iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** I **Month of publication:** January 2018

DOI: http://doi.org/10.22214/ijraset.2018.1168

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 6 Issue I, January 2018- Available at www.ijraset.com

Comparative Experimental Study of Physical Properties of Concrete Made by used Aggregate with and without Superplasticizer

Akant Patel[1], Vinay Kumar Singh Chandrakar[2], Praveen Singh Tomar[3]
[1, 2, 3] Civil Engineering Dept., Patel Institute of Technology, Bhopal (M.P.), RGPV University, Bhopal (M.P.)

Abstract*: In today's scenario the concrete is one of the most widely used construction material in the world. Increase in the population growth is leads to increase in demands of various fields like cultivation, transportation and construction etc. Nowadays, there is a very much increase in the demand for construction works like residential buildings, commercial buildings, bridges, dams, roads etc. and because of this increase in demand the availability of resources for the concrete ingredients is getting very difficult. Hence people are looking for the alternative resources for the concrete ingredients in order to meet their requirements. This thesis work deals with the study of physical properties of concrete with using superplasticizer, by using superplasticizer we can reduce the water demand of concrete mix. The main objective of this research is to determine that what percentage the superplasticizer can be used in the concrete mix to achieve its target mean strength. In this ongoing research work it is concentrated on the use of superplasticizer for reducing the water demand in the mix. A series of tests were carried out to determine the compressive strength, split tensile strength with and without addition of superplasticizer. This study utilizes the Conplast sp430 which is a superplasticizer; it is used in the concrete mix with variable quantity i.e. 250 ml – 1,000 ml per bag of cement. The use of superplasticizer helps in reducing the utilization of water and it also increases the strength of the concrete. The use of superplasticizer also helps in preservation of the environment by saving the water. However, in coming few decades, it can raise new challenges for the construction industry. The use of superplasticizer in the production of concrete can be a good solution to the growing problems regarding the large water demand during the making and mixing the concrete for a construction activity. During the development of new generation product like concrete made with superplasticizer, it is essential to investigate the properties of fresh and hardened concrete to encourage and escalate its application in the civil engineering construction industry. This research investigates the properties of fresh and hardened concrete made with different quantity utilized of superplasticizer in concrete mix.

***Keywords*: Used aggregate concrete, workability, compressive strength, flexural strength, superplasticizer.**

I. INTRODUCTION

Construction developments are on their peak level in the 21^{st} century round the globe. There are number of skyscrapers, roads, dams, bridges, underground tunnels and under water structures all over the world. The old days when it was very difficult to talk about the advantages of using admixtures have passed. It is now fairly clear that admixtures can both solve technical problems and save substantial cost also by increasing the strength of concrete and reducing the water demand. However, they also have the potential to generate technical problems if not correctly selected or used. According to (22) (Neville A.M., 1994), several benefits are obtainable through the use of admixtures, such as improved quality, retardation or acceleration of setting time, coloring, improved concrete strength, increased flowability for the same water/cement ratio, better frost and sulfate resistance, improved fire resistance, improved workability, cracking control and superior finish ability. The specific effects of an admixture usually vary with the type of cement, mix proportion, special conditions (particularly temperature) and dosage (11) (Irving Kett). In the construction industry a lot of admixtures are used for different purposes to improve different desirable properties of cement concrete. Generally, admixtures are classified in to two groups:-

A. Mineral
B. Chemical admixtures.

Water reducing admixture is one type of chemical admixture which provide a wide range of benefits for concrete in the fresh and hardened sates. Different water reducing admixtures can be easily available in the market; from those admixtures high range water reducing admixture also known as superplasticizer, type F is the main type of admixture which provide a lot of improvement in the

properties of the for concrete properties. This admixture is produced in our country as the name mega flow SP1 and SP4, which has a capacity to improve the workability, compressive strength and permeability of concrete. Though, in our country researches and investigation are not yet done on admixtures. Consequently, this research has investigated some benefits which are obtained by the use of superplasticizing admixture as an additional construction material. In order to show the effects of superplasticizing admixture on the concrete properties, such as: workability, strength and permeability, laboratory experimentations were performed by adding dosages of 0%, 0.5%, 1% and 1.5% superplasticizing admixture in the concrete mixes prepared by used and virgin aggregate with four stages and results are determined. Then, based on the experimental results the conclusions are drawn and recommendations have been forwarded. Large numbers of structures have been demolished due to their limit of life span, unsuitable position in continuous growing city, and damaged condition caused by natural disaster and hazards. The demolition of the structures is generating concrete rubbles and causing the environmental problems due to unplanned disposal and lacking of the landfill sites. A large portion of the potentially useful demolition waste is disposed off in the landfill sites. The transportation and disposal of these wastes are economically and environmentally not sustainable. To overcome from these problems, nowadays alternative aggregate are drawing more interest in the construction industry (20) (Md. Safiuddin, Ubagaram Johnson Alengaram, June, 2011).
Sustainable infrastructure and construction management largely depends upon the reuse and recycling of construction and demolition (C&D) waste. In Canada, construction and demolition waste constitutes almost 30% of the overall municipal solid waste (MSW) (27) (Statistic Canada 2008). It is estimated that, in British Columbia, construction and demolition waste is almost 28% of total MSW where in Ontario and Alberta it is 30% and 8%, respectively (27) (Statistics Canada 2008). The construction and demolition C&D wastes in Canada concrete waste occupies a large portion. As their disposal is very costly and occupies a large amount of empty space for landfills, it is very difficult to find a way to reuse them so that this heavy amount of waste can be turned into a natural resource for the construction industry. One best possible way of utilizing this used concrete is to use it as coarse aggregate in new concrete mix, which can lead to a cleaner and greener environment and pavement the way for sustainable construction practice. Used Aggregate Concrete (UAC) is a relatively new construction material which is produced by crushing of old concrete and used as aggregate replacement in new concrete mix. On the other side, as this concrete gets older and it need to be demolished, it will regenerate further concrete waste materials, which has also the potential for similar reuse of this material. Therefore, repeated used coarse aggregate concrete is a completely innovative green and eco friendly product, which requires extensive experimental investigation and research as its utilization will lead us one step forward towards a more sustainable and eco friendly world. Repeated used coarse aggregate concrete is produced by sequential crushing of used concrete products. Its uses in the construction industry will help minimize two major environmental problems. Although Used Aggregate Concrete (UAC) is a promising constructional material, before any large industrial application its strength and durability properties must be properly analyzed and investigated since the prominent characteristics of Used Aggregate different from the natural aggregate. The differences in the mechanical properties of Used aggregate significantly influence the quality of Used Aggregate Concrete (UAC), and considered as one of the major barriers related to the field application of Used Aggregate Concrete (UAC). In order to provide a sustainable and eco friendly construction material a suitable balance is essential between the cost and quality of Used Aggregate Concrete (UAC). The use of Used Aggregate Concrete (UAC) is a very cost effective option if the quality and properties remains comparable to the conventional concrete. To improve the use of Used Aggregate Concrete (UAC) and its acceptance as a sustainable and eco friendly construction material, the investigation over mechanical and durability properties is necessary which will help in gaining confidence regarding its application and lead us significantly closer to an ideally safe, sustainable and eco friendly solution to our requirement for clean and green infrastructures.

