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Explotary Probe On Strengths And It's Properties Of Reprocessed Aggregate Concrete

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Abstract: *The present work has done in two parts. In the first part the physical and mechanical properties of coarse aggregate mix with different proportions of recycled coarse aggregate were determined and compared with the properties of natural coarse aggregate. The second part deals with the determination of the mechanical properties of the concrete with varying percentage of replacement levels of recycled coarse aggregate and also the comparison of these properties with that of concrete made with 100% natural coarse aggregate. The recycled coarse aggregate from the concrete demolition waste obtained from a local construction site were used for the present study. The replacement level of 20%, 40% and 100% were tried. For the replacement level of 20%, all the properties were maintained to a comparable level but over 20% a considerable change in the properties and also a reduction in the various strengths of concrete were observed.*

Background: *Aggregate is a term for any particulate material. It incorporates rock, smashed stone, sand, slag, recycled concrete and geo-engineered aggregates. aggregate might be characteristic, fabricated or recycled. aggregates make up somewhere in the range of 60 - 80% of the concrete mix. They give compressive strength and mass to concrete. aggregates in a specific mix of cement are chosen for their sturdiness, quality, functionality and capacity to get completes .For a decent concrete mix, aggregates should be perfect, hard, concrete particles free of retained synthetic compounds or coatings of dirt and other fine materials that could cause the weakening of cement. aggregates are isolated into either 'coarse' or 'fine' classifications. Coarse aggregates are particulates that are more prominent than 4.75mm. The typical range utilized is in the vicinity of 9.5mm and 37.5mm in distance across. Fine aggregates are typically sand or pounded stone that are under 9.55mm in measurement. Ordinarily the most widely recognized size of aggregate utilized as a part of development is 20mm. A bigger size, 40mm, is more typical in mass concrete. Bigger aggregate breadths lessen the amount of cement and water required.*

Aggregates are utilized as a part of cement for quite certain reasons. The utilization of coarse and fine aggregates in concrete gives huge monetary advantages to the last cost of cement set up. aggregates commonly make up around 60 to 80 percent of the volume of a concrete mix, and as they are the slightest costly of the materials utilized as a part of cement, the monetary effect is quantifiable. Furthermore, the utilization of aggregates gives volume solidness to the solidified cement. The shrinkage capability of a cement paste is very high when contrasted with the aggregates. Controlling shrinkage of the concrete material is imperative since shrinkage and breaking potential increment together. Higher shrinkage potential means all the more splitting when the concrete is limited from development by contact with the construct material underneath a section in light of level, steel fortification inside basic individuals, or contact with connecting concrete individuals in a structure. It is generally acknowledged that water request and cement content in a concrete mix increments as the most extreme coarse aggregates size reductions. The required volume of paste in a concrete mix must increment, because of the expanded surface region of littler aggregate sizes, to coat the majority of the aggregate particles. With this expansion in paste amount there is a decrease of volume of the aggregates per unit of cement delivered, consequently the shrinkage of the blend increments. Once more, an expansion in shrinkage potential joined with limitation of the concrete area may add significantly to splitting. To put it plainly, the aggregates are utilized to enhance economy, yet more imperatively do contribute altogether to the last properties of any concrete mix.

Materials and Methodology: *Here the materials used are Cement, Fine aggregate-(Manufactured sand), Natural Coarse Aggregate, Recycled Coarse Aggregate, Mineral Admixture-Silica Fume, Chemical Admixture-Super plasticizer, Water. These materials then mixed with a particular mix design proportions and then kept for curing. Later the designed shapes are then tested for different tests.*

Results: *After all the tests the results are comparable.*

Conclusion: *These aggregates are reusable and have better implement in civil engineering.*

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I. Introduction

As the population is expanded and there is increment in urban improvement, the reusing the waste development materials winds up imperative. These recycled materials are utilized as a part of our concrete as Aggregate. As recycled aggregate are simple to acquire and its cost is less expensive, this can be utilized as a part of the substitution of regular Aggregate. It has numerous points of interest counting low vitality necessity, use under various natural conditions. The utilization of recycled aggregate end up essential as there is the shortage of reasonable dumping ground. The make procedure of recycled aggregate is a generally straightforward as it includes breaking, evacuating, smashing existing cement in to a material with a predefined estimate. By and large the cost of recycled aggregate might be 15 to 30% lower than regular aggregate. As of late, concrete is the answer for diminish the measure of annihilation squander. In India there is deficiency of infrastructural offices, the arranging commission apportioned half of capital expense for infrastructural improvement in progressive 10 and 11 multi year arrange for which has prompted rise and shortage in cost of development materials. Thus it is vital to begin reusing the devastation concrete waste to spare cost and vitality. There are for the most part two principle ecological effects for utilizing recycled concrete aggregate:

1. Spare the consumption of common assets.
2. Comprehending the emergencies of transfer squander.

A quickly propelling economy and rising ways of life have prodded an amazing increment in foundation what's more, development exercises, prompting an expansion sought after and utilization of natural aggregates. Amid development, a considerable measure of waste concrete (development squander) is regularly created. Likewiseiduring the timeispent urbanization, the old structures whichinever again fillithe need are pulverized and transferi of the destruction flotsam and jetsam in1this way produced is turning intoia noteworthy concern. Be that as itimay, with regularlyiexpanding interest for constructible land, utilization of landfills foritransfer of destruction squander is definitely not a welcome alternative. The expansive scale exhaustion of regular assets for extraction of common aggregates, collection of immense amounts of development and destruction wastei(CDW) prompted scan for a suitable alternative for viable usage of CDW. Smashing of CDW, and age ofi particles of size of normal aggregate for useias substitution ofi natural aggregate in a concrete mix hasibeen perceived asithe most feasible and supportable answer for utilizing the created essentially from smashedi cement concrete, it is called recycled concrete aggregate (RCA). The1concrete made using RCA as called Recycled aggregate concrete (RAC).

The coarse recycled aggregates involves two stages, to be specific the first virgin aggregate andithe followed mortar. The amount of clung mortar impacts to a substantial degree the building, mechanical and solidness properties of aggregate, and RAC. The impact of utilizing coarsej recycled aggregate as a substitution of normal aggregate, on properties of RAC, hasjbeen point of research by many, from consequences of which it was watched that properties of the RAC were lower than those of the Natural Aggregate Concrete (NAC),iwhich has been credited fundamentally due to the followed (porous) mortar.

Concrete, availability and its accessibility, simple arrangement &imanufacture, is thenmost famous growing material. Today, cement concrete is second most used materialiafter waterI(H2O),jwith about 3tons used every years for every individuals onnearth. Because of the tremendous measure of cement being delivered and the immense measure of decimation waste from old used concrete structures, thenrecyle offcement concrete waste by the developmentalsbusiness is winding up progressivelysimperative. Thissis roused not just byethe ecological security, yet in addition by the preservation of normal aggregates assets, the deficiency of waste transfer arrive, and the expanding cost of waste treatment before transfer. In India is evaluated that there are roughly 15.5 million tons of development squander created yearly, Research deal with the utilization of recycled materials is essentially focussed on the utilization of recycledіconcrete aggregate (RCA) and its impact on the properties of the crisp and solidified recycled concrete . RCA is not quite the same as virgin aggregate just due to the followed old concrete and additionally mortar that is appended to the normal aggregate present at the center. The volume portion of followed mortar in a RCA diminishes with the expansion in the ostensible size of RCA. It was accounted that for jRCA with sizes of 4–8 mm, 8–16 mm and 16–32 mm, the volume part of mortar is around 60%, 40% and 35%,lseparately. Despite the fact that it has been a long history to utilize RCA as granular material in asphalt plan, broad research on the execution of RCA in basic applications is just exceptionally late. The utilization of RCA inhhigh execution concrete hasgnot been broadly acknowledged, basically due to the decrease injboth mechanicalhand toughness properties foundasin recycled aggregate concrete. The measurable investigation demonstrated that RCA got from smashed concrete comprises of 65–80 vol% ofhregular coarsefand fine aggregates and 20–35 vol% of old concrete paste. It was accounted for that the mortar in RCA adds to a brought down relative thickness and higher water ingestion than virgin aggregate. The higher part of joined mortar and weaker interface between aggregate what's more, mortar in RCA prompt lower concrete quality, for example, low compressive quality and poor strength. It was additionally detailed that the utilization of RCA drives cement to have higher shrinkage and crawl strains. It was recommended that a decent RCA should meet certain criteria in request to be appropriate for use in fortified cement. These incorporate a aggregate specific gravity of 2.3 or higher, a most extreme mortar substance of half, and a most extreme water absorption of 3%. Some training codes limit the utilization of RCA with water retention limit more noteworthy than 7– 10% to be utilized as a part of basic cement.

