- Water Absorption of Normal and Recycled Aggregate.

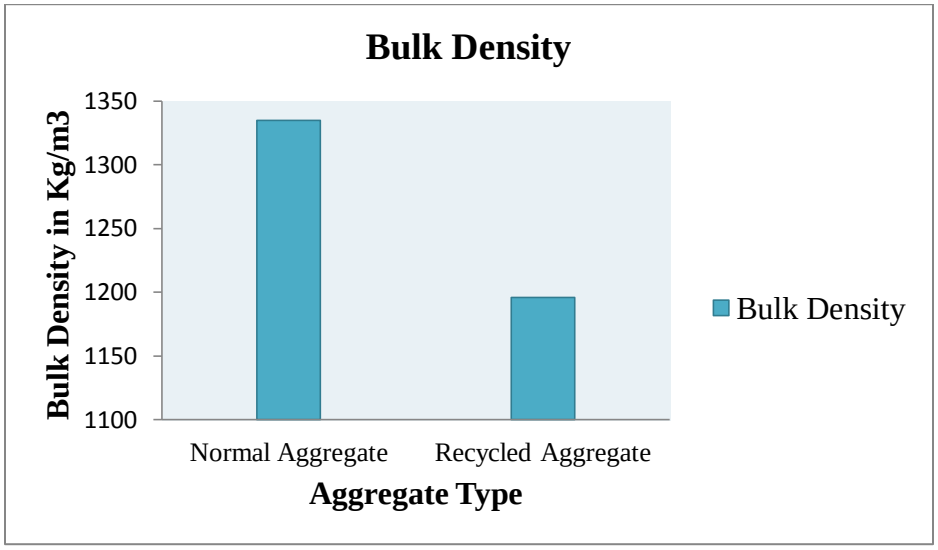

Fig 1d:- Bulk Density of Normal and Recycled Aggregate.

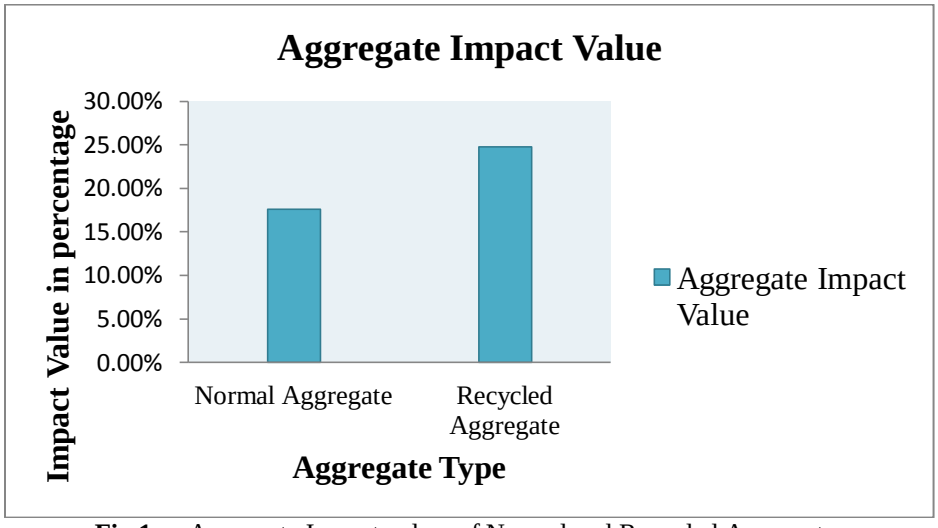

Fig 1e:- Aggregate Impact value of Normal and Recycled Aggregate.

Aggregate test results show that:

1. Shape of recycled aggregate are irregular, mostly with angular shape, rough and with somewhat cracked surface and porous and normal aggregate are well rounded ,smooth to angular and rough surface.
2. Fineness modulus of normal aggregate is 1.93 times more than the recycled aggregate.
3. Specific gravity of normal aggregate is more than that of recycled aggregate.
4. Water absorption test results shows that water absorption of recycled aggregate is 8.51 times more than normal aggregate.
5. Bulk density of recycled aggregate is less compared to normal aggregate.
6. Also recycled aggregate has more impact value than the normal aggregate.

Along with coarse aggregate tests after mixing of Self Compacting Concrete with various percentage of recycled aggregate replacement with normal aggregates its fresh state properties such as slump flow,T50cm slump flow, V-funnel, L box were tested .Table 2 Shows the fresh state properties of Self Compacting Concrete results

Table 2:- Fresh state properties of SCC.

Sr No	Mix Type	Slump Flow (mm)	T50 Slump Flow (Sec)	V-funnel (sec)	L-box
1	30R0	690	3	10.32	0.82
2	30R25	680	3.47	10.63	0.86
3	30R50	670	3.82	10.90	0.90
4	30R75	665	4.93	11.45	0.96
5	30R100	645	5.24	13.11	0.98

Above table shows results of fresh concrete testing. All mixes shows slump flow values in the range of 645mm to 690mm. Slump flow values decreased with the addition of recycled aggregate. T50cm slump flow time ranges from 3sec to 5.24sec.It gives viscosity of concrete mix. V-funnel test ranges from 10.32sec to 13.11sec.With the addition of recycled aggregate V-funnel time also increased. L-box test shows values in the range of 0.82 to 0.98.All the mixes satisfies fresh properties of self -compacting concrete as per EFNARC values except 30R100 where concrete is made with 100% replacement of coarse aggregate by recycled coarse aggregate.