C. Superplasticizer

Superplasticizing admixture is a type of high range water reducing chemical admixture, which have a capacity of reducing the mixing water up to 35%. This type of admixture will provide high quality development or improvement for concrete in both fresh and hardened states. Generally, superplasticizing admixtures improve the workability, compressive strength, flexural strength and permeability of the concrete (28) (Steven Kosmatka H., 2003). Therefore, the main discussion of this chapter focus on reviewing the admixtures, particularly on superplasticizing admixture used to produce a quality concrete.

D. Used Aggregate Concrete (UAC)

Concrete is being used as a constructional material for more than 2 centuries. In building construction industry, concrete has become more acceptable for its dependable natural and long durable property. Other than construction use, the contribution of concrete in financial growth, social progress, and environmental safety is often not considered. It was found that the energy performances of the concrete structure are superior to the steel structures (17) (Lemay 2011). The Concrete structures are not only flexible in the design but also low costly. Moreover, concrete structures are more eco friendly than steel or aluminum structures. To make the concrete industry more durable and eco friendly, researchers and scientist are working continuously and they came up with the idea of Used Aggregate Concrete (UAC) also known as Green concrete. Green concrete or Used Aggregate Concrete (UAC) is a durable type of concrete resulting from aggregate replacements such as Used Aggregate Concrete (UAC), ceramic waste, tile, rubber tire, glass aggregate etc. It could also be a resultant of portl and cement replacements such as fly ash, slag, and silica fume or it could result from waste material admixtures such as waste latex paint. As a result, Used Aggregate Concrete (UAC) has less environmental impact in the terms of energy consumption and emission during its manufacturing process in the laboratory (10) (Hameed 2009) and can reduce the cost associated with the concrete production.

II. LITERATURE REVIEW

In this chapter, we discussed previous researches regarding Used Aggregate Concrete (UAC) prepared with superplasticizer (water reducing admixture) characteristics and the influences of these materials on properties of fresh and hardened concrete.

Used or recycled coarse aggregates contain crushed, graded inorganic particles treated from the materials used in the old constructions and demolition (C & D) rubbish. When virgin coarse aggregates are replaced by recycled coarse aggregates, strength properties of concrete are decreased to some level. The basic target of this research work was to examine or investigate the effect of using recycled concrete pieces as coarse aggregate on flexural strength and tensile strength of concrete. The investigation was carried out by carrying out split tensile strength cylinder and flexural strength tests on six different batches of concrete mixes prepared by using 20% increment of natural coarse aggregate replacement from 0% to 100% by recycled coarse aggregates. The test results showed a gradual decrease in the tensile and flexural strength properties as the percentage of recycled coarse aggregate used in the test specimens increased. After the induction of a super plasticizer (RHEOBUILD 850), loss in the flexural strength was more than compensated successfully (18) (Liaqat A. et al., 2016).

The mechanical properties of recycled aggregate concrete (RAC) from demolition have been studied for several years. It has been documented that rheological properties of these concrete are usually affected by the use of recycled aggregates. They could present physical properties less affected by the presence of recycled aggregates if the initial concrete were of the good quality. Though, manufacturing issues, mainly attributed to the angular character of these aggregates and to the granulometry of the recycled sand, restrict their industrial use. The significant point of this study consists in the optimization of the cement concrete formulation using the specific admixture, adapted to this aggregates in sort to facilitate its manufacturing. It posses that the new generation of the superplasticizers containing some copolymer polycarboxylate makes it possible to significantly improve the flowability of the recycled aggregates concrete in its fresh state. The object of this research is to control the rheological properties of the fresh recycled aggregates concrete with fine and coarse recycled aggregates to restrict the negative influence of the aggregates on mechanical properties of the concrete (25) (Sandrine Braymand et al., 2015).

Following an example of the world's greatest powers that developed the recycling industry after the natural disasters and wars, the paper points to the possibility of using the large quantities of construction and demolition (C & D) waste, generated as a result of the recent floods in the Serbia. Based on the years of extensive experimental research and the research conducted by renowned experts, an overview is provided of the most basic properties and application of the recycled aggregate concrete (RAC). It has been shown that the application of the coarse recycled concrete aggregate, as the component materials in the cement concrete mixtures, it is probable to produce the structural concrete that can be satisfactory and constant with high quality, which primarily depends upon the characteristics of crushed demolished concrete (21) (Mirjana Malešev, et al., 2014).

After performing laboratory tests we found that when we reduces W/C ratio in the mix the properties like tensile strength and modulus of elasticity of concrete increases, the replaced RAC absorb more water than virgin aggregate, recycled aggregate materials produce harsh mixes with lower workability than natural aggregate. The 100% replacement of Natural Aggregate by Recycled Concrete Aggregate in cement concrete mix might effect on chloride ions resistance, if proper design is not implemented (13) (Jitender Sharma and Sandeep Singla, 2014).

Concrete is the most broadly used strongest construction material that forms the basis of our modern life. It is used in different structures, such as: dams, buildings, bridges, tunnels, highways and other civil engineering structures. Starting from the past, concrete was produced by the combination of binding materials, fine aggregate, coarse aggregate and water. However, when the concrete technology develops, additional materials known as admixture have produced. This additional material may be added to the basic mix to develop specially required properties of the concrete mix in fresh and hardened states (16) (Kumar M. P. and Paulo M. J. M., 2006).

A. Admixtures

Historically, the admixtures are almost as older as concrete itself. They have been recognized as significant components of concrete used to enhance its performance. The original use of admixtures in cementitious mixtures as an additional material is not well documented. It would be a logical development to use such materials, which imparted desired qualities to the surface, as an integral part of the mixture. It is known that the Romans used milk, animal fat and blood to improve their concrete properties. Although these were added to improve the workability of concrete, blood is a very effective air entraining agent and might well have improved the durability of Roman concrete; eggs during the middle ages in European country; polished gluey rice paste, gloss, tung oil, blackstrap molasses and extracts from elm soaked in the water and boiled bananas by the Chinese; and in Mesoamerica and Peru, cactus juice and latex from rubber plants (6) (Edward G.N, 2008). At the present time, admixtures are very important and necessary components for the modern concrete technology.

The concrete properties both in fresh and hardened states can be modified or improved by the addition of admixtures. Currently, admixtures are obtained as mineral and chemical admixtures which used to improve the short term and long term properties of the concrete (1) (ACI Manual of concrete practice, 2009).