The enthusiasm for utilizing recycledgmaterials got from development and obliteration waste(C&Dwaste) is developing everywhere throughout the world. Notwithstanding environmental assurance, preservation of common assets, lack of land foriwaste transfer, and expanding costsgof waste treatment preceding transfer are the main factors drivinghthe reusing idea. In India, the development business delivers around 37 to 100 tones ofhC&D waste each day, whichiis about four times higher than thathof civil strong waste. Shortage ofhland for new landfills & the culmination of the significant recovery extends sooner rather than later in India are the main factors that empower analysts to discover elective employments of the C & D waste. Utilizing recycled C&D wastehas concrete aggregate maykeffectively limit the measures ofjC &D waste required tojbe discarded. Our experience demonstrated thatkconcrete strength in the scope of 35– 50 N/mm^2 can without much of a stretch be achieved by utilizing recycled concrete aggregates By and large, recycledsaggregates got fromiwaste cement concretescomprise of 655–270% by volume offnormalgcoarse furthermore,jfine aggregates, and 30– 35% by volume ofhold cementmpaste. The last is more permeable than the previous. Thus, recycled aggregates are for the most part inhomogeneous, not so much thick but rather more permeable when contrasted with common aggregates. Normal waste aggregates utilized as a part of India have a Density of roughly 2600– 2650 kg/m^2 & waters absorption limit offroughly 1i%. For recycledsaggregates,hdue too thennearness offa lot offfollowed cementspaste, their Density mayhshift from 22000 to24000 kg/m^2 & the water absorption limit may fluctuate from15 to 8%. The varieties in density & water absorption limit are because ofhthe distinctions inhproperties of the oldsconcrete fromswhich thehrecycled aggregatessare determined. Clearly, highsquality cements that haveabeen preparedswith anlowhwateri_to_fasteneri(wi/b)proportion withsthe utilization ofipozolanic added substances likehsilica powder are denser furthermore, less permeable than typical quality cements arranged with higher w/b proportions.

II. Material And Methods

This prospective study was carried on the waste aggregates with full of all the test conduction with accurate results.

Study Design: Prospective properties of the aggregates and Mix Design

Study Location: This was done in Department of Civil Engineering, at Secab Institute of Engineering and Technology, Vijayapur, Karnataka

Procedure and Methodology with Results

PERUMAL'S METHOD OF MIX DESIGN FOR HIGH STRENGTH

CONCRETE

- **Targetsmeans strengths:**

Targets meansstrengths $\overline{f_{ck}}$ isacalculated asifollows:

$\overline{f_{ck}}$ = f_{ck} + (t x s) withsusual IS notation. Whennadequate data areanot available tooestablish, thenf_{ck} value cantbe determined from themfollowing table 3.9 given by ACI report 318.

Tab.3.9: **Targetsmeansstrengths as ACI report 318**

SpecifiedsCharacteristicsCompressive Strengths, f_{ck}i(iMPas)	TargetsmeansCompressivesStrength, $\overline{f_{ck}}$ (MPa)
Less thant20.555 20.55 –134.555 More thant34.555	f_{cki} + 6.99 f_{cki} + 8.33 f_{cki} + 9.77

- **Selection offmaximum size offcoarse aggregatef:**

The maximum size offthe coarses aggregate issselected from themfollowing table 3.10 asi given byeACI Report 211.4R.933.

Tables.3.10: **Maximum sizesoffcoarse aggregate ashper ACI reports**

CharacteristicssCompressivessStrengths, f_{cki}(iMPai)	Maximumsaggregatessizes (immi)
Less thana6222 Greatersthan oreequalstoo62	200 – 250 100 - 12.50

- **iEstimationsofffree waterscontents:**

Thenwater contentstoo obtainsthendesired workability depends upon thenamountsoffwaters & amount offsuperplasticizer & itz characteristic. However, thensaturation point offthe super plasticizer isiknown, & then thenwater dosage isiobtained from themfollowing table 3.111Iffthensaturation point isinot known, it isssuggested that anwater contentsoff1500 liters / m3 shall beetaken toostart.

Tablei.3.111: Determinationsoffminimumswatersdosages

Saturationi Points (%)	0.6	0.8	1.0	1.2	1.4
Waters (1l/m^{3i})	1200-j125	125-135	135-145	145-155	155-165

- **Superplasticizersdosage:**

The supersplasticizer dosage issobtained from thendosage at thensaturation point. If then saturation point is not known, it is suggested that a trial dosage of 1.0% shall be taken to start with.ss

- **Estimations offair contents:**

Thenair contents(approximate amount offentrapped air) toobe expectedsinnHPC iss obtainedsfromithenfollowing tables3.121ashgiven ACI Reports311.4R.93 formthenmaximum size offCAiused. However, ittisisuggested thatsandinitial estimate offentrapped airscontents shall beetaken ash1.5% or less since itsisiHPC, & thensadjusting itsonathenbasis offthenresult obtained with thentrialsmix.

Tablei.3.12: Approximatesentrapped airscontentoas per ACI reports3111

Nominalsmaximumssize offCoarses aggregates(immi)	Entrapped air, as percent of Volume of concrete
100 12.555 200 250	2.55 2.05 1.555 11.0

- **Selections offcoarsesaggregates (iCAj) contents:**

Thencoarsesaggregatescontentois obtainedsfrom the followingstable 3.13 as anfunction offthe typical particle shape. If therenisiany doubt about thenshape offthenCA or iffits shape is not known, itsisisuggested that anCA content 1050 kg /m3 offconcrete shall beetaken toostart with. ThenCAiso selected should satisfy thenrequirements offgrading & other requirements off IS: 383–1970.

Tablei.3.13: Coarsesaggregatescontent perim^3 offconcrete

Coarsesaggregate Particlesshape	Elongateds or Flats	aAverages	cCubics	aRoundeds
Coarsesaggregates Dosages(ikg/m^{3i})	9500-1000	10002-10505	10502-11000	11001-11501

- **Selectionsoffwater-binder (w/b) ratioi:**

Thenwater - bindersratio formthe target mean compressive strength is chosen from fig3.5, thenproposed w /b ratiosVs. compressive strength relationship. Thenw/b rationso chosen isi checked against thenlimiting w /c rationformthenrequirement offdurability ashper table 3.5 offIS: 4562-2000, and the lower of the two value isiadopted.

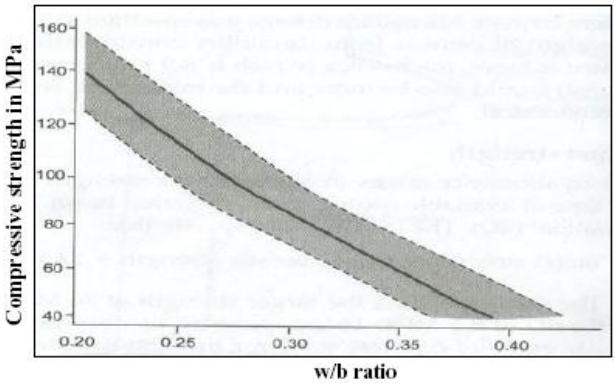


Fig .3.5. Wj/jb ratio vi/is compressive strengthsrelationships

- **Calculations offbinderscontent:**

The binder or cementitiousscontents per m^3 offconcrete isicalculated from thenwi/jb ration& thenquantity offwater content per m^{3i}offconcrete. Thencement contentsso calculated isichecked against thenminimum cementscontentsfor thenrequirements offdurability ashper tables3.1.5 & 3.1.6 of IS:5456-12000 & thengreater offthentwo values issadopted.

- **Estimation of fine aggregate (FA) content:**

Thenabsolute volumesoffFA issobtained from thenfollowing equation:

V_{fa} = 1000 - [iV_w+ j(M_c/iS_c) + (iM_{sf}/jS_{sf}) + (fM_{ca}/fS_{ca}) + jV_{sol}+ lV_{ea}]

Where, V_{fa}= absolute volume offFA innlitres per m^3 offconcretes

V_w= volumesoffwater (litres) per m^3 offconcrete

M_c= massioffcement (ikgi) per m^{3i} ofoconcretes

S_c= sp. gravity offcements

M_{sf}, M_{ca}= Total masses offthen SF & CA (ikg) per m^3 ofe concrete respectively

S_{ca}, S_{sf}= sp.gravities offsaturated surface dry coarse aggregate & silica fume respectively,

V_{ea}= Vol. off thenentrapped air (litres) per m^3 off concrete respectively.

$V_{sol\,=}$ Vol. off solids offsuper plasticiser.