Also for assessing hardened properties of concrete, compressive strength test were conducted. Compressive strength test results show that after 7 days mixes with replacement percentage of recycled coarse aggregate gained more than 90% of strength what they have attained at the age of 28 days. Compressive strength result values of self-compacting concrete with recycled coarse aggregate are more than that of self -compacting concrete with natural(normal) coarse aggregate. Also with 50% replacement of natural aggregate with recycled aggregate attains maximum strength. Table 3 and Fig 2 show the details of compressive strength test results.

Table 3:- Compressive Strength Test.

Sr No	Mix Type	7daysStrength (N/mm^2)	28daysStrength (N/mm^2)
1	30R0	20.08	35.54
2	30R25	38.36	48.80
3	30R50	42.46	56.69
4	30R75	37.50	52.40
5	30R100	27.66	41.96

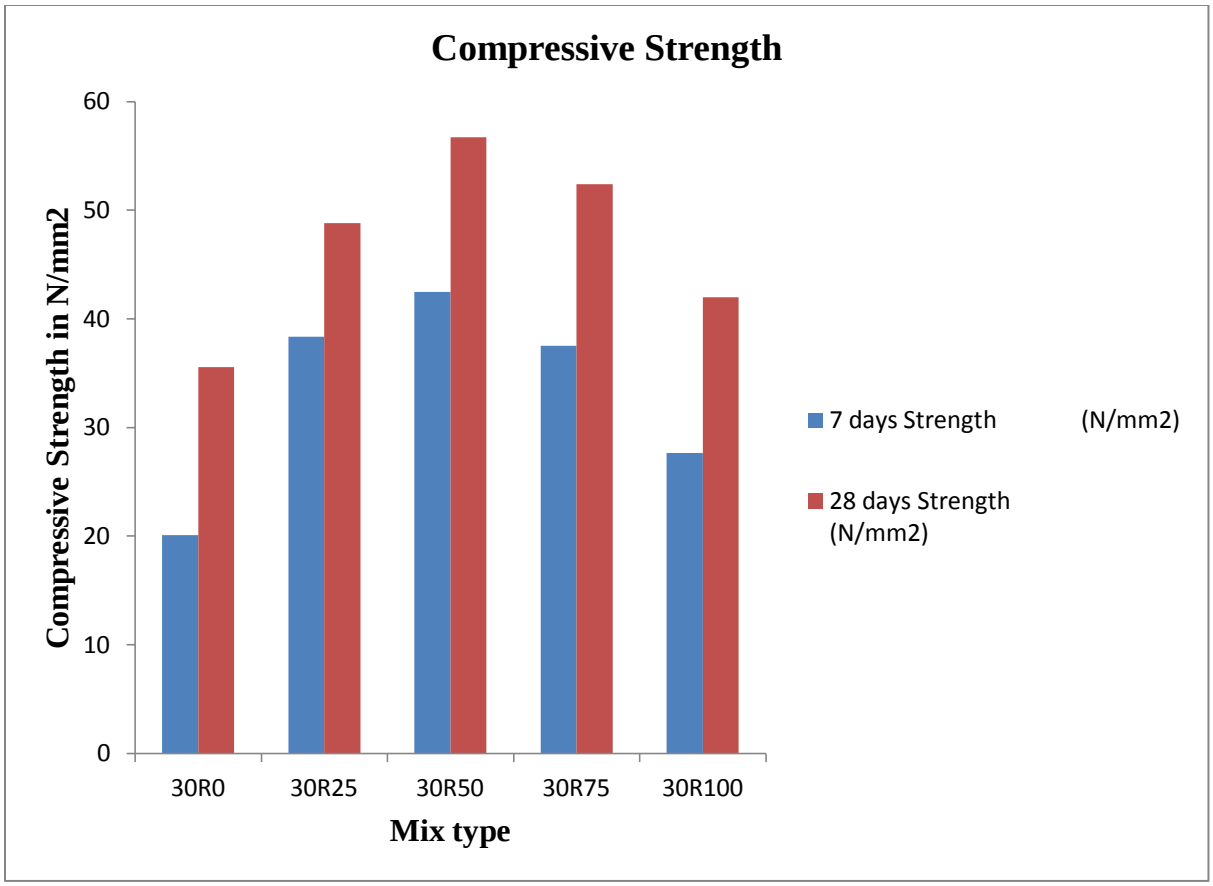

Fig 2:- Compressive Strength test.

Conclusion:-

From the present study, the following conclusions are arrived:

As compared to normal aggregate, recycled coarse aggregate has lower specific gravity, fineness modulus, bulk density and higher water absorption, impact value.

Fresh state properties of self compacting concrete has shown negligible effect with incorporation of recycled coarse aggregate.

Self compacting concrete with 50% replacement of coarse recycled aggregate shows higher water absorption than other two mixes.

Compressive strength of self compacting concrete with normal aggregate is less as compared to self compacting concrete with recycled aggregate.

At 50% replacement of recycled aggregate, compressive strength of self compacting concrete shows maximum strength. Upto 50% replacement of coarse recycled aggregate, strength gets increased and after that there is decrease in compressive strength at 7 and 28 days.

All the mixes gained more than 90% of strength at the age of 28 days.

Hence it is concluded that use of recycled aggregate can be considered as feasible solution for waste demolished concrete.

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