The effect of size of Recycled Aggregate on compressive strength described by the researchers. The 100% of RA used in concrete mix to replace the natural coarse aggregate in concrete with 100 x 100 x 100 cube mm were cast with target compressive strength is 25 MPa. The 28-day compressive strength was crushed at 3, 14, 28 days are reported found that the size of 10 mm and 14 mm of RA in RAC is quite similar performance with 10 mm and 14 mm size of Natural Aggregate (NA) in natural aggregate concrete (NAC) (12) (Ismail Abdul Rahman et al., 2009). The recycled aggregate that are obtained from site-tested concrete specimen makes good quality concrete. The compressive strength of used aggregate concrete (UAC) is found to be higher than the compressive strength of normal concrete. Used aggregate concrete is in close proximity to normal concrete in terms of split tensile strength, flexural strength and wet density. The slump of used aggregate concrete is low and that can be improved by using saturated surface dry (SSD) coarse aggregate (29) (Yong, P.C et al., 2009).

1) Classification of Admixtures: Admixtures primarily grouped in to two, these are:- i) Mineral and ii) Chemical admixture. Mineral admixtures are generally added to the concrete in large amounts. Moreover, cost reduction and enhancement of the workability of fresh concrete, they can improve the resistance of concrete to sulfate attack, thermal cracking and alkali-aggregate expansion. Due to several benefits connected with their use, they are also known as supplementary cementing materials. Mineral admixtures are mainly categorized in to four groups, these are:

a) Fly ash
b) Ground granulated
c) Blast furnace slag
d) Silica fume and
e) Highly reactive metakaolin (24) (Ramachandran V.S., 1995).

The chemical admixtures are additives designed to enhance the properties of concrete in the plastic and hardened states, increases the efficiency of ingredients and improve the economy of the concrete mixture. In certain instances, the desired objectives may be best achieved by changes to the mixture proportions in addition to using the proper admixture. The chemical admixtures also used to modify or improve the properties of hardened concrete, such as: reduce the rate of heat development during early cement hydration, accelerate the rate of strength development at the early ages, increase strength (compressive, split tensile or flexural), increase the resistance to freezing and thawing, reduce expansion caused by alkali aggregate reaction, increase bond to steel reinforcement and between existing and new concrete, decrease permeability and improve impact resistance and abrasion resistance, inhibit corrosion of surrounded metal, produce colored concrete or mortar and reduce the drying shrinkage (28) (Steven Kosmatka H., 2003).

2) Water reducing admixture: Water reducing admixtures can be defined as a water soluble organic compound that reduces the water demand of the concrete mix for a given consistency. It improves the properties of fresh and hardened concrete. The water reduction generally varies between in the range from 5% to 15%. Higher water reductions of the order of 25% -35% are possible with superplasticizer (7) (Esayas G/Y., 2006).

3) Superplasticizer Admixture: The Superplasticizers are also known as high range water-reducer belong to classes of Type F and G water reducers chemically different from the normal water reducers and capable of reducing water contents by about 35%. They are used to produce normal workability at a lower w/c ratio. They may be used to produce a highly flowable concrete. The original superplasticizers were melamine formaldehyde and sulphonated naphthalene. These are highly effective water reducers with a short period of effectiveness and in fact no permanent effects (no retardation or air-entrainment) (15) (Ken W.D, 1999).

B. Properties of Used Aggregate Concrete (UAC)

It is very difficult to accurately define the properties of Used Aggregate Concrete (UAC). This is because the properties of any type of concrete which is made with Used Aggregate Concrete (UAC) are very much dependent upon the quality of the Used Aggregate Concrete (UAC) used (19) (Limbachiya, Meddah and Ouchagour 2012). It is a general thought that if there is less mortar surrounding the Used Aggregate Concrete (UAC), the quality and effectiveness of the Used Aggregate Concrete (UAC) will increase. The base of this thought is the assumption that the Used Aggregate Concrete (UAC) will shows properties similar to the original Used Aggregate in the Used Aggregate Concrete (UAC) source material (9) (Garber, et al. 2011). Ahead, the better quality the source material used, the better will be the final concrete produced. Even if the Used Aggregate Concrete (UAC) source concrete is not of the best quality, it is still possible that the Used Aggregate Concrete (UAC) could be used effectively in a new concrete mix. However, the properties of the Used Aggregate Concrete (UAC) must be accurately established before the effectiveness of the Used Aggregate Concrete (UAC) can be determined for use in a particular application.

1) *Specific Gravity :* The specific gravity of Used Aggregate Concrete (UAC) is typically lower than that of the natural coarse aggregate. This is due to the presence of the mortar on the surface of aggregate. This mortar makes the material less dense than the natural aggregate because of its porosity and entrained-air in the structure (3) (Anderson, Uhlmeyer and Russel 2009). The specific gravity of Used Aggregate Concrete (UAC) is very important parameter because of replacing the natural coarse aggregate with the Used Aggregate Concrete (UAC) can result in a different total volume of batched of concrete mix. If the specific gravity differences are not calculated for (i.e., deduction is by weight), total yield of concrete will be greater than the expected. Additionally, this would result in overall proportions of the aggregate to cement and to water being different. However, if the specific gravity (SG) difference is calculated for and the Used Aggregate Concrete (UAC) is substituted based on the volume, then the overall mix proportions will be as intended. Therefore, calculating for specific gravity differences can be important when incorporating in Used Aggregate Concrete (UAC).
2) *Abrasion losses of Used Aggregate :* One more very important physical property of coarse aggregate is abrasion loss of aggregate. The Los Angeles abrasion test is a method to determine that how much an aggregate sample will abrade when impacted by steel the spheres in a rotating drum during test. Traditionally, natural coarse aggregate yield an abrasion loss of between in the range 15-25% (3) (Anderson, Uhlmeyer and Russel 2009). Based on the previous researches, the abrasion loss for Used Aggregate Concrete (UAC) can range from 25-45% (3) (Anderson, Uhlmeyer and Russel 2009). The wide range of values comes from variations in the quality of aggregate. Many pavement design specifications require coarse aggregate to possess a maximum abrasion loss of about 35%. Thus, not all Used Aggregate Concrete (UAC) sources would be acceptable based on these criterions. One of the major causes of the increased abrasion loss in Used Aggregate Concrete (UAC) is that the bonding strength between cement and natural aggregate is weaker than inner structure of the natural coarse aggregate (2) (Amorim, de Brito and Evangelista 2012). However, besides this weaker bond, many of Used Aggregate Concrete (UAC) samples do pass the Los Angeles abrasion tests limits and consequently would be acceptable for use in new concrete mix for a pavement.

C. Properties of fresh concrete

There are the 3 most important properties of fresh concrete those are workability, air content, and density. Previous researches have shown that the Used Aggregate Concrete (UAC) has an influence on each of these properties of concrete.