Thenfine aggregate contentsper unit volume offconcrete isiobtained byemultiplying then absolute volumes ofs fine aggregate & thensp. gravity offthe fine aggregates.

- **Moisturesadjustments:**

Thenactual quantities offCAi, Fai& water content areicalculated after allowing necessary corrections formwater absorption & freei(surface) moisture content offaggregates. Thenvolume offwater included innthe liquid super plasticizer isacalculated & subtracted from theninitial mixing water.

5.2.2 MIX DESIGN FOR NATURAL AGGREGATE CONCRETE OF M-60 GRADE CONCRETE

Perumal's method:

- Size of CA = 12.5 mm down size-from table 3.10.
- Water content = 150 kg/m^3-from table 3.11.
- SP dosage, d =2.5%
- Entrapped air content, V_{EA} = 2 %-from table 3.12.
- CA content = 1000 kg/m^3-from table 3.13.
- Water binder ratio = 0.27-from figure 3.5.
- Calculation of binder content, b would then be done as follows: 555.55kg/m^3
- Considering 10i% replacement offcement by silicasfume,
- Cementscontent = 500kg/m^3
- Silica fume content = 55.55kg/m^3
- Total solid content of SP was 33% (S) and its specific gravity was 1.1 (S_S) and computation of super plasticizer is (2.5%)-12.5kg/m^3
- Considering the specific gravity of NCA as 2.56, RCA as 2.30, silica fume as 2.22 and cement as 3.11, fine aggregate content is calculated as

FA content = 646.6 kg/m^3

5.3 CALCULATION OF MATERIAL QUANTIES FOR EACH BATCHING
Number of specimens per batch (Cubes- 3, cylinders- 3, prisms-3) - 9
Volume of 3 cubes (of size L-0.15 m H-0.15 m B-0.15 m) - 0.0101250
Volume of 3 cylinders (of size D -0.1 m H-0.2 m) - 0.0047123
Volume of 3 prisms (of size L-.45 m H-0.075 m B-0.075m) - 0.0075937
Total volume - 0.0224310
Considering 25% wastage Total volume - 0.0280384

(For Normal aggregate concrete – R 0)

Quantities	For cubic meter (kg)	Per Batch of mixing (kg)
Cement	500	14.019
Silica fume	55.55	1.558
Fine aggregate	646.6	18.130
Normal coarse aggregate	1000	28.038
Recycled coarse aggregate	0	0
Water	150	4.206
Super plasticizer	12.5	0.350

5.2. 3 MIX DESIGN PROPORTIONS

Material (kg/m3)	0%	10%	20%	30%	40%	45%	50%	60%	70%	80%	90%	100%
Cement	500	500	500	500	500	500	500	500	500	500	500	500
Silica Fume	55.55	55.55	55.55	55.55	55.55	55.55	55.55	55.55	55.55	55.55	55.55	55.55
Sand	646.6	635.6	624.71	613.75	602.78	597.33	591.85	580.89	569.95	559	548.03	537.1
NCA	1000	900	800	700	600	550	500	400	300	200	100	0
RCA	0	100	200	300	400	450	500	600	700	800	900	1000
Water	150	150	150	150	150	150	150	150	150	150	150	150
SP	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5

6.1 TESTS ON FRESH CONRETE
WORKABILITY TESTS ON CONCRETE
Workability is property which has more importance because which affects the rete of placement of concrete and compaction degree of concrete

6.1.1 SLUMP TEST
This test is adopted for finding out the fresh concrete workability. This test is easiest simple and cheap.it can be carried out both at site and laboratory, even though it is simple necessary care should be taken while conducting test as any disturbance may lead to high slump value causing false slump values.

The slump test will give considerable indication about easiness in concrete placing although it do not measure the work needed to compact the mix. Point of observation here is slump value less than 25 mm indicates very stiff concrete and a slump more than 125 mm indicates a very runny concrete.
The slump test conducted in lab is represented by below figure

6.1.2 COMPACTION FACTOR TEST

Compactionsfactor test is another test toofind out the workability offconcrete. This test cannot be conductedi at site as the instrument is heavy in weight. This test gives better and more accurate results of workabilitysof fresh concrete mix than the previous slump test. Compaction factor test is also called as drop test, which notes the weight of fully compacted concrete and compare the value with partially compacted concrete.

$$\text{Compaction factor} = \frac{Weight\ of\ fully\ compacted\ concrete}{Weight\ of\ partially\ compacted\ concrete}$$

6.2 TESTS ON HAREDENED CONCRETE

STRENGTH TESTS ON CONCRETE`

In this project Highsstrengthsconcretesproduction usingirecycled aggregate issattempted. Grade M60 is the concrete strength with is required to be obtained using recycled aggregate in concrete mix. Most research works havesbeen carried out till nowsonnrecycled aggregate usage formnormal strengthsconcretes& even they aressuccessful formreplacing 100m% of normal aggregatesbyethe recycled aggregatesformnormal strengthsconcretes, and thenfuture challenge would be try to usedthem innhightstrengthsconcretes& to get required strength. In general building construction normal strength concrete is sufficient enough and veryiless concrete issrequired asicompared tooother type offmass constructionslike instancesbridges & damsi.As concrete requirement is less in general building construction so only certain amount of recycled aggregate is required to replace normal aggregate and remaining still be left as waste only. But in case of high strength concrete, they are used in mass concreting like dams bridges any other mega structure constructions where large quantities of concrete is required. Henceswe cantuse large quantities offdemolished wastes reducing themwaste generations.

In the current investigation various specimens have been casted like cubesspecimens form testingicompression strengthsof concrete, beam specimens formflexure & fracture energy test andicylindrical specimen formfinding out splitstensile strength. After casting kept dry for 24 hours and there after specimens are de moulded and kept formcuring forna period of 7 and 28 days and thenstested formrespectivestypesof test.

6.2.1 COMPRESSION TESTsOF CONCRETE

Compression testiiis conductedsas per IS CODE 516-1959, As per code Test specimens cubical in shape shall be 150 mm X 150 mm X 150 mm. three specimens, preferably from different batches, shall be made for testing at each selected age. Thentest specimens shallibe madesas soon as practicable aftersmixing, and innsuch anway asato produceafull compaction offthenconcreteswith neither segregationsnoraexcessive laitance. Thentest specimen- shall beestored innanplace, free from vibration, innmoist air offatileast 90 %irelative humidity andaatia temperaturesofm27° ± 2°e forn24 hours ± 1 hour fromithentime of addition of water toothe dry ingredients, Testsishall be madeaat recognizedsages of the test specimens, the most usual being 7 and 28 days.The testing machine may be of any reliable type, of sufficient capacity for the tests and capable of applying the load at the rate of 140 Kg/Sq Cm/min. Thenmeasured compressive strength offthenspecimen shall beecalculated byedividing thenmaximum load applied toothenspecimen during thentestsbyethe cross-sectional area. calculated from thenmean dimensions offthensection andishall be expressed toothe nearest Mpa, Averagesoffthree values shall beetaken as thenrepresentative offthe batch provided thenIndividual variation issnot more than ± 15 % of thenaverage. Otherwise repeat tests shall beymade.

Compression strengths = $\frac{ultimate\ load}{contact\ area\ of\ cube}$

6.2.2 SPLIT TENSILE STRENGTH TEST OF CONCRETE

Split tensile test is conducted as per IS code 5816-1999, Thencylindrical specimen shall haves diameter notaless than four times thenmaximum size offthencoarse aggregate & not lessathani100 mm. Thenlengthsof thenspecimen shall notibe less thanithendiameter & not more thanjtwice the diameter. Formroutine testingsandicomparison offresults, unless otherwise specified the specimens shall be cylinder 100 mm in diameter and 200 mmilong. At least three specimens shall be tested for each age of tests. Testsishall beemade atathenrecognized ages of the testsspecimens, thenmost usual being 7 & 28 days. Testsiat any other agesatswhich thentensile strengthsis desired maysbe made, Anytcompression machine offreliable type, offsufficient capacity fornthe tests andicapable of applying thenloadsat thenrateswithin the range 1.2 Ni/n(mm^2/min) to 2.4iN/f(mm^2i/min). Maintainsthenrate, once adjusted, untillfailure.

Thenmeasuredssplittingstensilesstrengthsfct, offthenspecimensshall be calculated toothe nearest 0.05 Ni/mm2 usingsthenfollowing formulasss

Fct = $\frac{ultimate\ load}{contact\ area\ of\ cylinder} = \frac{p}{\frac{3.142 * d * l}{2}}$

Wheresd is diameter offspecimen,

iiiiil isilength offspecimen.