1) *Workability of concrete:* Concrete mixtures made with used aggregate are typically less workable than those concrete which are made with only natural aggregate. This decreased in workability comes from two sources.
   a) Used Aggregate Concrete (UAC) has a more angular shape than that of natural aggregate which increases the friction between the aggregate (2) (Amorim, de Brito and Evangelista 2012). This is due to the crushing processes involved in producing the Used Aggregate Concrete (UAC).
   b) The adjoined cement mortar portion of the aggregate has increased the water absorption of Used Aggregate Concrete (UAC). This higher water absorption can reduce the effective mix water, thus making the harsher and less workable mix (9) (Garber, et al. 2011). The decreased workability of the Used Aggregate Concrete (UAC) mix can be mitigated by adding a water reducing admixture or by adding more water to the mix design.
2) *Air Content of concrete:* Concrete mix incorporating the used aggregate tends to have slightly higher air contents than in the concrete mixtures prepared with only natural aggregate. This is because of the entrained air of the adjoined mortar portion of the used aggregate Concrete (UAC) (3) (Anderson, Uhlmeyer and Russel 2009). In an effort to counter this issue, it is

recommended that as much of the mortar be removed from the Used Aggregate Concrete (UAC) as is sufficient before incorporating it into a concrete mix.

3) *Density of concrete:* The density of concrete mix incorporating the Used Aggregate Concrete (UAC) is traditionally lower than that of the concrete made with only natural aggregate. The mortar portion of Used Aggregate Concrete (UAC) has an entrained air in the structure that is less dense than the rock it is adjoined to.
Therefore, as more Used Aggregate Concrete (UAC) is incorporated into a concrete mix, the resulting concrete density will be lower (3) (Anderson, Uhlmeyer and Russel 2009).

D. Hardened Concrete Properties

During the consideration of Used Aggregate Concrete (UAC) can have many effects on hardened concrete properties. Five of these properties are compressive strength, coefficient of thermal expansion, drying shrinkage, modulus of rupture, and durability. One study found that up to a 30% replacement of Used Aggregate Concrete (UAC) has no significant negative effects on hardened concrete properties (19) (Limbachiya, Meddah and Ouchagour 2012).

1) *Compressive Strength of Used Aggregate Concrete (UAC):* The conclusions on the effects of Used Aggregate Concrete (UAC) on the compressive strength fall into two parts. Some researchers conclude that there is no difference in compressive strengths between normal and Used Aggregate Concrete (UAC) concretes (2) (Amorim, de Brito and Evangelista 2012). It is expected that the stronger interfacial transition zone between the new cement paste and the more angular aggregate accounts for the lack of a reduction in the compressive strength of concrete. However, other research shows that the compressive strength of concretes made incorporating Used Aggregate Concrete (UAC) are traditionally lower than those with the only natural aggregate (3) (Anderson, Uhlmeyer and Russel 2009). Several other factors have been also suggested as contributing to cause the reduction in the strength. Used Aggregate Concrete (UAC) concretes traditionally require a higher water/cement ratio to achieve required workability. An increased water/cement ratio has the effect of lowering the compressive strength of the concrete. Ahead, Used Aggregate Concrete (UAC) concretes usually have higher air content than conventional concrete. Concretes with higher air contents tend to have the lower compressive strengths.
2) *Modulus of Rupture of Used Aggregate Concrete (UAC):* The modulus of rupture is defined as the flexural tensile strength of the concrete when subjected to a flexural type loading. Similar to the compressive strength, the modulus of rupture of concrete using Used Aggregate has been reported to be lower than that of the concrete with natural aggregate. One research study found that the flexural strength of the Used Aggregate Concrete can be up to 8% lower than the concrete made with only natural coarse aggregate (3) (Anderson, Uhlmeyer and Russel 2009). This reduction in strength may be a result of the relatively weaker bond strength between the mortar and the new cement paste adjoined to the Used Aggregate Concrete (UAC) (19) (Limbachiya, Meddah and Ouchagour 2012). Ahead, as with the compressive strength, the higher water/cement ratio and the air content of Used Aggregate Concrete (UAC) may contribute to the reduced flexural strength of concrete.
3) *Coefficient of Thermal Expansion of Used Aggregate Concrete (UAC):* Coefficient of thermal expansion is a property of material that is used to define the expected length change of a specific material when subjected to a temperature loading. Ordinary concrete traditionally has a coefficient of thermal expansion ranging from 3.2 to 7.0 millionths per degree Fahrenheit (23) (Portland Cement Association 2002). The coefficient of thermal expansion of concrete is affected by many factors out of them aggregate type having the most effect (23) (Portland Cement Association 2002). One report indicates that incorporating Used Aggregate decreases the coefficient of thermal expansion of hardened concrete (26) (Smith and Tighe, 2009).
4) *Drying Shrinkage of Used Aggregate Concrete (UAC):* The drying shrinkage of the hardened concrete depends upon the ability of the aggregate to resist the paste from shrinking. Since Used Aggregate Concrete (UAC) has mortar adjoined to the aggregate, there is less aggregate to restrain the drying shrinkage of concrete. Therefore, the Used Aggregate Concrete (UAC) typically has an increased drying shrinkage (3) (Anderson, Uhlmeyer, & Russel, 2009).
5) *Durability of Used Aggregate Concrete (UAC):* A major concern with the durability of Used Aggregate Concrete (UAC) is that it can come from the natural cycle of the freezing and thawing. When water penetrates the aggregate and cement paste and then freezing action takes place, harmful expansion can occur. Concretes with an entrained air structure are highly resistant to the harmful effects of the freeze and thaw cycle (23) (Portland Cement Association 2002). It is anticipated that concretes made with used aggregate will be more resistant to freeze and thaw effects as a result of the porosity of the adhered mortar portion of the RA (3) (Anderson, Uhlmeyer and Russel 2009).

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 6 Issue I, January 2018- Available at www.ijraset.com

III.EXPERIMENTAL WORK

The main objective of this study is to perform the experimental study to investigate the properties of concretes produced with used aggregate and superplasticizer i.e. Conplast sp430 in and comparison of them with conventional concrete prepared with virgin aggregate. During the experimental work, different concrete samples with variable percentages of Used Aggregate and superplasticizer i.e. Conplast sp430 in mix designs were investigated by different ages (7 days and 28 days).

A. Preparation

Various test specimens were prepared to determine the compressive strength, split tensile strength and other properties of the concrete mix. The data is the reference of study experiment that has to be done. Experiments needed to be done to achieve the objectives given are sieve analysis, specific gravity, water absorption, impact and crushing strength of aggregate.

B. Materials and Their Testing Methods

1) Materials used: Materials - Ordinary Portland Cement, fine aggregate and coarse aggregate
2) Testing Methods
a) Sieve Analysis Test
b) Specific Gravity Test
c) Water Absorption Test
d) AIV Test
e) Crushing Value Test
f) Slump Cone Test
g) Compressive Strength Test

IV.EXPERIMENTAL WORK

A. Proportioning Of Concrete

Before having any concrete mixing, the selection of materials and their proportion must be determined through mix design. There are various methods to determine concrete mix design. Five batches of mixtures were determined in our thesis. The initial mix batch is using 100% natural aggregate and then we use four different mixes prepared using with Conplast sp430 (Superplasticizer) in quantity 10 ml, 20 ml, 30 ml and 40 ml per kg weight of cement. In second mix batch 75% natural aggregate and 25% used aggregate with 10 ml quantity of Superplasticizer. Successive batches were made by successively adding 25% extra used aggregate also 10 ml increment of Superplasticizer and corresponding decrease in natural aggregate as shown in Table 4.1. First batch of the mix called a control mixture used only natural aggregate and four successive mixtures with increasing percentage of used aggregate and superplasticizer with corresponding decrease of natural aggregate from 25% to 100% by weight. All these mixtures were prepared with cement and aggregate in the proportion by weight, and were expected to achieve a target compressive strength.

TABLE-1 PERCENTAGE OF AGGREGATE USED IN ALL 5 BATCHES OF MIXES

Material	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
Natural Aggregate (%)	100	75	50	25	0
Used Aggregate (%)	0	25	50	75	100
Superplasticizer (ml/kg weight of cement)	0	10	20	30	40

B. Water Absorption Test For Both Types Of Aggregate

The water absorption capacity of used aggregate is higher than natural aggregate. The average water absorption of used aggregate is around 5.0%, but water absorption of natural aggregate is only 1.83 %.This shows that water absorption of used aggregate is around 2.5 times of natural aggregate. This result shows that more water needed to be added when using used aggregate in the concrete mixing to get an acceptable workability.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 6 Issue I, January 2018- Available at www.ijraset.com

TABLE-2 WATER ABSORPTION TEST

S. No.	Details	UAC	NA
1)	Wt. of empty Container = W1	2.0	2.0
2)	Wt. of soaked aggregate + Container = W2	3.4	4.3
3)	Wt. of oven dried aggregate + Wt. of container = W3	1.93	1.958
4)	% Water absorption = (W1-W3/W2-W1)*100	5%	1.83%

C. Specific Gravity test

The specific gravity of natural aggregate is around 2.75 and used aggregate is having 2.85 this means that the used aggregate is stronger than the natural aggregate in this case. Fine aggregate is having the specific gravity value of 2.65.

TABLE-3 SPECIFIC GRAVITY TEST

S. No.	Details	UAC	NA	Sand
1)	Wt. of empty Pycnometer =W1	0.644 kg	0.644 kg	0.644kg
2)	Wt. of Pycnometer + aggregate/sand =W2	0.844 kg	0.848 kg	0.848kg
3)	Wt. of Pycnometer + aggregate + Water =W3	1.632 kg	1.632 kg	1.629kg
4)	Wt. of Pycnometer + Water = W4	1.502 kg	1.502 kg	1.502kg
5)	Specific Gravity=(W2-W1)/(W2-W1)-(W3-W4)	2.85	2.75	2.65

D. Aggregate Crushing Value and Impact Value

From the result of crushing value we come to know that the used aggregate is having less resistance to the wear and tear than the natural aggregate. Impact test is the good indicator of strength and durability from the test result we can say that natural and used aggregate are having very less difference in impact and crushing value, which again shows that rock of used aggregate can also used as natural aggregate.

Table-4 Aggregate Crushing Value Test

Sample	Total Wt. of dry sample (W1)	Weight of fine passing 2.36mm IS sieve (W2)	Aggregate crushing Value = (W2/W1)*100
Used Aggregate Concrete (UAC)	4 kg	0.90kg	22.50 %
Natural Aggregate (NA)	4 kg	0.814kg	20.02 %

Table-5 Aggregate Impact Value (Aiv) Test Results

S. No.	Details	UAC			NA		
		Trial1 (kg)	Trail2 (kg)	Avg. (kg)	Trial1 (kg)	Trail2 (kg)	Avg. (kg)
1)	Total wt. of aggregate sample filling the cylindrical measure= W1	0.546	0.576	11.89%	0.625	0.630	7.81%
2)	Wt. of aggregate passing 2.36mm sieve after the test= W2	0.068	0.060		0.056	0.040	
3)	Wt. of aggregates retained on 2.36 mm sieve after the test = W3	0.478	0.516		0.569	0.590	
4)	Aggregate impact value= (W2/W1)*100	12.45%	10.41%		8.96%	6.66%	

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 6 Issue I, January 2018- Available at www.ijraset.com

V. TEST RESULTS AND ANALYSIS

Series of tests were carried out on materials, fresh and hardened concrete to obtain the strength characteristics of Used Aggregate for potential application as a structural concrete. The results for material test like water absorption, specific gravity, aggregate crushing value and aggregate impact value test are given in Table-6. Test results on fresh concrete are arranged in Table-7. Compressive strength of hardened concrete is presented in Table-8.

Table-6 Final Result Of All Tests On Materials

S. No.	Particulars	Natural Aggregate	Used Aggregate	Sand
1	Water Absorption	1.83 %	5 %	-
2	Specific gravity	2.75	2.85	2.65
3	Agg. Crushing value	20.02 %	22.50 %	-
4	Agg. Impact value	7.81%	11.89%	-

Table-7 The Slump Cone Test Result For Each Batch Of Mix Concrete

Percentage of Used Aggregate (%)	Water / Cement ratio	Slump (mm)
0	0.55	65
25	0.55	55
50	0.55	45
75	0.55	30
100	0.55	20