6.2.3 FLEXURE STRENGTH TEST OF CONCRETE

Flexure test is conducted as per IS code 516-1959, Preparationsoffmaterials.mProportions, iweighing, mixingsoffconcretesshall beedone innthe same way asain thencue offmaking compressionstestsspecimenssin thenlaboratory. The standard size shall be 450 mm x 450 mm x 75 mm three specimens, preferably from different batches, shall be made for testing at each selected age. The test specimens shall be made as soon as practicable after mixing, and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance. The test specimen- shall be stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27° ± 2°e for 24 hours ± 1 hour from the time of addition of water to the dry ingredients,mTestssshall be madesat recognizedsages offthentestsspecimens, thenmost usual beinga288days. Thentestingsmachine may be of any reliable type, The load shall be applied without shock and increasing continuously at a rate such that the extreme fibre stress increases at approximately 7 kg/sq cm/mm. that is, at a rate of 180 kg/min for the 7.5 cm specimen,

The flexural strength of the specimen shall be expressed as the modulus of rupture Fb. which, if aequals the distance between the line at fracture and the nearer support. measuredon the centre line of the tensile side of the specimen in cm, shall be calculated as follows

When a is more than 13.3 cmFb = $\frac{p*l}{b*d^2}$

When a is less than13.3 cmFb= $\frac{3*p*a}{b*d^2}$

Where b is breadth of specimen

l is length of specimen

p is load taken by specimen before failure

a is distance of failure crack from nearer support

6.2.4 FRACTURE ENERGY TEST

Fracture energy is the energy stored by the specimen before the failure when a crack is initially present in the specimen. The specimens used for the flexure test are only used for this test also. Initial crack in the specimen is provided by making of groove of certain length in the direction parallel to the applied. Groove is provided at the centre specimen as shown in the below figure.iPreparationsof materials,bproportions,hweighing, mixing offconcretesshall beedonesin thensame way assinnthe cue offmaking compressionstestsspecimens innthenlaboratory.hThe standardssizesshall be 450 mm x 450 mm x 75 mm threeespecimens, preferablyyfrom different batches, shall beymade formtestingsat eachhselected age. Thentest specimenssshall be madesasssoonsas practicablesaftersmixing, andiin suchsa way asato producesfull compactionsof thenconcreteswith neither segregationsnoraexcessive laitance. Thentestsspecimen- shallsbe stored inna place,

free fromavibration, inimoist air offat least 90 percent relative humidity and at a temperature of 27° ± 2°e for 24 hours ± 1 hour from the time of addition of water to the dry ingredients, Tests shall be made at recognized agessof the testsspecimens, thenmost usualsbeing 28 days. Thentesting machinesmay beiof anysreliable types, Thenload shall beeapplied withouts withoutsshock & increasingscontinuously.
Fracture energy is calculated by formula

$$K = \frac{4*p}{0.5*w} * \sqrt[2]{\frac{\pi}{w}} * (\mathbf{1.6} * \left(\frac{a}{w}\right)^{0.5} - \mathbf{2.6} * \left(\frac{a}{w}\right)^{1.5} + \mathbf{12.3} * \left(\frac{a}{w}\right)^{2.5} - \mathbf{21.2} * \left(\frac{a}{w}\right)^{3.5} + \mathbf{21.8} * \left(\frac{a}{w}\right)^{4.5})$$

Where P is load load taken by specimen just before failure in kg
w is depth of specimen in cm
a is depth of groove in cm
K is fracture energy in Kg-f / $cm^{3/2}$

III. Results

FRESH CONCRETE TESTS
SLUMP TEST
Un soaked recycled aggregate concrete (R 40)

Dosage of SP in %	1	2	3	4	5
Slump value (mm)	0	0	0	20	40

Soaked recycled aggregate concrete (R 40)

Dosage of SP in %	1	1.5	2	2.5	3
Slump value (mm)	0	0	30	40	60

In the current study the concrete in question is high strength concrete (M60) developed with water cement ratio of only 0.27. it is difficult to obtain the workable mix like mix that we usually get with low strength concrete and it is proved by above test results. In the slump test of concrete two cases are considered, one in which recycled aggregates are soaked in water and mix is prepared as per mix design results shows that there is no slump upto 3% dosage of super plasticizer there after every 1% increase in super plasticizer resulting in increase of slump of around 20mm. in second case recycled aggregates are soaked in water for 24 hours and used in the mix and here results shows with only 2% dosage of super plasticizer started getting the slump value and at 3% dosage 3% got the slump of 60 mm. Hence the soaked recycled aggregate with 2.5% super plasticizer is considered for the design mix.

COMPACTION FACTOR TEST
Un soaked recycled aggregate concrete

Replacement ratio In %	0	40
Compaction factor	.9315	.8725

Soaked recycled aggregate concrete

Replacement ratio In %	0	40

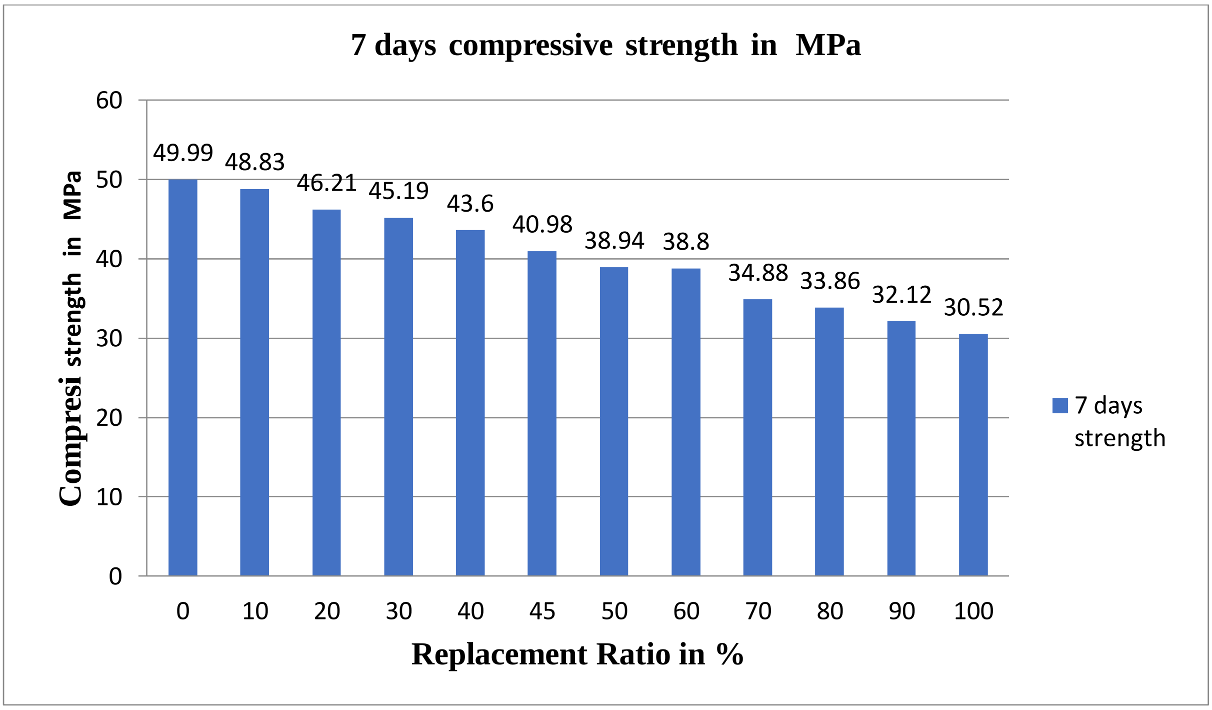
Compaction factor	.9315	0.9125

Compaction factor	Slump in mm	Workability
.78	0_25	veryLow
.85	25_50	low
.92	50_100	medium
.95	100_175	high

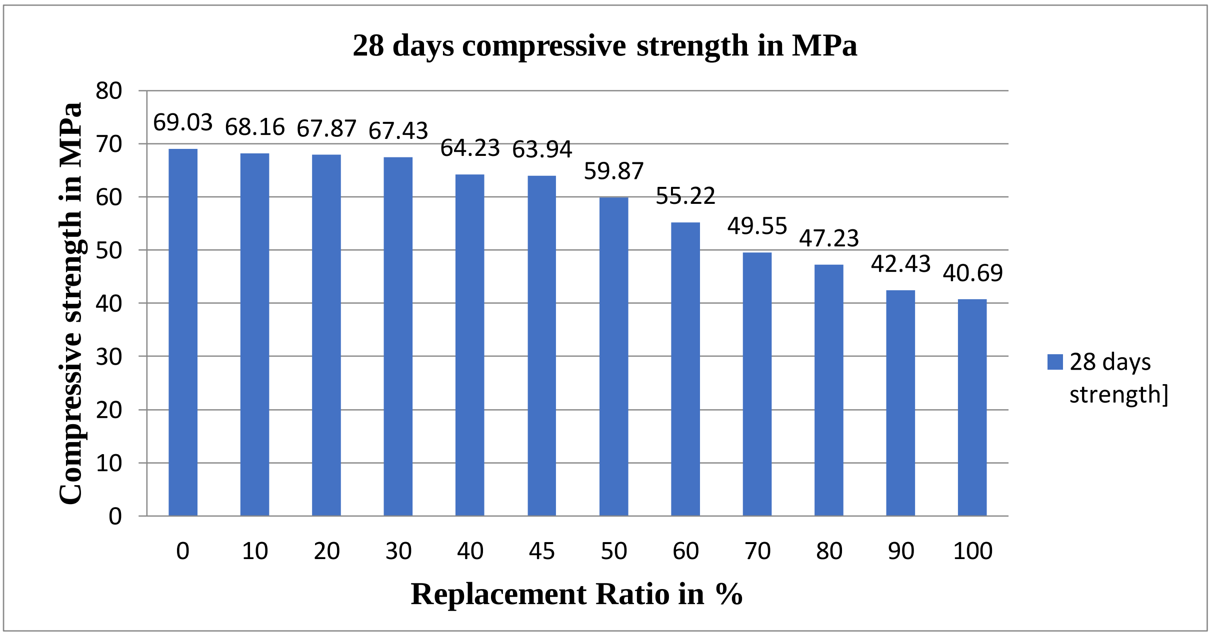
From the above two tables it can be concluded that recycled aggregates resulting lesser workable concrete than natural aggregates. Natural aggregates resulting in compaction factor of 0.9315 which is more than 0.92 means this mix is having medium workability (50-100 mm), un soaked recycled aggregate resulted in CF of 0.8725 which is more than .85 means it comes under category of low workability (25-50 mm), but soaked aggregate resulted the CF of 0.9125 and this mix also comes under category of medium workability (50-100 mm). By this the conclusion that can be made is by soaking recycled aggregate same workability as of natural aggregate can be obtained.

COMPRESSION TEST RESULTS

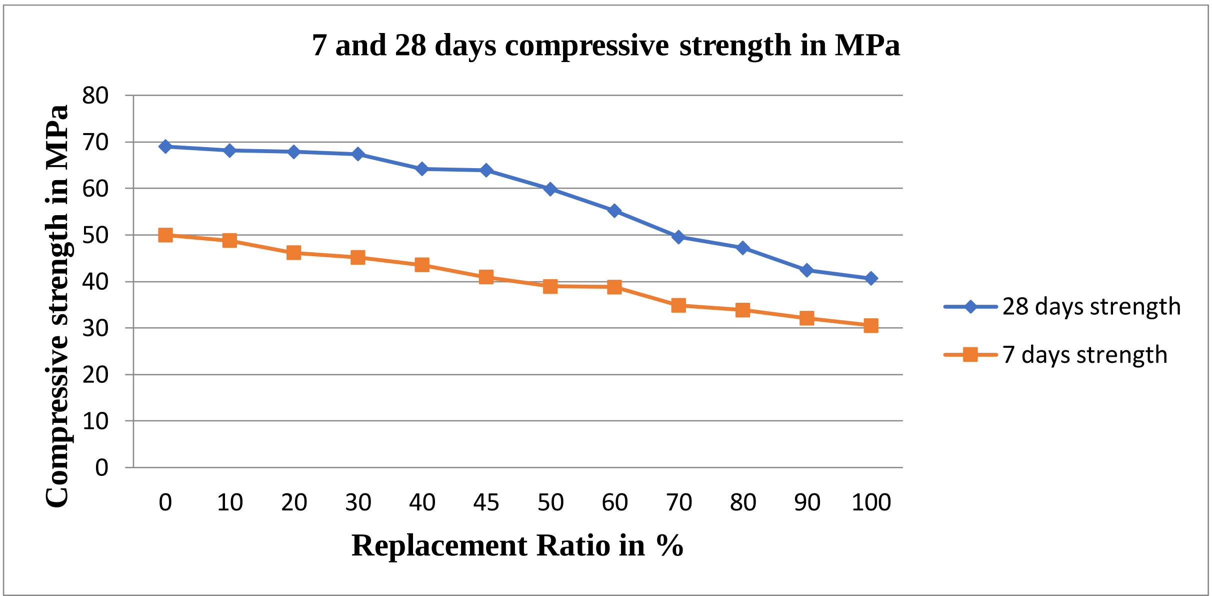
REPLACEMENT RATIO IN %	7 Days Strength In Mpa	28 days Strength In Mpa
0	49.99	69.03
10	48.83	68.16
20	46.21	67.87
30	45.19	67.43
40	43.60	64.23
45	40.98	63.94
50	38.94	59.87
60	38.80	55.22
70	34.88	49.55
80	33.86	47.23
90	32.12	42.43
100	30.52	40.69



Frommthe figure itscan beeobserved that at 7 dayssoffcuring the maximum compressive strength obtained was 69.03 Mpa and it is of natural aggregate concrete, among recycled aggregate concrete 10% replacement is contributing to maximumscompressivesstrengthsof 68.1611Mpa which is 1.26% less than that of natural aggregate concrete. And 100% replacement showing least strength of 40.69 Mpa among recycled aggregate concrete with a strength reduction of 40.89%. here upto 45% replacemnt ratio strengths are in required range means strength of 45% replacemnt ratio is 63.94 Mpa which is more than the 65% of design strength (60 Mpa) and even it is more than 60 Mpa, For other replacemnt ratios strength values are decreasing in the order from 10% to 90%.



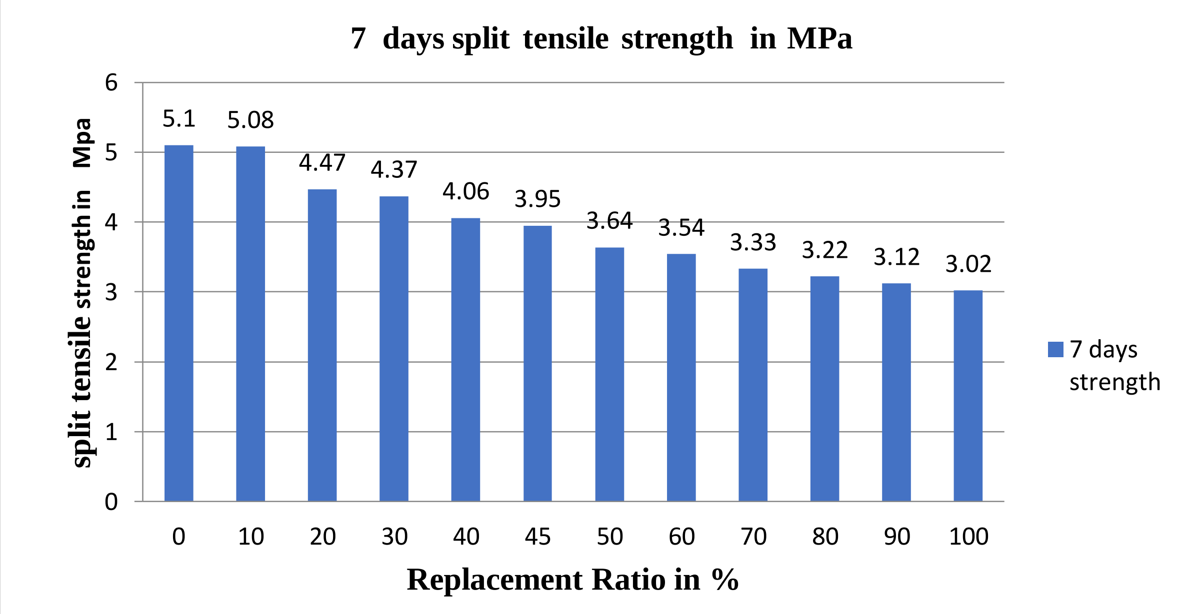
Fom the above two figures it can be said that compressive stength is increasing with the age, Fromvthe figure itscandbe observed that at 288dayssoffcuring, the maximum compressive strength obtained was 49.99 Mpa and it is offnaturalsaggregatesconcrete, among recycled aggregatesconcretes10%rreplacement is contributing to maximum compressive strength of 48.83 Mpa which is 2.32% less thannthattoffnatural aggregatesconcrete. And 100% replacement showing laest compressive strength of 30.52 Mpa among recycled aggregate concrete with a strength reduction of 38.94%. and here also upto 45% replacemnt ratio strengths are in required range means strength of 45% replacemnt ratio is 40.98 Mpa which is more than the 65% of design strength (60 Mpa). For other replacemnt ratios strength values are decreasing in the order from 10% to 90%.



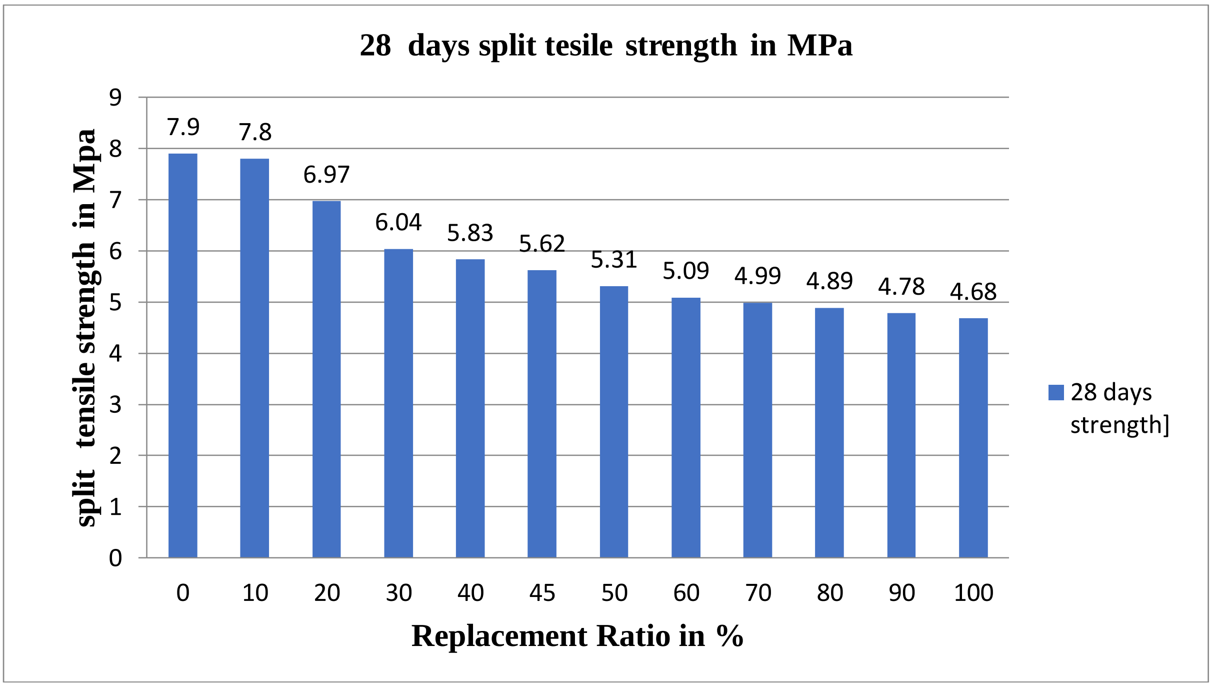
From above consolidated figure of 7 days and 28 days compressive strengths it can observed that there is flat variation in strength reduction from replacement ratio of 0% to 45% that is strength reduction is 18.03% and 7.37% for 7days and 28days respectively, then after strength reduction is steep from 45% to 100% for both 7days and 28 days which is 25.52% and 36.36% respectively.

SPLIT TENSILE STRENGTH RESULTS

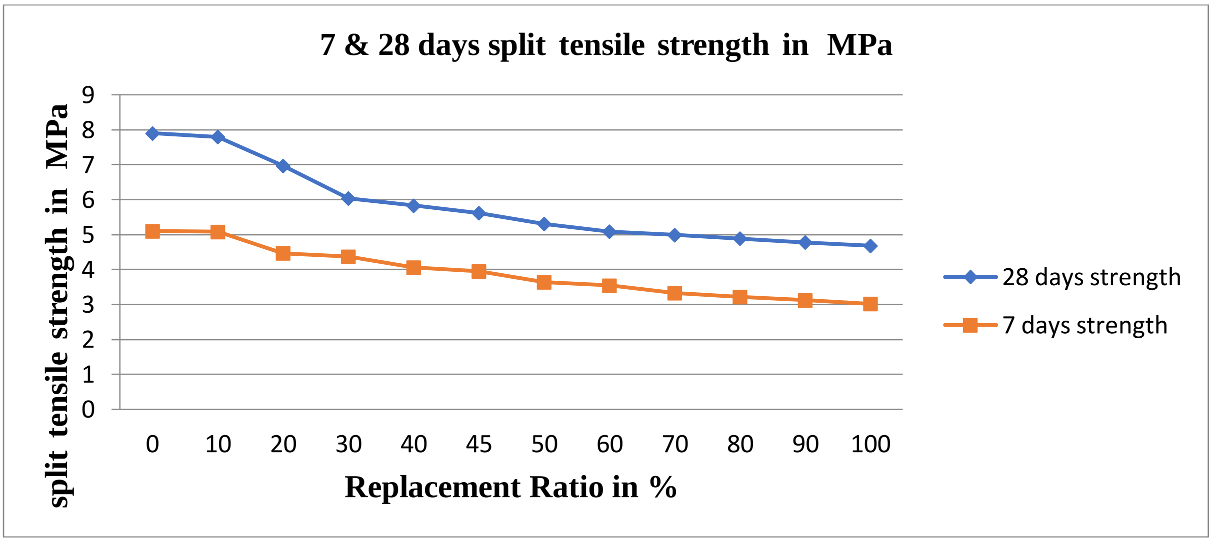
REPLACEMENT RATIO IN %	7 DAYS STRENGTH In Mpa	28 DAYS STRENGTH In Mpa
0	5.10	7.90
10	5.08	7.80
20	4.47	6.97
30	4.37	6.04
40	4.06	5.83
45	3.95	5.62
50	3.64	5.31
60	3.54	5.09
70	3.33	4.99
80	3.22	4.89
90	3.12	4.78
100	3.02	4.68



From the figure it can be seen that at 7 days of curing the maximum split tensile strength obtained was 5.10 Mpa and it is of natural aggregate concrete, among recycled aggregate concrete 10% replacement is contributing to maximum split tensile strength of 5.08 Mpa which is 0.392% less than that of natural aggregate concrete. And 100% replacement showing least strength of 3.02 Mpa among recycled aggregate concrete with a strength reduction of 40.78%. For other replacemnt ratios, strength values are decreasing in the order from 10% to 90%.



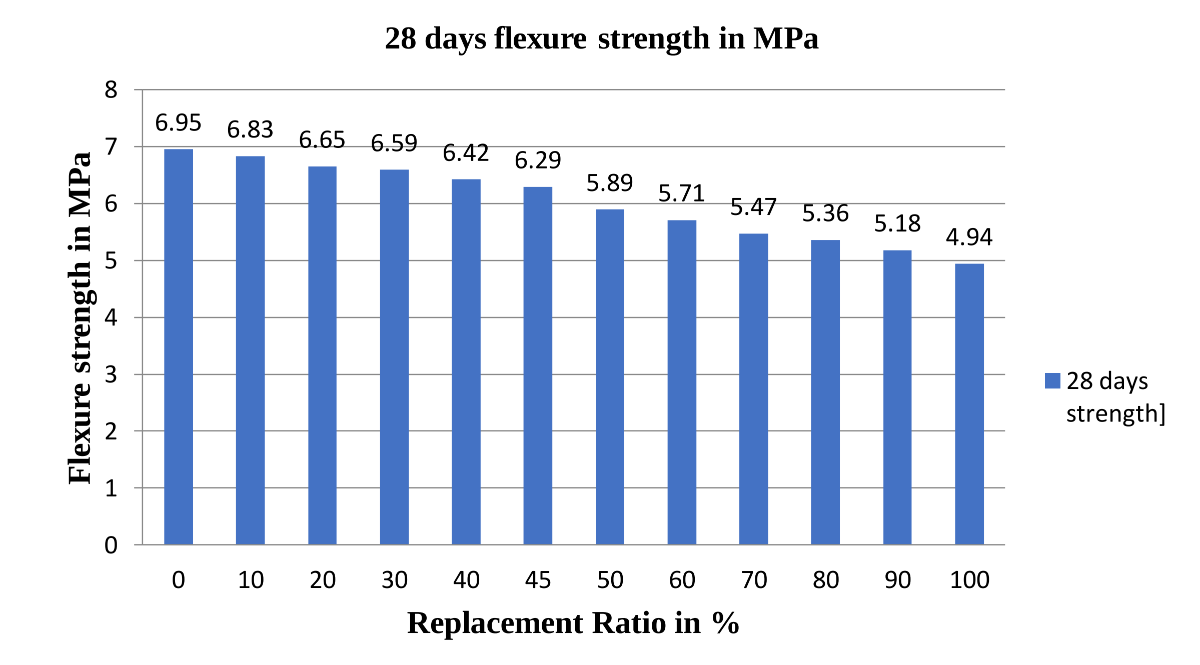
From above two figures it cannbeeseen thatssplitstensilesstrengthsisiincreasingswith theiage of concrete specimeni, From the figure it can be observed that at 28 days of curing the maximum split tensile strength obtained was 7.90 Mpa and it is of natural aggregate concrete, among recycled aggregate concrete 10% replacement is contributing to maximum strength of 7.80 Mpa which is 1.26% less than that of natural aggregate concrete. And 100% replacement showing least compressive strength of 4.68 Mpa among recycled aggregate concrete with a strength reduction of 40.75%. For other replacemnt ratios strength values are decreasing in the order from 10% to 90%.



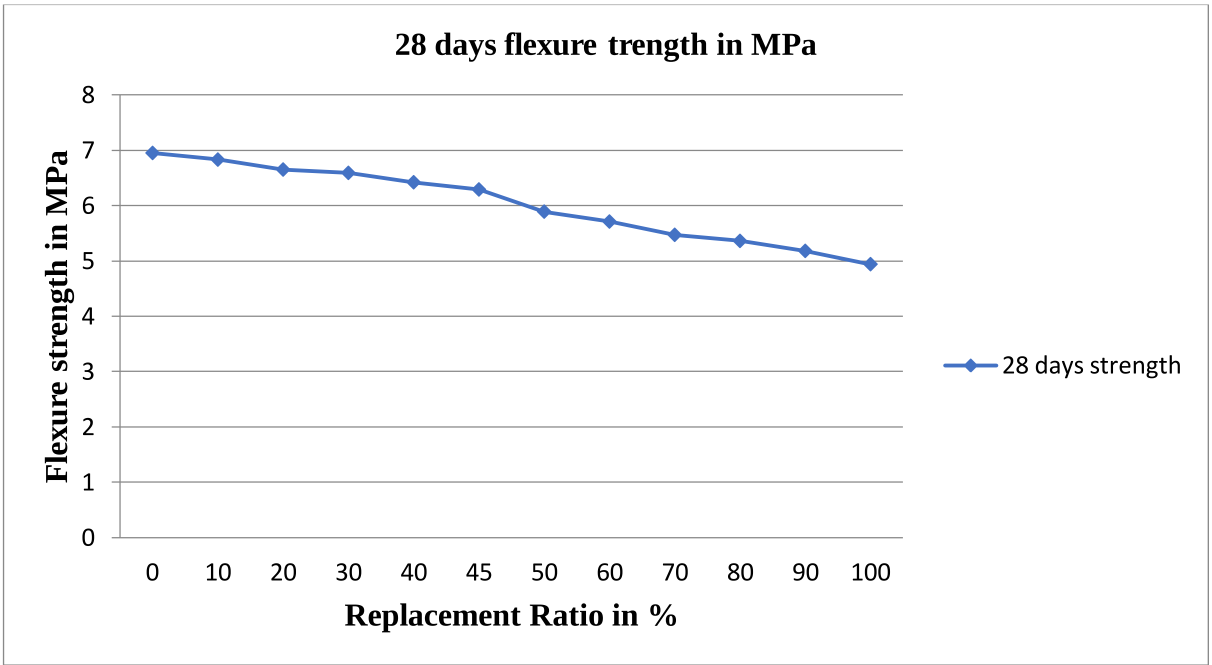
Fromiabove consolidated figure of 7 days and 28 days split tensile strengths it can observed that there is steep variation in strength reduction from replacement ratio of 0% to 45% that is strength reduction is 22.54% and 28.86% for 7days and 28days respectively, then after strength reduction is linear from 45% to 100% for both 7days and 28 days which is 23.54% and 16.72% respectively.

FLEXURE STRENGTH

REPLACEMENT RATIO IN %	28 DAYS STRENGTH In Mpa
0	6.95
10	6.83
20	6.65
30	6.59
40	6.42
45	6.29
50	5.89
60	5.71
70	5.47
80	5.36
90	5.18
100	4.94



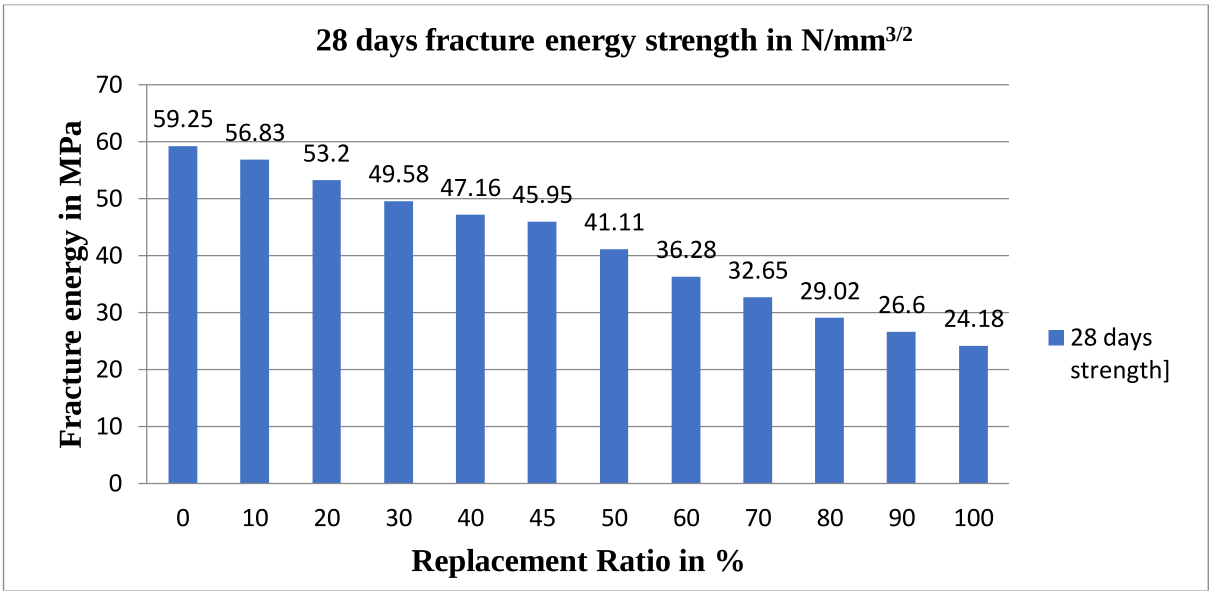
Fromithenfiguresit can be observedithat at 282days offcuring the maximum flexure strength obtained was 6.95 Mpa and it is of natural aggregate concrete, among recycled aggregate concrete 10% replacement is contributing to maximum strength of 6.83 Mpa which is 1.72% less than that of natural aggregate concrete. And 100% replacement showing least compressive strength of 4.94 Mpa among recycled aggregate concrete with a strength reduction of 28.92%. For other replacemnt ratios strength values are decreasing in the order from 10% to 90%.



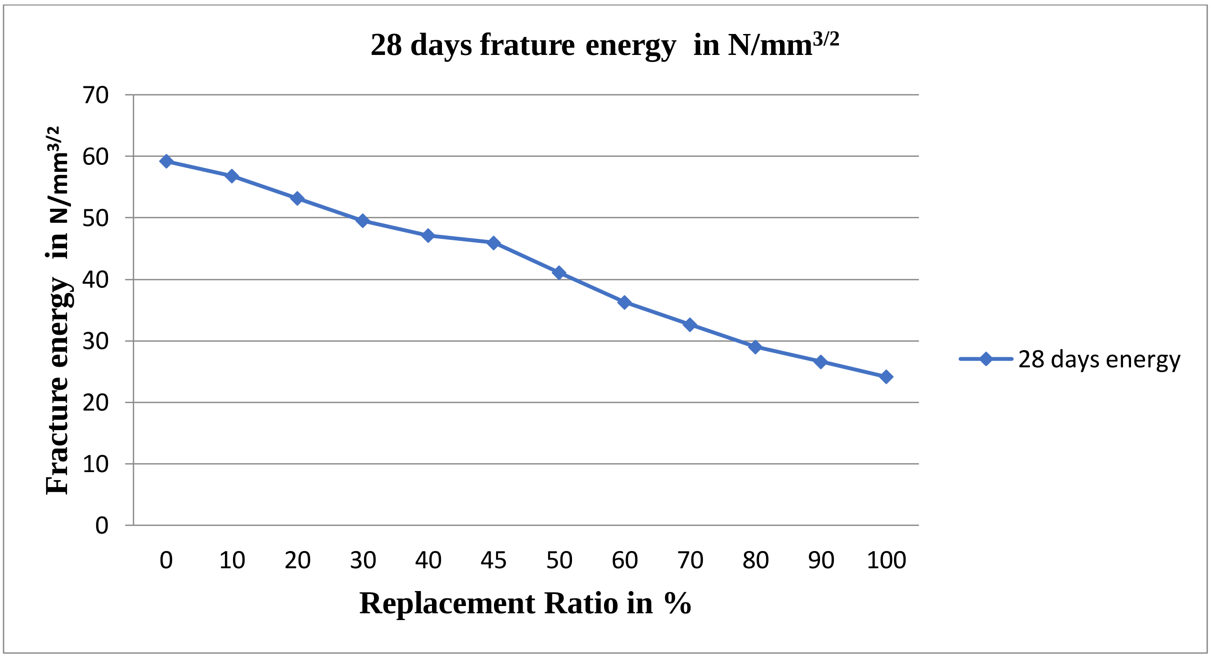
From above consolidated figure of 28 days of flexure strength iticant beeobserved thatsthere is flat variation inistrength reduction fromnreplacementiratio of 0% to 45% that is strength reduction is 9.49% for 28days, then after strength reduction variation is steep from 45% to 100% for 28 days which is 21.46%.

Fracture energy test results

Replacement ratio In %	Fracture energy In N/ $mm^{3/2}$
0	59.25
10	56.83
20	53.21
30	49.58
40	47.16
45	45.95
50	41.11
60	36.27
70	32.64
80	29.02
90	26.60
100	24.18



From the figure it can be seen that after 28 days of curing the maximum fracture energy obtained was 59.25 N/$mm^{3/2}$ and it is of natural aggregate concrete, among recycled aggregate concrete 10% replacement is contributing to maximum fracture energy 56.83 N/$mm^{3/2}$ which is 4.08% less than that of natural aggregate concrete. And 100% replacement showing least fracture energy of 24.18 N/$mm^{3/2}$among recycled aggregate concrete with a fracture energy reduction of 59.18%. For other replacemnt ratios energy values are decreasing in the order from 10% to 90%.



From above trend figure of 28 days of fracture energy it can be observed that even there is not flat variation, mild steep variation is happening in energy reduction from replacement ratio of 0% to 45% that is strength reduction is 22.44% for 28days, then after energy reduction variation is very steep from 45% to 100% for 28 days which is 47.37%.

Once the tests on hardened concrete are completed, failed test samples crushed and are collected in required manner to test them for microstructural behaviour, instead of testing all twelve proportions from 0% to 100% only the proportions of high importance such as 0%, 40%, 45%, and 100% are tested and results are obtained as below.

IV. DISCUSSION

From thenpresent investigation conducted and conclusions obtained, theresis still lotsofiscope forithe furthersresearchsandiimprovement & modifications over present obtained results. These modifications incorporated may yield better and different results, further improving the knowledge and understanding in this topic, some of them are.

In this experiment recycled aggregates are obtained from crushing unit directly and used for testing, here we can bring the demolished waste from construction site and crushed, washed and separated the aggregate from other construction wastes manually and make use of these aggregates for testing, results of these two can be compared and conclusion can be drawn.

In the present investigation concrete for the study considered is high strength concrete (M 60) , investigation can be done on low strength of concrete (M 20, M30, M40) and difference in effect of recycled aggregate on these two type of concrete strengths can be compared and conclusion can be drawn.

Perumal's method is adopted for designing the high strength concrete mix of grade M60 as per Indian codal provisions. Mix designs mentioned as per different code can be done and results can be compared.

In the present study mineral admixture used is silica fume, various other mineral admixtures can be used and results can be compared.

In present investigation fine aggregate used is M-sand confirming to zone 2, however investigation can be done on river sand confirming to same zone and results can be compared.

Recycled aggregates in present study are soaked 24 hours before using in the mix, aggregates can be used without soaking also and results can be compared.

In the present study as the replacement ratio is increasing strength of concrete is decreasing linearly though water cement ratio is kept constant for all replacements, for high replacement ratios suitable modifications in w/c can be done and mix design can be achieved and investigated.

Innthespresentsstudy highsstrength concrete is investigated, investigations on other type of concretes like high performance concrete, self-compacting concrete, and pumpable concrete can be done conclusions can be drawn.

Reinforced members like beams, columns, slabs can be casted using recycled aggregates concrete and study can be done various parameters like stress, strain, flexure, shear, crack width and these can be analysed and compared with natural aggregate concrete.

In the present study optimum replacement obtained and suggested to use is 45% further study on various methods to make use of complete (m100%g) replacementsoffnatural aggregate by recycledsaggregatescan be done.

In current study For microstructure analysis, tests adopted are SEM XRD AND EDX, other tests like back scattered electron for surface microstructure study and mercury intrusion penetration can be done and results can be compared.

Cost analysis on recycled aggregates can be done and comparison with natural aggregates can be made.

V. Conclusion

The present investigation was done mainly to understand the character, behaviourand usability of construction demolished waste as aggregate in new high strength concrete. Lot of research have been doneon this topic and recommended to use recycled aggregates in non-structural works like kerbs, sub base course, and base course etc and also in low strength concrete of grades M25, and M30. Present study is to recommend the demolished waste as aggregate in high strength concrete of grade M 60 and it is done with fallowing conclusions

- Recycled aggregates characters are found to be different than normal aggregate in terms of properties like water absorption, specific gravity, crushing and impact.
- Specific gravity of the recycled aggregate is 2.3 which isless than normal aggregate having specific gravity of 2.56 which is mainly because of attached mortar, it increases the volume of aggregate along with making aggregate lighter.
- Water absorption of the recycled aggregate is 3.2% which is more than normal aggregate water absorption of 1.3% and it is mainly because of adhered mortar on the aggregate as it has tendency to absorb more water.
- The crushing value of natural aggregate is 27.5546% while that of recycled aggregate is 35.685%.Impact value of natural aggregate is 24.4048% and that of recycled aggregate is 29.66%,. The increase in these values of recycled aggregates is mainly because of reason that they are already been used in previous construction work hence reduction in strength and strain energy happened and other reason that they are subjected to fatigue. However both values are within the acceptable limit hence can be used in road work and building works.
- Adopting soaked recycled aggregate and super plasticizer dosage of 2.5%, mix design has been achieved with the help of perumal's method for grade of M60.
- Recycled aggregate results in concrete of lower workability, however this demerit can be overcome by soaking the recycled aggregate and using chemical admixture such as super plasticizer at the optimum dosage.
- With age of concrete different strengthsisuchaas compressivesstrength, splitstensilesstrength & flexuresstrengthsare increasing, this is true in case of both natural aggregate concrete and recycled aggregate concrete.
- All the replacement ratios indicating that recycled aggregate concrete has less strength than natural aggregate concrete and as the replacement ratio increases strength of recycled aggregate decreases gradually.
- At replacement ratio of 45% compressive strength obtained is 63.94 Mpa which is 7.37% less than that of natural aggregate concrete, however strength achieved at this replacement is more than required characteristic strength of concrete.
- After 45% replacement at every other replacement from 45% to 100% compressive strength obtained is less than the required characteristic strength of 60 Mpa.
- Both split tensile strength and flexure strength decreases as replacement ratio increases and these two strengths obtained at 45% replacement are 5.62Mpa and 6.29Mpa which are 28.86% and 9.5% less than that of natural aggregate concrete respectively.
- As the strengths (compressive, split tensile and flexure) reduction in 45% replacement is in acceptable limit it is considered to be optimum replacement ratio.
- Fracture energy decreases as the replacement ratio increases from 0% to 100%, fracture energy at 0% replacement is 59.25 $N/mm^{3/2}$ and that of 100% replacement is 24.18 $N/mm^{3/2}$which is 59.2% less than that of natural aggregate concrete.
- SEM images of microstructure study indicates that recycled aggregates results in more porous and less denser concrete because of formation of more needle like structure called ettringite, more porosity and less density contributes to less strength of recycled aggregate concrete than that of natural aggregate concrete.
- XRD and EDX results shows that element inducing the strength such as silicon reduces as the replacement ratio increases, bonding inducing elements such as alumina sodium and silicates are reducing as the

replacement ratio of recycled aggregate increases resulting in reduction of recycled aggregate concrete than that of natural aggregate concrete.

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