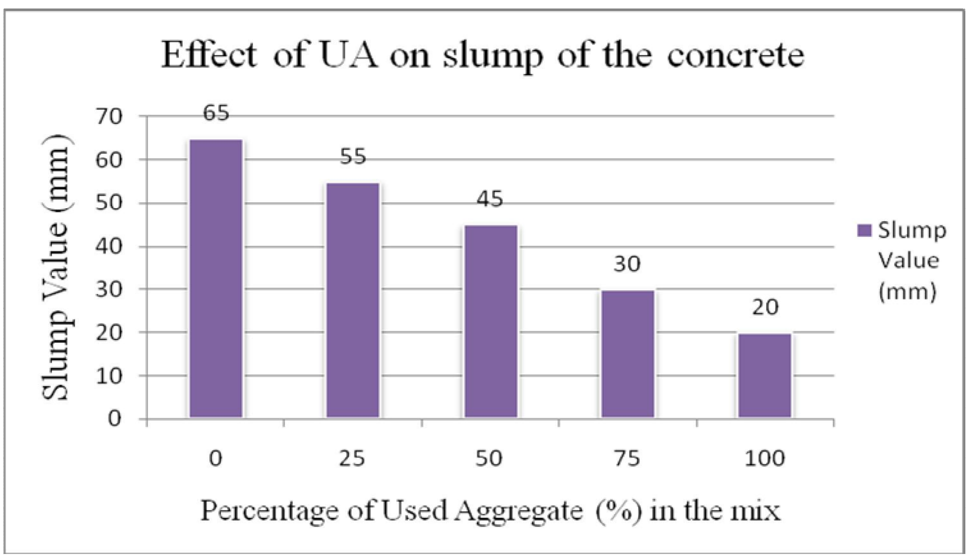


Figure-1 Effect of Used Aggregate on workability of concrete

According to the result, the highest slump obtained was 65 mm and the lowest slump was 20 mm. From the result it indicates that the workability was tending to harshness with increase in replacement with Used Aggregate because used aggregate are more porous as compared to conventional or natural aggregate. Then we prepare mixes with adding superplasticizer with increment rate 10 ml in each batch. The mixes are prepared with 25 % addition of Used Aggregate with 10 ml addition of superplasticizer in each mix. The following mixes are as follows.

Table-8 The Slump Cone Test Result For Each Batch Of Mix Prepared With Superplasticizer

Percentage of Used Aggregate (%)	Water / Cement ratio	Superplasticizer (ml)	Slump (mm)
0	0.55	0	65
25	0.55	10	70
50	0.55	20	70
75	0.55	30	75
100	0.55	40	75

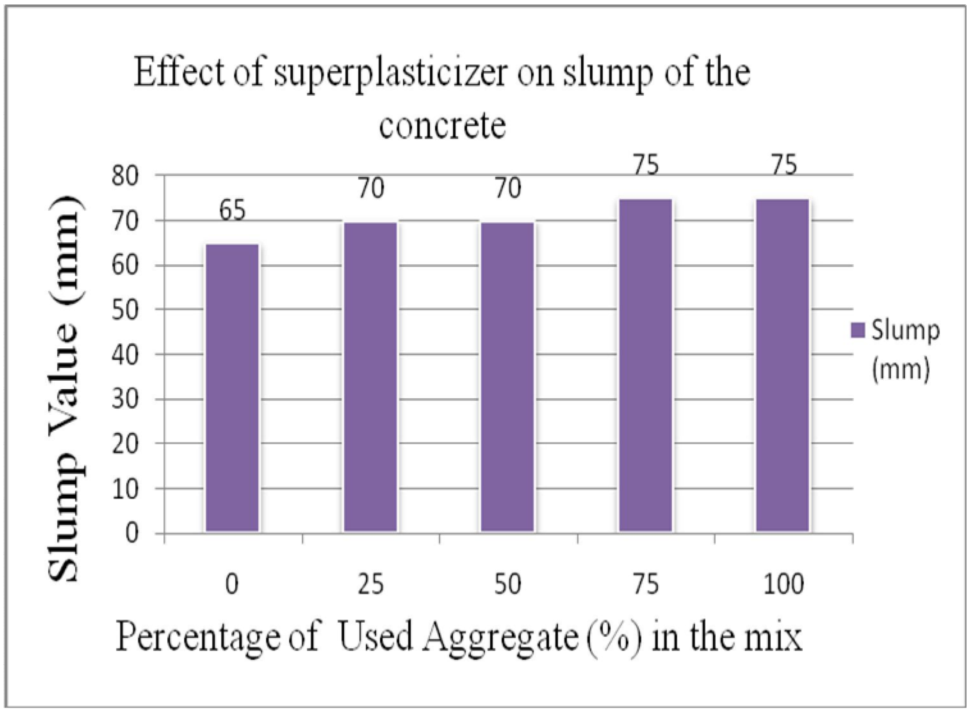


Figure-2 Effect of superplasticizer on workability of concrete

A. Compressive Strength Test Result And Analysis

The compression test by CTM (Compressive Testing machine) indicates an increasing trend of compressive strength with age of the concrete specimens. However, it shows that the strength of used aggregate specimens is lower than natural aggregate specimens.

Table-9 Combine Compressive Strength Results (7 Days)

Mix (Without Superplasticizer)	7 Days compressive strength (Kg/cm^2)	Mix (With Superplasticizer)	7 Days compressive strength (Kg/cm^2)
Mix-I	160	Mix-I	160
Mix-II	150	Mix-II	155
Mix-III	145	Mix-III	150
Mix-IV	140	Mix-IV	145
Mix-V	135	Mix-V	145

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 6 Issue I, January 2018- Available at www.ijraset.com

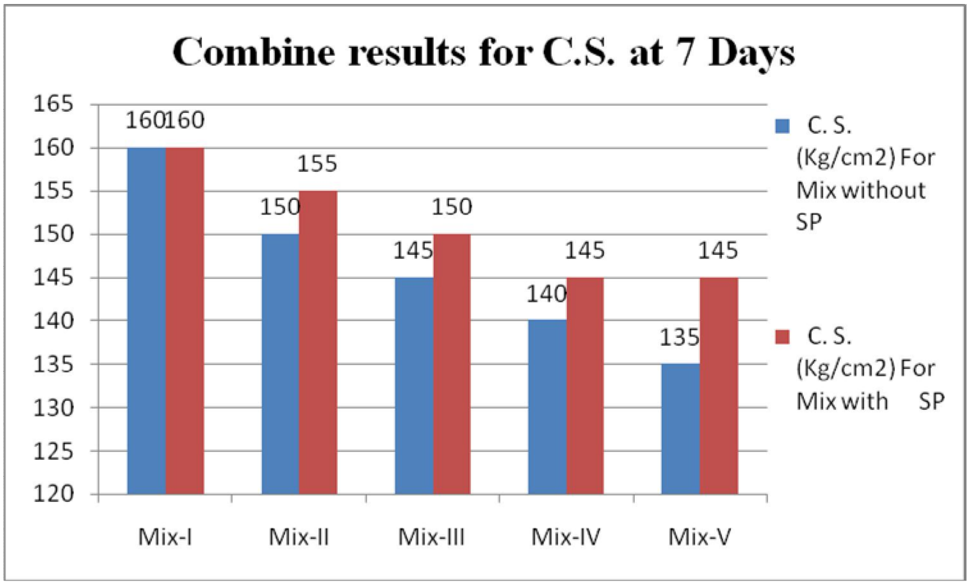


Figure-3 Combine results for C.S. at 7 Days

Table-10 Combine Compressive Strength Results (28 Days)

Mix (Without Superplasticizer)	28 Days compressive strength (Kg/cm^2)	Mix (With Superplasticizer)	28 Days compressive strength (Kg/cm^2)
Mix-I	250	Mix-I	250
Mix-II	240	Mix-II	245
Mix-III	235	Mix-III	240
Mix-IV	230	Mix-IV	235
Mix-V	225	Mix-V	230

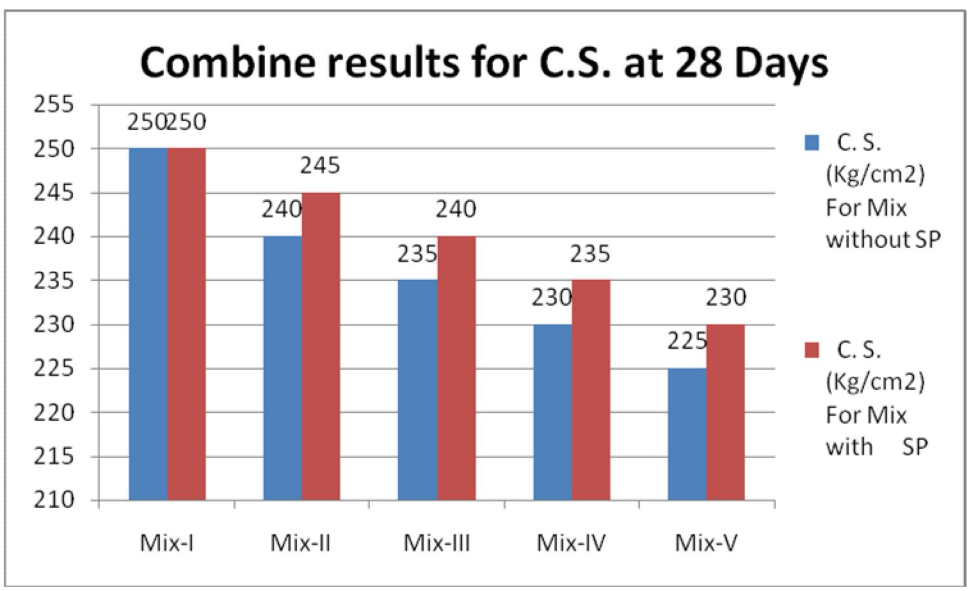


Figure-4 Combine results for C.S. at 28 Days

The target strength for our thesis was 250 kg/cm^2 obtained results shows that the mixes that met the target strength were having 0%, 25%, 50%, 75% and 100% used aggregate. The compressive strength for other mixes is around 250 kg/cm^2. While using the Used Aggregate with superplasticizer the compressive strength of the mixes improves as compared when we were not using superplasticizer in the concrete mix a specimen for 100% Used Aggregate and superplasticizer 40 ml with 0.55 water/cement ratio is achieved 230 kg/cm^2 which is a good level of strength.

These test results also shows that the concrete specimens with higher percentage of replacement of Used Aggregate got the lowest compressive strength when we were not using superplasticizer as compared to the concrete specimens prepared with superplasticizer.

VI. CONCLUSION AND RECOMMENDATION FOR FUTURE WORK

A. Conclusion

These experimental test results indicates that as the percentage of Natural Aggregate decreases by replacing the Used Aggregate, the corresponding compressive strength goes on decreasing, however up to 50% replacement it reduces less compressive strength. Hence, for structural concrete natural aggregate can be replaced by the used aggregate up to 50% limit. The other property like workability of concrete considerably reduces as the amount of used aggregate increases. At the same time when we use superplasticizer with these mixes in varying amount enhances the compressive strength as well as workability. This research paper is targeted to determine the strength characteristics of used aggregate concrete for the potential application in the structural concrete. One thing should always keep in mind while using used aggregate that water content in the concrete mix has to be monitored carefully, because used aggregate absorb more water than natural aggregate by this cause it reduces the compressive strength of the mix to overcome this problem we used superplasticizer i.e. Conplast SP_{430} in the mix.

B. Future Scope

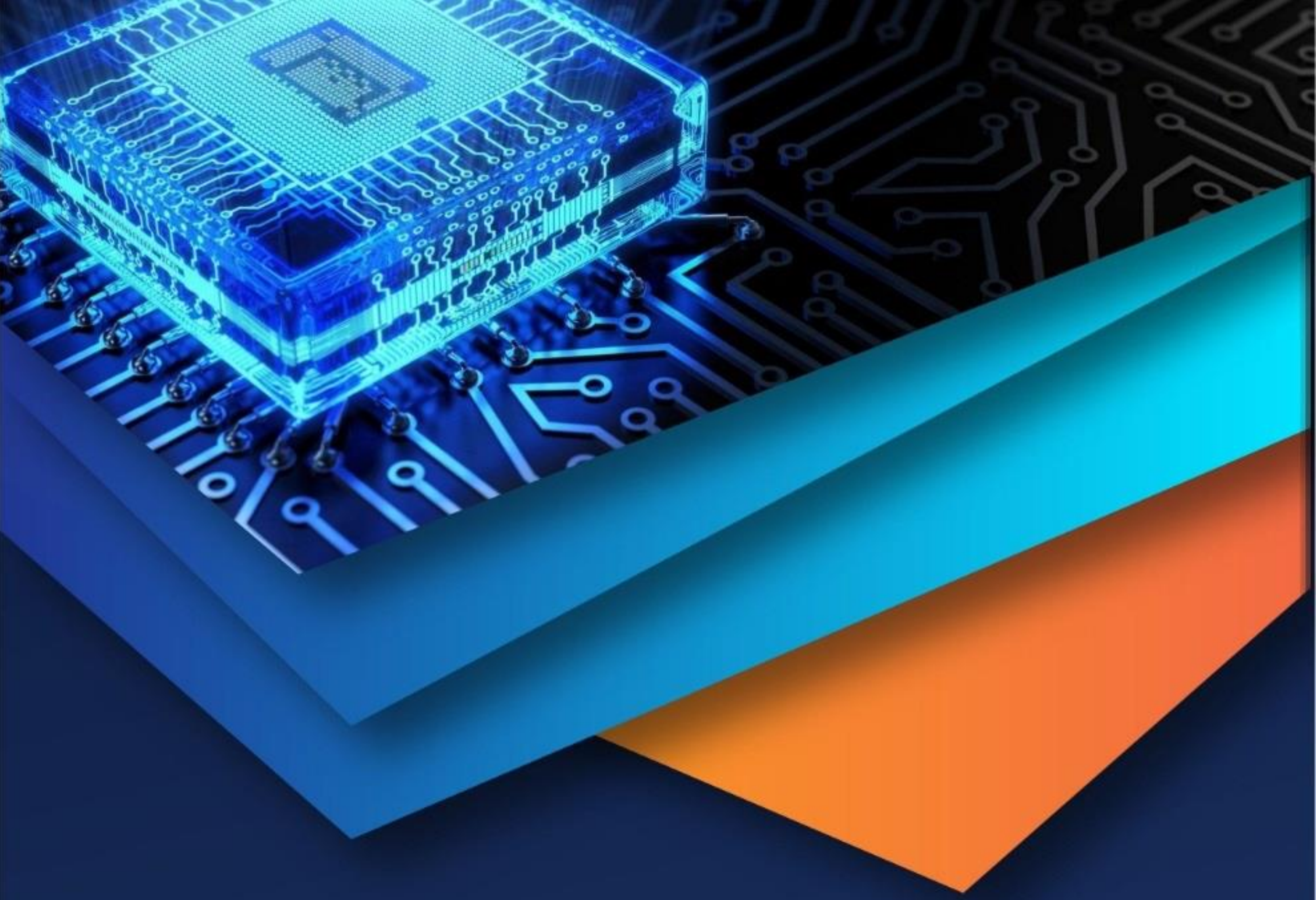
Further testing and studies on the Used Aggregate Concrete are highly recommended to indicate the strength characteristics for application in the structural concrete. Here are some of the recommendations for further research in this field:

1) The effect of admixtures such as water reducer, accelerator and silica fume can be check to improve the workability of Used Aggregate Concrete.
2) The effect of nylon fiber on the compressive strength of Used Aggregate Concrete can be determined.
3) The effect of waste rubber with their variable percentage on the compressive strength of Used Aggregate Concrete can be determined.
4) The effect of stone dust on the various properties of Used Aggregate Concrete can also be determined
5) The effect of used aggregate on conventional concrete with proportion like 5 % U.A. + 95 % N.A., 10 % U. A. + 90 % NA etc could also be study.

REFERENCES

[1] ACI. Manual of concrete practice, 2009.
[2] Amorim, Pedro, Jorge de Brito, and Luis Evangelista. Concrete Made with Coarse Concrete Aggregate: Influence of Curing on Durability. ACI Materials Journal, 2012, 195-204.
[3] Anderson, Keith W, Jeff S Uhlmeyer, and Mark Russel. Use of Used Concrete Aggregate in PCCP: Literature Search. Olympia: Washington State Department of Transportation, 2009.
[4] Building Innovation and Construction Technology, 1999, Recycled Hit, New High, viewed 30 August 2004.
[5] CRISO and Wilmot, Commonwealth Scientific and Industrial Research Organisation, viewed 4 April 2004.
[6] Edward G.N, Concrete Construction Engineering Handbook, Second Edition, the State University of New Jersey New Brunswick, New Jersey, 2008.
[7] Esayas G/Y., chemical admixture, handout for civil engineering students, Addis Ababa University, Institutes of Technology, 2006.
[8] Fact File C & D Recycling Industry, n.d., History, viewed 11 April 2004
[9] Garber, S, et al. Development of a Technology Deployment Plan for the Use of Used Concrete Aggregate in Concrete Paving Mixtures. Ames: National Concrete Pavement Technology Center, 2011.
[10] Hameed, M. 2009. "Impact of transportation on cost, energy, and particulate emissions for used concrete aggregate". Master's Thesis, University of Florida, Florida, USA.
[11] Irving Kett, Engineered Concrete Mix Design and Test Methods; Second Edition.
[12] Ismail Abdul Rahman and Hasrudin Hamdam (2009), "Assessment of recycled aggregate concrete," Modern Applied Science, vol.3, No.10, pp. 47-54.
[13] Jitender Sharma, Sandeep Singla (2014), "Study of Recycled Concrete Aggregates" International Journal of Engineering Trends and Technology (IJETT) – Volume 13 Number 3 – Jul 2014.
[14] Kajima Corporation Research and Development, 2002, recycled aggregate concrete for Within-Site Recycling, viewed 9 September 2004
[15] Ken W.D, concrete mix design, quality control and specification, second edition, E & FN Spon, London, 1999.
[16] Kumar M. P. and Paulo M. J. M., Concrete Microstructure, Properties, and Materials, Third Edition, University Of California at Berkeley, Department Of Civil And Environmental Engineering, United States of America, 2006.
[17] Lemay, L. 2011. "Life cycle assessment of concrete buildings" A report (concrete sustainability report) prepared by NRMCA.

[18] Liaqat A. et al. 2016 “Effect of Using Recycled Concrete as Coarse Aggregate on Tensile and Flexural Strength of Concrete” Fourth international conference on sustainable construction materials and technologies. http://www.claisse.info/proceedings.htm.
[19] Limbachiya, Mukesh, Mohammed Meddah, and Youssef Ouchagour. Use of Recycled Concrete Aggregate in Fly-Ash Concrete. London: Kingston University, 2012, 439-449.
[20] Md. Safiuddin, Ubagaram Johnson Alengaram et al,“Properties of high-workability concrete with used concrete aggregate” Mat. Res. vol.14 no.2 São Carlos 2011 Epub June 03, 2011.
[21] Mirjana Malešev et al. 2014 “Properties Of Recycled Aggregate Concrete” UDK 666.97/.98:691.32 doi: 10.7251/COMEN1402239M.
[22] Neville A.M., Properties of Concrete, Third Edition, Long Man Scientific & Technical Series, Singapore, 1994.
[23] Portland Cement Association. Design and Control of Concrete Mixtures. Skokie, IL: Portland Cement Association, 2002.
[24] Ramachandran V. S., Concrete Admixtures Handbook: Properties, Science, and Technology, Second Edition, Institute for Research in Construction, National Research Council Canada, Ottawa, Ontario, Canada, 1995.
[25] Sandrine Braymand et al. 2015 “Rheological Properties of Recycled Aggregate Concrete Using Superplasticizers” Journal of Civil Engineering and Architecture 9 (2015) 591-597 doi: 10.17265/1934-7359/2015.05.011.
[26] Smith, James T, and Susan L Tighe. "Recycled Concrete Aggregate Coefficient of Thermal Expansion" Transportation Research Board: Journal of the Transportation Research Board (Transportation Research Board of the National Academies), 2009: 53-61.
[27] Statistics Canada 2008. Waste management industry survey: business and government sectors. Available online: http://www.statcan.gc.ca/pub/16f0023x/2010001/t005-eng.pdf Accessed: 11th Jan 2014
[28] Steven Kosmatka H., Beatrix Kerkhoff, and William Panarese C., Design and Control of Concrete Mixtures, USA, 2003.
[29] Yong, P. C. and Teo, D. C. (2009), “Utilization of recycled aggregate as Coarse Aggregate in Concrete,” UNIMAS E-Journal of Civil Engineering, vol. 1, issue1, pp 1-6.



doi crossref

10.22214/IJRASET

INDEX COPERNICUS

45.98

ISRA JIF

IMPACT FACTOR: 7.129

SJIFactor Scientific Journal Impact Factor

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY