# SONARGAON UNIVERSITY

## DEPARTMENT OF CIVIL ENGINEERING

**"A Study on the Utilization of Tiles chips as Coarse Aggregate instead of stone chips in concrete mixture by testing the Compressive and Tensile strength of concrete in the laboratory"**


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**FALL-2019**

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**In partial fulfillment of the requirement for the degree of**

**Bachelor of Science (B.Sc.) in Civil Engineering**

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**SONARGAON UNIVERSITY**

**DEPARTMENT OF CIVIL ENGINEERING**

**Certificate of Approval**

The thesis titled
**"A Study on the Utilization of Tiles chips as Coarse Aggregate instead of stone chips in concrete mixture by testing the Compressive and Tensile strength of concrete in the laboratory"**

Submitted by **Zubayer Ahmad**, **Md.Zahid Hasan**, **Adeson Chakma, Monirul Islam**, **Faisal Ahmed**, Session: Fall -2019 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor degree of Science(B.Sc.) in Civil Engineering.

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# Declaration

We hereby declare that the undergraduate research work reported in this thesis has been perform by us under the supervision of Md. Redowan Rashid and this work has not been submitted elsewhere for any purpose (except for publication).

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**DEDICATED TO OUR**

**PARENTS AND TEACHER**

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**AUTHORS**

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# Abstract

The aim of this experimental work was the investigation of possibilities of utilization of homogenous tiles as coarse aggregate for new building structures. The property of aggregate, such as specific gravity, absorption capacity was tested. 50-cylinder concrete specimens of diameter 100 mm & height 200 mm were made with water cement ratio. Concrete specimens were tested at 14 & 28 days for compressive strength, tensile strength. The selected mix proportion is 1:1.5:3(cement: fine aggregate: coarse aggregate) by volume.

To make a comparison between the properties of concrete made with stone chips and concrete made with 0%, 5%, 10%, 20%, 30% replacement of coarse aggregate by tiles chips.

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## List of Abbreviations

| Acronyms | Elaboration |
|---|---|
| BBS | Bangladesh Bureau of Statistics |
| BNBC | Bangladesh National Building Code |
| LGED | Local Government Engineering Department |
| BUET | Bangladesh University of Engineering and Technology |
| NCA | Natural Concrete Aggregate |
| F.M | Fineness Modulus |
| ACV | Aggregate Crushing Value |
| AIV | Aggregate Impact value |
| F.I | Flaking Index |
| SSD | Saturated Surface Dry |
| PSI | Pound Per Square inch |
| PWD | Public Works Department |
| W/C | Water Cement Ratio |
| Mpa | Mega Pascal |
| ACI | American Concrete Institute |
| ASTM | American Society for Testing and Materials |
| SU | Sonargoan University |
| X | Percent of replacement of concrete. |
| UN | United Nations |
| UTM | Universal Testing Machine |
| SG | Specific Gravity |
| AASHTO | American Association of State Highway and Transportation Officials |
| C&D | Construction and Demolition |
| FA | Fine Aggregate |

# Chapter 1
# Introduction

## 1.1 General

Use of waste tiles materials in construction is a green approach. The alternate materials to replace constituent materials of concrete are a hot research topic. It provides the value addition to the waste materials and helps to achieve the sustainability goals in the construction. Hence, the large number of homogeneous tiles chips are available in the construction and demolition (C&D) waste generated during the renovation and reconstruction work of old building. It is important to identify a method to utilizing the broken tiles chips. In this study, potential of the use of these broken tile's chips in concrete production as coarse aggregate is studied.

One of the significant problems nowadays is the accumulation and management of construction waste. Due to the extensive use of natural aggregate in construction, many countries throughout the world tried to find other of this material to use in construction, such as crushed tiles, pavement blocks, construction waste …etc. One of the alternatives is to recycle and reuse the waste tile. Crushed tile is an industrial waste that causes environmental pollution. Therefore the possible utilization of this material would reduce environmental pollution. The amount of tile waste on earth is enough for use as an aggregate in concrete. Tile is produced from natural materials sintered at high temperatures. Some parts of tiles are used as flooring and also flooring in tennis courts, walkways, cycling paths and gardens as a ground material. Waste tiles are stored in factory fields because of their economic value. Nevertheless, each year approximately 250,000 tons of tiles are worn out, while 100 million tiles are used for repairs. These waste materials can be recycled to save money [1]. The technology of concrete recycling is well established in the U.S. Recycling of Portland cement concrete, as well as asphaltic concrete, has been shown to be a cost-effective alternative for new road, street, and highway construction. As early as 1987, more than 1000 lane miles of Portland cement-

Concrete pavement had been recycled into new pavement. Concrete recycling to produce structural grade concrete for non-pavement uses is technically feasible, with certain precautions. For example, it is generally accepted that when natural sand is used, up to 30 % of natural crushed aggregate can be replaced with coarse recycled aggregate without significantly affecting any of the mechanical properties of the concrete [2].

Poon and Chan (2005)[3] presented study on the investigation of blending recycled concrete aggregate and crushed clay brick as aggregates in the production of paving blocks. The results indicated that the incorporation of crushed clay brick reduced the density, compressive strength and tensile strength of the paving blocks. Due to high water absorption of crushed clay brick particles, the water absorption of the resulting paving blocks were higher than that of the paving blocks that did not incorporate crushed clay brick. Although it was found that crushed clay brick impaired the quality of the resulting paving blocks to a certain extent, the paving blocks using 50% crushed clay brick met the minimum requirements specified by AS/NZS 4455 and ETWB of Hong Kong (Grade B) for pedestrian areas. Also, they found that it was possible to replace 10% fine RCA by a combination of fine brick and tile aggregate in the production of concrete paving blocks, which showed satisfactory performances.

Fung, (2005)[4] discovered that the maximum content of recycled coarse aggregates could be raised to 50% from a current practice of 20% for Grade 30 concrete and below, and to 30% for Grade 35 to Grade 45 concretes. Lower replacement levels are suggested for recycled aggregates of lower quality. Similarly other properties of recycled aggregate concrete have also found satisfactory and its use in Hong Kong for structural application is now gradually increasing.

Dunster (2007)[5] described the use of both natural stone waste and production waste as coarse aggregates in concrete landscaping products. Many of these concrete products routinely include industrial by products and recycled/secondary aggregates.

Example includes mainly recycled concrete aggregates (from crushed production waste), furnace bottom ash, ground granulated blast furnace slag, pulverized fuel ash. Increasingly, manufacturers of landscaping products crush this material into recycled concrete.

Aggregate at the manufacturing site and recycle into new production as a partial replacement for primary aggregates.

Johnny et al (2007)[6] investigated that the salvage of aggregate from the recycled demolition waste is receiving more and more attention across the globe due to its importance in sustaining our environment.

Arunaet al[7] studied the potential of use of broken tiles for the part replacement to coarse aggregates in concrete. The percentage replacement used was 0 to 30 percent. Elci [8] studied the use of floor and wall tiles as aggregate in concrete production. The wall tile is reported to have lower density and high water absorption compared to floor tiles. Prasad et al. [9] used clay tile aggregate to replace crushed stone aggregate in 30 MPa concrete. The replacement ratios of 0, 5, 10 and 30 % were tried and the test results indicated that up to 20 % replacement can be recommended.

Awoyera et al. [10] used ceramic tile waste as coarse aggregate in concrete. The results showed that the increase in strength is about 36.1 % corresponding to a replacement ratio of 100%. Kavitha and Sundar [11] carried out experimental study to use ceramic tile waste as partial replacement of coarse aggregate in concrete. It was suggested that the optimum dosage of the ceramic tile aggregate is 25% of the total aggregate in concrete. Isah [12] suggested that the optimum replacement ratio of the waste ceramic tile chips as aggregate in concrete is 10%.Sekar [13] studied the influence of partial replacement of coarse aggregate with ceramic tile waste in concrete. The replacement percentage of 0, 15, 30 and 45 % was used.

The test result showed that there is a significant increase in strength up to 15% replacement and beyond which there is no such improvement in the strength. .

Abdulla [14] prepared concrete containing construction and demolition waste. The aggregate replacement ratio of 100 % was used. The test results indicated that the use of demolition waste aggregate in concrete does not influence the strength properties of concrete.

## 1.2 Objectives

### The main objective of the research is:

a) To determine the mechanical properties of tiles chips aggregate
b) To make a comparison between the properties of concrete made with stone chips and concrete made with 0%, 5%, 10%, 20%, 30% replacement of coarse aggregate by tiles chips.
c) To observe the compressive and tensile load capacity of concrete.
d) To know the effect of tiles chips incorporation on the permeability of
Previous concrete.

## 1.3 Concrete

Concrete is a composite material consist of mainly water, aggregate, and cement. The physical properties desired for the finished material can be attained by adding additives and reinforcements to the concrete mixture. A solid mass that can be easily molded into desired shape can be formed by mixing these ingredients in certain proportions. Over the time, a hard matrix formed by cement binds the rest of the ingredients together into a single hard (rigid) durable material with many uses such as buildings, pavements etc., The technology of using concrete was adopted earlier on large-scale by the ancient romans, and the major part of concrete technology was highly used in the Roman Empire. The coliseum in Rome was built largely of concrete and the dome of the pantheon is the World's largest unreinforced concrete structure. After the collapse of Roman Empire in the mid-$18^{th}$ century, the technology was re-pioneered as the usage of concrete has become rare. Today, the widely used man made material is concrete in terms of tonnage.

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## 1.4 Historical Background

Although high strength concrete is considered as relatively a new material, its development has been gradually increasing over years. In 1950s, USA considered the concrete with a compressive strength of 34mpa as high strength. In 1960's, the concrete with compressive strength 41mpa to 52mpa was used commercially. In the early 1970's, 62mpa concrete was been made. With in the world state of affairs, however, within the last fifteen years, concrete of terribly high strength entered into the construction sector of high-rise buildings and long span bridges. The compressive strength over 110mpa has been thought-about by IS 456-2000 for the applications in pre-stressed concrete members and cast-in-place buildings.

However, recently reactive concrete could be the one that having a compressive strength of nearly 250mpa. It is fully supported by pozzolanic materials. The first distinction between high-strength concrete and nominal-strength concrete refers to the relation of utmost resistance offered by compressive strength of the concrete sample for the application of any type of load. Though there is no correct separation between
High-strength concrete and normal-strength concrete, the Yankee Concrete Institute defined the compressive strength greater than 42mpa as high strength concrete.

## 1.5 Properties of concrete

Generally the Concrete is a material having high compressive strength than to tensile strength. As it has lower tensile stress it is generally reinforced with some materials that are strong in tension like steel. The elastic behavior of concrete at low stress levels is relatively constant but at higher stress levels start decreasing as matrix cracking develops. Concrete has a low coefficient of thermal expansion and its maturity leads to shrinkage.
Due to the shrinkage and tension, all concrete structures crack to some extent. Concrete prone to creep when it is subjected to long-duration forces. For the applications various tests be performed to ensure the properties of concrete correspond to the specifications. Different strengths of concrete are attained by different mixes of concrete ingredients, which are measured in psi or Mpa. Different strengths of concrete are used for different purposes of constructions. If the concrete must be light weight a very low-strength concrete may be used. The Lightweight concrete is achieved by the addition of lightweight aggregates, air or foam, the side effect is that the strength of concrete will get reduced. The concrete with 3000-psi to 4000-psi is oftenly used for routine works. Although the concrete with 5000-psi is more expensive option is commercially available as a more durable one. For larger civil projects the concrete with 5000-psi is often used. The concrete strength above 5000 psi was often used for specific building elements. For example, the high-rise concrete buildings composed of the lower floor columns may use 12,000 psi or more strength concrete, to keep the columns sizes small.

Bridges may use concrete of strength 10,000 psi in long beams to minimize the number of spans required. The other structural needs may occasionally require high- strength concrete. The concrete of very high strength may be specified if the structure must be very rigid, even much stronger than required to bear the service loads. For these commercial reasons the concrete of strength as high as 19000-psi has been used.

## 1.6 Construction waste in Bangladesh

In the present construction world, the solid waste is increasing day by day from the demolitions of constructions. There is a huge usage of homogeneous tiles in the present constructions is going on and it is increasing in day by day construction field. Homogeneous products are part of the essential construction materials used in most buildings. Some common manufactured homogeneous include wall tiles, floor tiles, and household homogeneous and technical homogeneous. They are mostly produced using natural materials that contain high content of clay minerals. However, despite the ornamental benefits of tiles, its wastes among others cause a lot of nuisance to the environment. And also in other side waste tile is also producing from demolished wastes from construction. Bangladeshi tiles production is 100 million ton per year in the industry, about 15%- 30% waste material generated from the total production. This waste is not recycled in any form at present, however the tiles waste is durable, hard and highly resistant to biological, chemical and physical degradation forces so, we selected these waste tiles as a replacement material to the basic natural aggregate to reuse them and to decrease the solid waste produced from demolitions of construction. Waste tiles were collected from the surroundings. There are some researchers are also going on solid waste from construction to reuse them again in the construction to reduce the solid waste and to preserve the natural basic aggregates. These researches promotes to use the recycled aggregates in the concrete mix and they got good result when adding some extent percentages of recycled aggregates in place of natural coarse aggregate.

## 1.7 Homogeneous tiles

Homogeneous tiles are considered the strongest floor materials available commercially. These tiles are also known as porcelain tiles or unglazed porcelain tiles due to the lack of color in the tiles. Composed of special tiling materials and clay, the homogenous tiles are subject to high heat temperature of up to 1500 degree centigrade. The strong firing process makes the homogeneous tiles strong and water-resistant, which is why they're mostly used in tile installation and tile renovation projects. Homogeneous tiles are best used for long-term purposes as they do not show any signs of chipping or wearing in comparison to the glazed tiles.

## 1.8 Characteristics and uses of Homogeneous tiles

- Designed especially for heavy foot traffic
- Near impermeable quality
- Low maintenance
- Wide selection range
- Stain and chemical resistant
- Mechanical strength
- Slip resistance

## 1.9 Environmental and Economic Benefits of Tile chips as coarse aggregate in concrete

The usage of waste tile chips as replacement to coarse aggregate in concrete has the benefits in the aspects of cost and reduction of pollution from construction industry. The cost of concrete manufacturing will reduce considerably over conventional concrete by including tile aggregate since it is readily available at very low cost and there-by reducing the construction pollution or effective usage of construction waste.

## 1.10 Research Methodology

Figure 1.1 is the follow diagram of methodology, shown in the following section

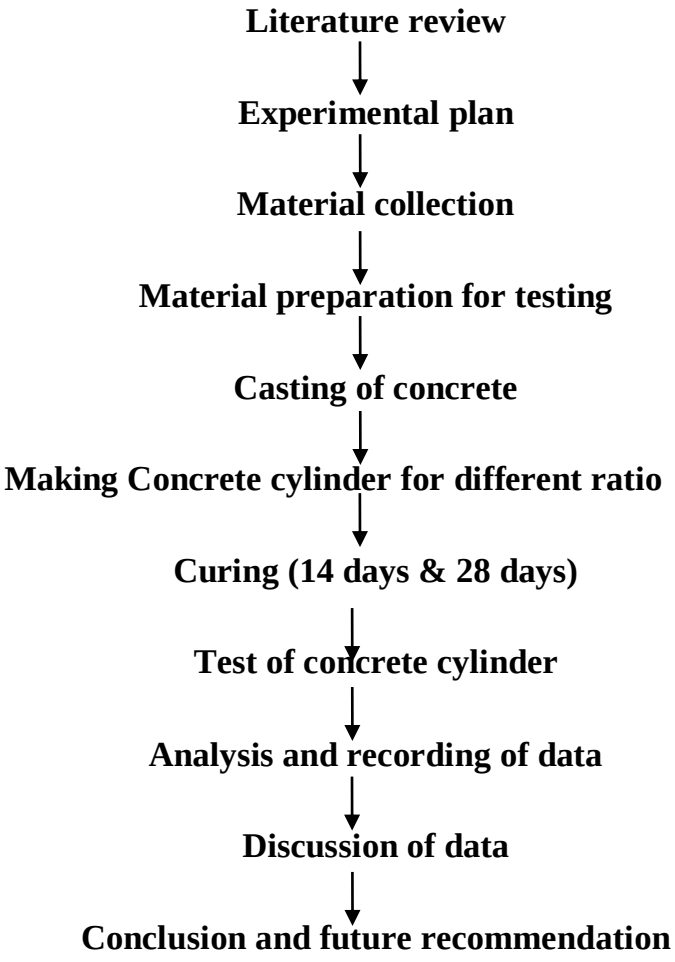



**Figure 1: 1 Flow diagram of methodology**

# Chapter 2
# Literature review

## 2.1 General

In this study it has been used tiles chips& stone chips aggregates. Concrete mixture can be designed to provide a wide range of mechanical properties to meet the design requirement of a structure. The compressive strength of concrete is the most common parameter used by the engineer to design the buildings and other structure. The different Compressive strength test result primarily uses to determine the concrete mixture to meet the requirement of specified strength *f'c.* This chapter we will discuss the Characteristics and historical development of concrete and also include the properties of mixed design.

## 2.2 Historical development mixed design

Significant quantities of waste are being produced and discarded by the construction and demolition (C & D) industries within the Asia and many other developed countries, and this is likely to increase considerably in the future. On the other hand, in recent years the construction industry throughout the world has supported initiatives to improve sustainability by increasing the use of partial replacement in concrete production.
This is mainly because of the depletion of quality primary aggregates and in some quarters, greater awareness of environmental protection. It is now widely accepted that there is a significant potential for reclaiming and recycling demolished debris for use in value added applications to maximize economic and environmental benefits.
American Concrete Institute (ACT) method (1996) is one of the most popular methods for design of normal concrete mixes. The method utilizes the fact that water content determines the workability for a given maximum size of coarse aggregate. A further

assumption is made that coarse aggregate volume per unit volume of concrete depends on maximum size of aggregate and fineness modulus of fine aggregate.

## 2.3 Effective Coarse aggregate content on the compressive strength

The effect of coarse aggregate content on the compressive strength concrete with and without chemical admixture is illustrated Fig. 2.1. When no chemical admixture was added, increasing the coarse aggregate content from 44% to 47% hassled to an increase of the compressive strength. This result is in accordance with stock et al.'s conclusion which stipulates that the compressive strength increases when increasing the aggregate content. Moreover, when adding chemical admixtures, the results showed that the optimum content of the coarse aggregate is ranging generally between 45% to 46%.

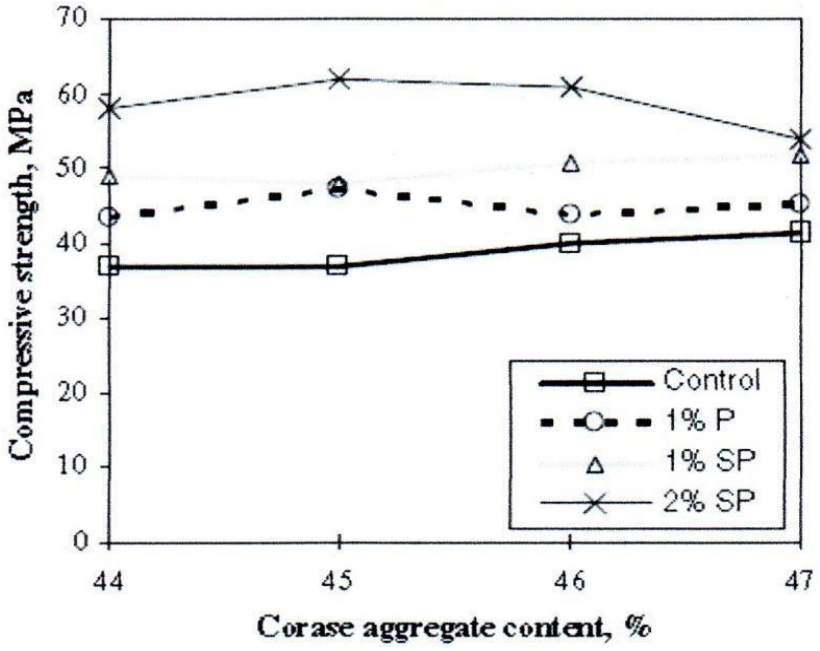



Figure 2.1: Effect of the coarse aggregate content on the compressive strength concrete.

Regarding the results of the compressive strength obtained it should be noted that in case of the NSC and for the same coarse aggregate content, a continuous grain size

Distribution system is more advantage and provides a better compressive strength than the gap graded aggregate, conversely, for the HSC, the gap system provided the highest compressive strength than the continuous granular system. The sand/gravel ratio (s/g) may also illustrate the effect of the coarse aggregate on the compressive strength

Development of concrete mixture. Fig.2.2 shows the compressive strength development versus the s/g. It can be observed that within the value ranging from 0.58 to 0.49, the s/a have no significant effect on the compressive strength of control. However, decreasing the w/c by the addition of different proportion of the WRA or HRWRA, the effect of the s/a become more perceptible. The results have indicated that the proportion of both coarse and aggregates should be optimized regarding the mixture parameters and the mechanical properties. Figure 2.2: Effect of s/g on the compressive strength. Meddah et al. 2010[15]

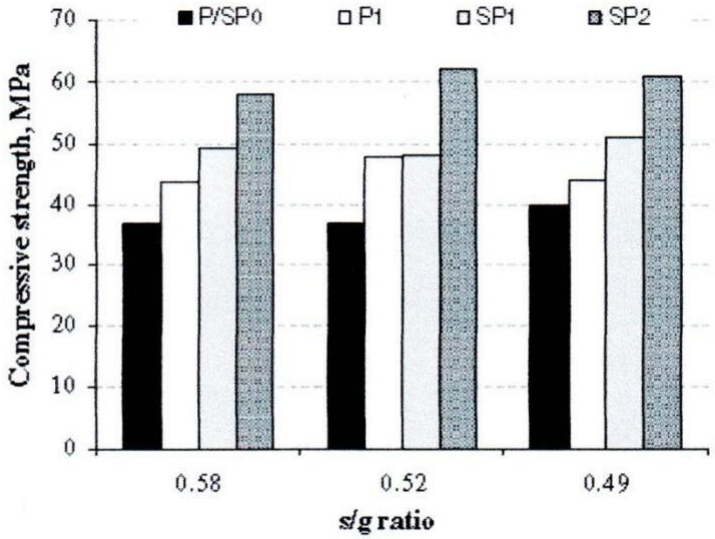



Figure 2.2: Effect of s/g on the compressive strength

Aitcin and Mehta (aitcin,P-C and ,P.k,1990)[16] studied the effect of coarse aggregate characteristics on mechanical properties of high strength concrete. The experiment was carried out using four coarse aggregate types available in North California and similar mix properties. The results showed that using database and limestone aggregates produced concrete with significantly higher strength and elastic modulus than those using Granite and river gravel. They concluded that the mineralogical differences in the aggregate's types were responsible for this behavior.

**Table 1 ACI mix design parameters, variation ranges and assigned values**

| Sl No | Mix design parameters | Unit | Variation range | Assigned value |
|---|---|---|---|---|
| 1 | Void ration of coarse aggregate | - | 0.1-0.5 | - |
| 2 | Design strength | Mpa - | 13.8-34.5 | 27.6 |
| 3 | Fitness modulus of fine aggregate | - | 1.75-3.00 | 2.4 |
| 4 | Maximum size of coarse aggregate | Mm | 10-75 | 40 |
| | | | | |

Table 2.1: Materials required for 1 $m^3$ of Concrete.

The unit weight of coarse aggregate was varied and the respective values of the other parameters were assigned to their initial ones (Table 1).

After having a picture of the effect of this variation on the fa/ca ratio and cement/total aggregate ratio, other parameters were also varied from their initial ones. Figures 1 graphically present the effect of these variations on fa/ca content, while Figures 7 to 12 illustrate those effects on cement/total aggregate content. Figure 2.3: Effect of variation CA unit weight and design strength on fa/ca.

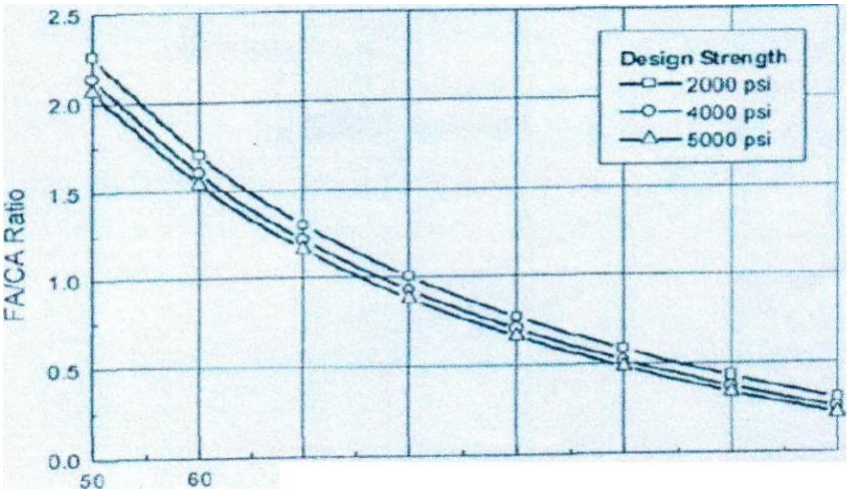
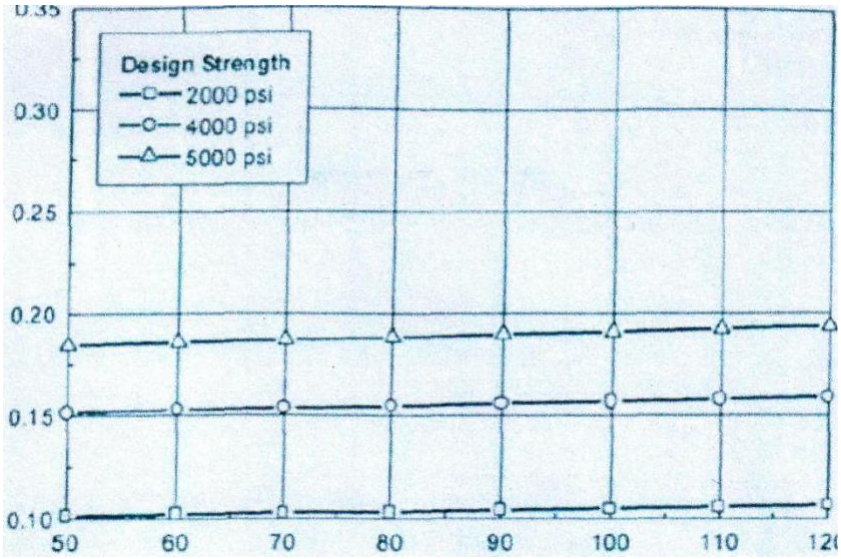



Figure 2.3: Effect of variation CA unit weight and design strength on FA/CA Figure 2.4: Effect of variation of CA unit weight and design strength on Cement/Total aggregate ratio.



## 2.4 **Effect of sand to aggregate ratio**

Malhotra, H. L. 1965[17] The aggregate/cement ratio has a significant effect on the strength of concrete exposed to high temperature, the proportional reduction being smaller for lean mixes than for rich mixes. Concrete under a compressive stress of the order of its design stress has a smaller proportional decrease in strength than if the stress were absent. The effect of temperature on the crushing strength of concrete is independent of the water/cement ratio within the range normally used in its manufacture.

## 2.5 **Effect of water to cement ratio**

No significant effect for the changes of water to cement ratio of ordinary concrete on its shielding. The strength of the studied specimens decreases significantly with the increase of the W/C ratio. Hence, there is no need to increase this water to cement ratio as a way to improve the shielding effectiveness of ordinary concretes.

Cement ratio (w/c) which ranges from 8 to 0.40. Compressive strength function the PSD of coarse aggregate was determined at 7, 14 and 28 days. Results have revealed that the mixtures without chemical admixture made with a ternary combination of granular fraction and having a maximum size of 25 mm, that assures a continuous granular size distribution, have shown the highest compressive strength. However, decreasing the w/c by the inclusion of WRA or HRWRA requires a decrease of the maximum size of coarse aggregate and some adjustment in the granular size distribution system. The binary granular system has led to the highest compressive strength when dealing with low w/c.

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## 2.6 **Fresh property test**

Concrete is tested to ensure that the material that was specified and bought is the same material delivered to the job site. There are a dozen different test methods for freshly mixed concrete and at least another dozen tests for hardened concrete, not including test method unique to organization like the Army Corps of Engineers, the Federal Highway Administration, and State department of transportation. **Air content, unit weight and compressive strength tests** are most common tests.

**Air content** measure the total air content in a sample of fresh concrete, but does not indicate what the final in-place air content will be, because a certain amount of air is lost in transportation Consolidating, placement and finishing.

The lost in transportation Consolidating, placement and finishing. Three field tests are widely specified: the pressure meter and volumetric method are ASTM standards and the Chace Indicator is an AASHTO procedure.

**Unit weight** measures the weight of a known volume of the fresh concrete.

Break the concrete cubes at prescribed interval as they harden. According to Building Code Requirements for reinforced concrete (ACI 318) as long as no single test more than 500 psi below the design strength and the average of three consecutive tests equals or exceed the design strength then the concrete is acceptable. If the strength tests don't meet these criteria, steps must be taken to raise the Compressive strength are testes by pouring cubes of fresh concrete and measuring the force needed to average.

## 2.7 **Hardened properties:**

The properties which determine the quality of the **hardened concrete** broadly fall into the following three groups:

1. Strength.
2. Durability.
3. Dimensional stability.

Fully cured, hardened concrete must be strong enough to withstand the structural and service loads which will be applied to it and must be durable enough to withstand the environmental exposure for which it is designed

If concrete is made with high-quality materials and is properly proportioned, mixed, handled, placed and finished, it will be the strongest and durable building.

The saturated surface dry (ssd) density of the recycled coarse aggregate due to the presence of adhered mortar was lower than that of conventional aggregates. However, the largest difference existed in the water absorption capacity because of the high absorption capacity of the adhered mortar, as illustrated in Table 1. The Los Angeles abrasion of recycled coarse and conventional was 33.5% and 19.8%. Respectively. The largest abrasion happened in adhered mortar.

### 2.7.1 **Compressive Strength of Concrete**

Compression test is the most common test conducted on hardened concrete. In this study cylindrical specimens were used. The size of the cylinder specimens were 4 in. dia And 8 in height. Universal testing machine was used to loading. Capacity of the testing machine 1000 KN and rate of loading was 250 KN/minute. The test method conforms to the ASTM standard requirements of specification C39 for cylinder. Figure 3.3 shows the set-up of compressive strength test.

### 2.7.2 Tensile strength

Although concrete is not normally designed to resist direct tension, the knowledge of tensile strength is of value on estimating the load under which cracking will develop. In this study we have consider two types of test for strength of tension:

- Flexural test and
- Splitting cylinder test.

Higher tensile strengths were obtained with crushed basalt and limestone compared to the gravel aggregate when used in high strength concrete. In the replicate mixture, approximately 30 percent. increase in flexural and splitting tensile strengths were obtained as a result of using stronger cement, while the compressive strength was not affected at all.

### 2.7.3 Flexural Strength Test

In this test a plain concrete beam is subjected flexure using two point loading until failure occurs. The theoretical maximum tensile stress reached if the bottom fiber of the test beam is known as the modulus of rupture. And it is Me computed by —

PL h

^ = ^

PLh12 6 bh3

2PL $bh^2$

i $P^{=}$ maximum total load on the beam L= Span

b= width of the beam h= depth of the beam

The test method conforms to the standard requirements of specification ASTM C293 for cylinder. Fig. 3.4 shows the set-up of beam during tensile strength test.

The flexural strength depends on the w/c ratio, coarse aggregate volume, and the quality of the interface between the aggregate and cement paste. The flexural strength should be determined in accordance with ASTM C 78 or C 293 by an ACI certified technician.

# Chapter 3
# Methodology

## 3.1 General

In this chapter we describe are experimental work of project and also briefly description are collection of materials, predation of materials, testing of materials and explained of experimental works.

## 3.2 Materials

In this thesis project we were used to tile chips aggregate in local market and. Both coarse aggregate maximum size 25 mm and minimum size 5 mm. Fine aggregate were used to Sylhet sand. In this project were used PCC Cement.

## 3.3 Materials investigation

Investigating materials is very important. It provides a good starting point for countless other investigations relating to the special characteristics or properties of materials which make different materials suitable for different jobs.

There are a great many things which can be done. Following is an outline structure for a series of possible activities based around the properties of materials. All of the activities have been tried and tested. The aim is to keep pupils interested, learn about materials and encourage pupils to be inquisitive and to suggest ways in which more can be discovered.

### 3.3.1 Coarse aggregate gradation

We were used to two types of coarse aggregate. The materials collected from local market. We were lab test collected materials for investigation of physical properties of the aggregates. The figure of coarse aggregate is shown below.



Figure 3.1: Tiles chips

### 3.3.2 Fine aggregate

For this research purpose we were used to Sylhet sand which FM value were 2.66 that is available in gabtoli beribadh local market. For concrete casting we were used to SSD condition fine aggregate.



Figure 3.2: Fine aggregate

### 3.3.3 Sieve analysis

The sieve analysis commonly known as the gradation test is a basic essential test for all aggregate technicians. The sieve analysis determines the gradation the distribution of aggregate particles by size within a given sample. Production control requirements and verification specifications. The gradation data may be used to calculate relationships between various aggregate or aggregate blends to check compliance with such blends and to predict trends during production by plotting gradation curves graphically to name just a few uses. Used in conjunction with other tests the sieve analysis is a very good quality control and quality acceptance tool. This test is issued under fixed designation of ASTM C136-03.

| Sieve no | Sieve Opening (mm) | Material Retained (gm) | %of Material Retained | Cumulative % of Retained | % of Fine |
|---|---|---|---|---|---|
| #4 | 4.75 | 0 | 0 | 0 | 100 |
| #8 | 2.36 | 22.4 | 4.48 | 4.48 | 95.52 |
| #16 | 1.19 | 100.6 | 20.12 | 24.6 | 75.4 |
| #30 | 0.59 | 165.8 | 33.16 | 57.76 | 42.24 |
| #50 | 0.15 | 136.8 | 27.36 | 85.12 | 14.88 |
| #100 | | 56 | 11.2 | 96.32 | 3.68 |
| Pan | | 18.4 | 3.68 | 100 | 0 |

Table 3.1: Sieve analysis of fine aggregate

FM = *Zj* of cumulative % of material retained on standard sieve 7100

266.28 100= 2.66

So the FM of fine aggregate is 2.66

### 3.3.4 Cement

For this research purpose (PCC) was used name Crown Cement. This is Portland composite Cement.

| Chemical | % of composition |
|---|---|
| Clinker | 65-70 |
| Fly ash | 0-20 |
| Gypsham | 0-10 |

Table 3.2: Reveal the chemical composition of PCC

### 3.3.5 Water

For this test was used the potable water for all concrete mix. And temperature of the mixing water was about 25± l°C.This was collected from the same source.

## 3.4 Preparation of aggregate for casting

Preparation of Aggregate for all concrete casting is divided into two steps. Two steps are preparation of coarse Aggregate (Tile chips & stone chips) and fine aggregate.

### 3.4.1 Preparation of coarse aggregate

First of all the coarse aggregate gradation of materials were done. The coarse aggregate was kept under water in 24 hours for all casting. Remove of the coarse aggregate from the water after 24 hours and wiped out the water surface using cloths, jute clothes fan for SSD condition. By those steps, the course aggregate is preparation for casting. Figure 3.3: Preparation of coarse aggregate.



Tile chips



Stone chips

Figure 3.3: Preparation of coarse aggregate

### 3.4.2 Preparation of fine aggregate



Figure 3.4: preparation of fine aggregate

### 3.5.1 Mold Preparation



Figure 3.5: Mold preparation

### 3.5.2 Casting and mixing

In this experiment hand mixing method is used for the casting. Hand mixing should be done on a smooth, clean and watertight platform of suitable size. We have maintained the following manner: Measured quantity of sand is spread evenly.

The required quantity of cement is dumped on the sand and spread evenly.

The sand and cement is then mixed intimately with spade, turning the mixture over and over again until it is of even color throughout and free from streaks.

The sand cement mixture is then spread out and measured quantity of coarse aggregate is spread on its top. Alternatively, the measured quantity of coarse aggregate is spread out and the sand cement mixture is then spread on its top.

The whole mass should be mixed at least three times by shoveling and turning over by twist from center to side, and then back to the center and again to the sides.

A hollow is made in the middle of the mixed pile.

Three quarters of the total quantity of water required should be added while the materials are turned in towards the center with spades. The remaining water is added by a water-can fitted with rose head, slowly turning the whole mixture over and over again until a uniform color and consistency is obtained throughout the pile.

5 percent extra cement shall be added than the specified for machine mixing, when hand mix cement concrete is produced.

The required PPEs (Personal Protective Equipment) shall be worn by the labors and masons while mixing and handling the concrete.

The mixing platform should be washed at the end of the day.

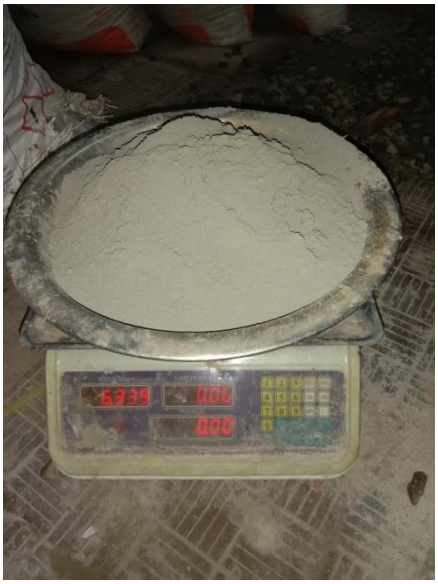


Figure 3.6: measurement of cement



Figure 3.7: Mold processing& mixing

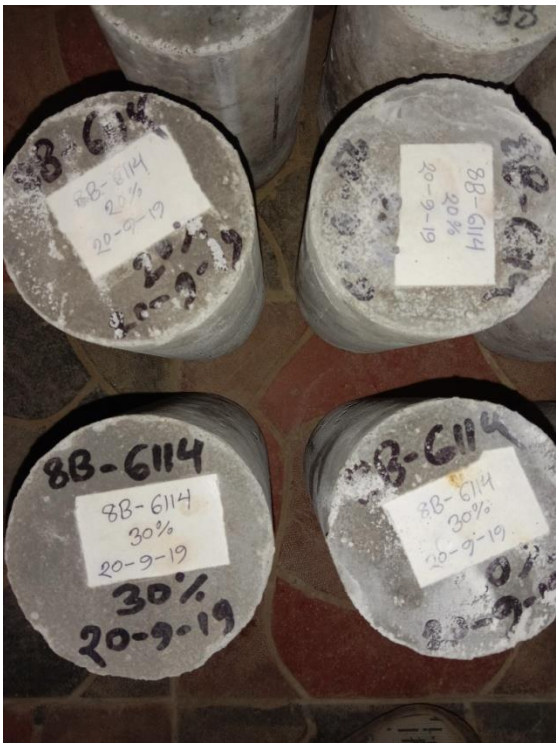



Figure 3.8: 14 days curing
Cylinder before crush

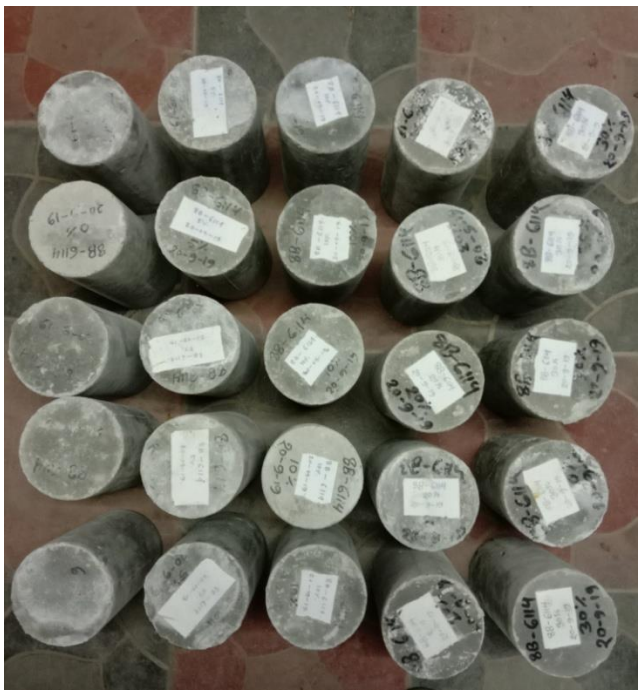


Figure 3.9: 28 days curing
Cylinder before crush



Figure 3.10: preparation of crushing & data collection for cylinder

## 3.6 Test procedure of hardened properties

Molds were curing under the water were lifted out after 14 days, 28 days. Then those mold specimens washed and wiped out from surface properly.

Molds compressive and tensile strength were tested. These test method under issued fixed designation of ASTM C39 / C39M-03 and ASTM C496-03.



Figure 3.11: compressive strength test for 14 days curing cylinder



Figure 3.12: compressive strength test for 28 days curing cylinder



Figure 3.13: Tensile strength Test for 14 days curing cylinder.



Figure 3.14: Tensile strength Test for 28 days curing cylinder.

# Chapter 4

# Data Analysis

| Sample | 14 days strength data | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Details (% of Tiles chips) | Compressive Strength | | | | | | Tensile Strength | | | | |
| | | Weight (gm) | Load (kN) | Load (lb) | Strength (Psi) | Avg. (Psi) | Weight (gm) | Load (kN) | Load (lb) | Strength (Psi) | Avg. (Psi) |
| 0% | 1 | 4287 | 170 | 38216 | 3042 | 3221 | 4305 | 50 | 11240 | 895 | 760.5 |
| | 2 | 4191 | 200 | 44960 | 3580 | | 4287 | 35 | 7868 | 626 | |
| | 3 | 4159 | 170 | 38216 | 3042 | | -- | -- | -- | -- | |
| 5% | 1 | 4145 | 195 | 43836 | 3490 | 3770 | 4222 | 50 | 11240 | 895 | 966.5 |
| | 2 | 4291 | 170 | 38216 | 3042 | | 4190 | 58 | 13038 | 1038 | |
| | 3 | 4153 | 200 | 44960 | 3580 | | -- | -- | -- | -- | |
| 10% | 1 | 4209 | 235 | 52828 | 4206 | 3788 | 4270 | 75 | 16860 | 1342 | 1118.5 |
| | 2 | 4174 | 215 | 48332 | 3848 | | 4110 | 50 | 11240 | 895 | |
| | 3 | 4174 | 185 | 41588 | 3311 | | -- | -- | -- | -- | |
| 20% | 1 | 4117 | 200 | 44960 | 3580 | 3729 | 4092 | 35 | 7868 | 626 | 626 |
| | 2 | 4172 | 205 | 46084 | 3669 | | 4067 | 35 | 7868 | 626 | |
| | 3 | 4139 | 220 | 49456 | 3938 | | -- | -- | -- | -- | |
| 30% | 1 | 4169 | 110 | 24728 | 1969 | 1850 | 4038 | 40 | 8992 | 716 | 626.5 |
| | 2 | 4045 | 100 | 22480 | 1790 | | 4042 | 30 | 6744 | 537 | |
| | 3 | 4043 | 100 | 22480 | 1790 | | -- | -- | -- | -- | |

Table 4.1: Concrete strength data after 14 days curing cylinder

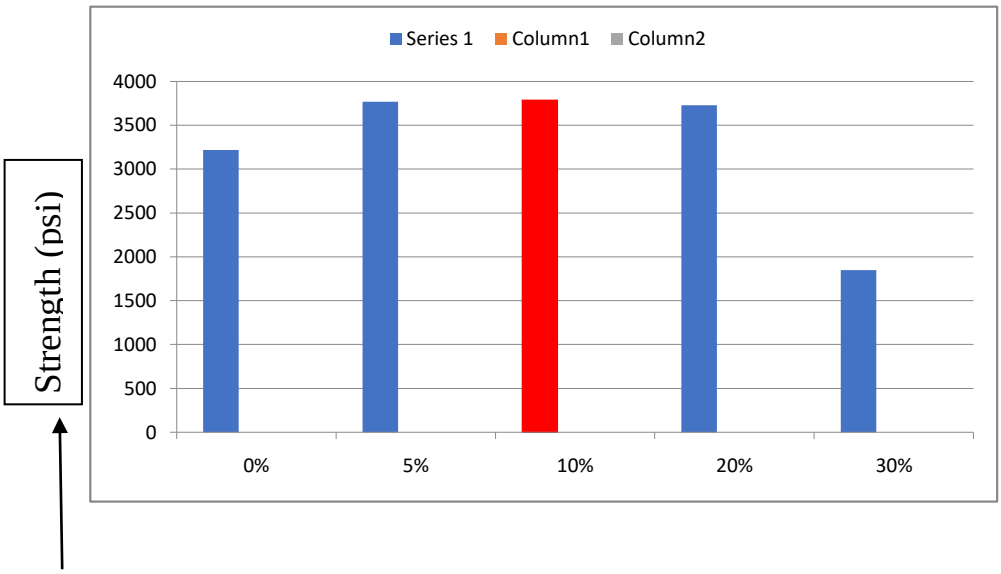



Figure 4.1: Compressive strength (psi) average (14 days)

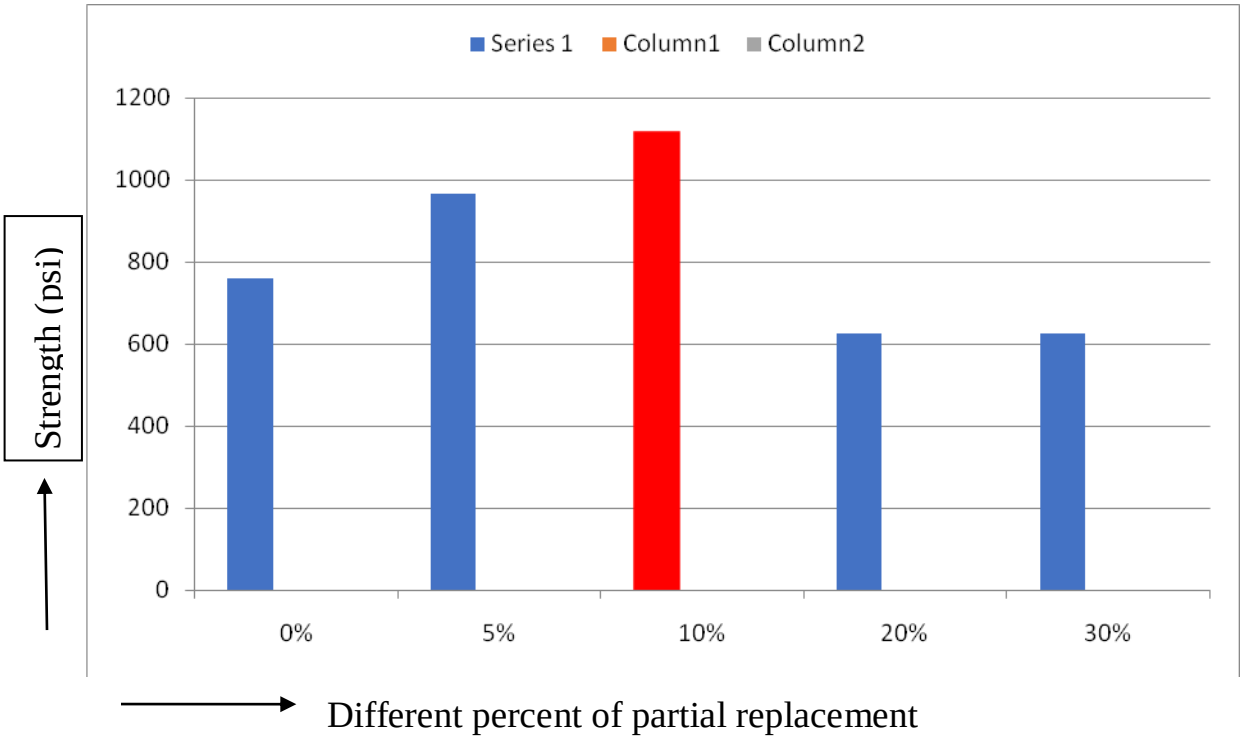



Figure 4.2: Tensile strength (psi) average (14 days)

| Sample | 28 days strength data | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Details (% of Tiles chips) | Compressive Strength | | | | | | Tensile Strength | | | | |
| | | Weight (gm) | Load (kN) | Load (lb) | Strength (Psi) | Avg. (Psi) | Weight (gm) | Load (kN) | Load (lb) | Strength (Psi) | Avg. (Psi) |
| 0% | 1 | 4071 | 220 | 49456 | 3938 | 3729 | 4284 | 53 | 11914 | 949 | 1190.5 |
| | 2 | 4149 | 200 | 44960 | 3580 | | 4210 | 80 | 17984 | 1432 | |
| | 3 | 4147 | 205 | 46084 | 3669 | | -- | -- | -- | -- | |
| 5% | 1 | 4098 | 200 | 44960 | 3580 | 3699 | 4234 | 60 | 13488 | 1074 | 1163.5 |
| | 2 | 4119 | 202 | 45409 | 3615 | | 4173 | 70 | 15736 | 1253 | |
| | 3 | 4146 | 218 | 49006 | 3902 | | -- | -- | -- | -- | |
| 10% | 1 | 4205 | 205 | 46084 | 3669 | 3997 | 4118 | 60 | 13488 | 1074 | 1118.5 |
| | 2 | 4261 | 235 | 52428 | 4206 | | 4012 | 65 | 14612 | 1163 | |
| | 3 | 4250 | 230 | 51704 | 4117 | | -- | -- | -- | -- | |
| 20% | 1 | 4089 | 227 | 51029 | 4063 | 4564 | 4048 | 65 | 14612 | 1163 | 1208 |
| | 2 | 4030 | 270 | 60696 | 4832 | | 3991 | 70 | 15736 | 1253 | |
| | 3 | 4128 | 268 | 60246 | 4797 | | -- | -- | -- | -- | |
| 30% | 1 | 4043 | 170 | 38216 | 3043 | 2595 | 3997 | 55 | 12364 | 984 | 939.5 |
| | 2 | 4019 | 145 | 32596 | 2595 | | 4101 | 50 | 11240 | 895 | |
| | 3 | 4176 | 120 | 26976 | 2148 | | -- | -- | -- | -- | |

Table 4.2: Concrete strength data after 28 days curing cylinder

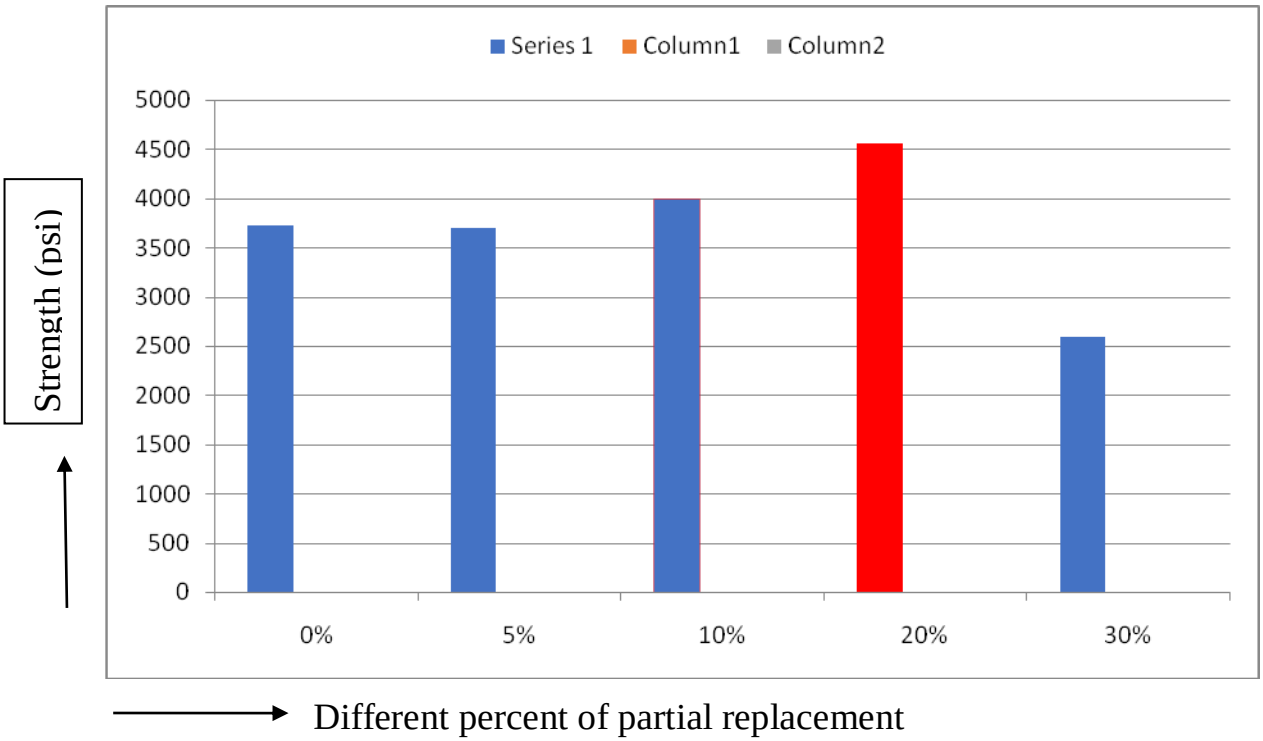



Figure 4.3: Compressive strength (psi) average (28 days)

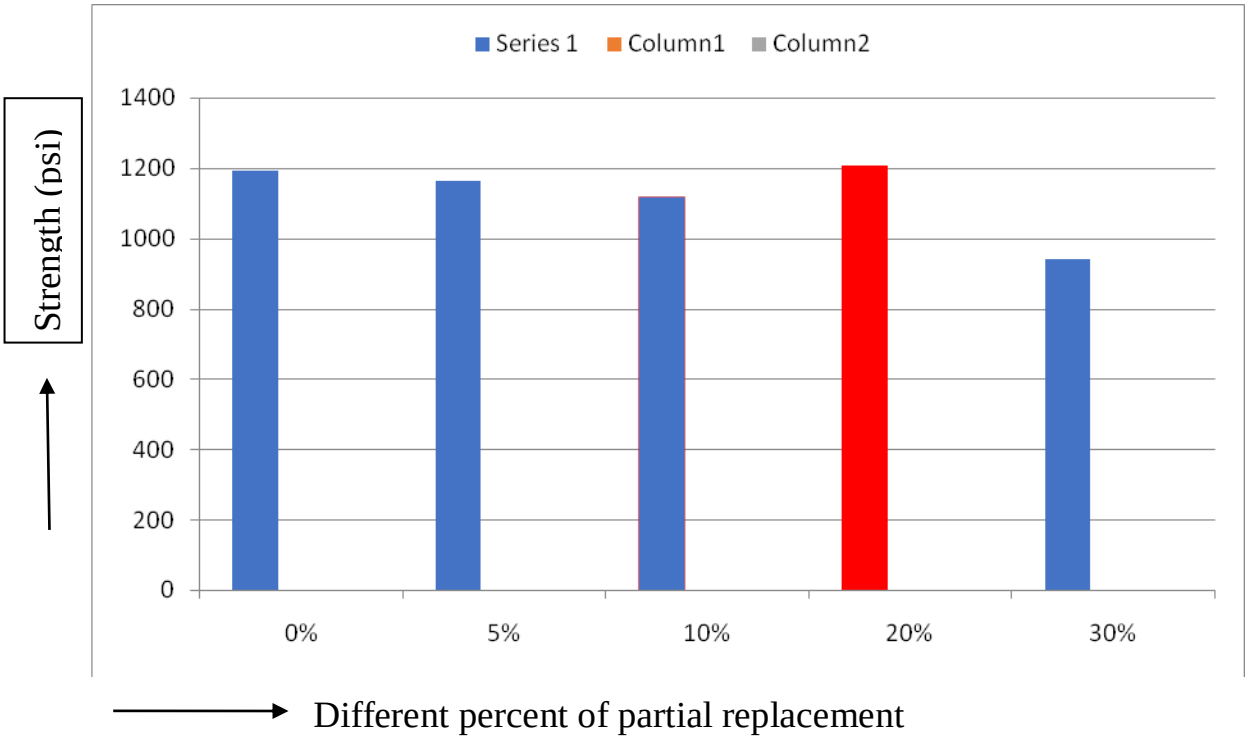



Figure 4.4: Tensile strength (psi) average (28 days)

## 4.1 General

We are preparing total 50 cylinders at deferent percent at partial replacement.25 cylinder that's compressive and tensile strength was tested after 14 days curing and 25 cylinders that are compressive and tensile strength was tested after 28 days curing. In this chapter we will find out and analysis the compressive and tensile strength after changing the tiles chips against stone chips at deferent percent.

## 4.2 Findings

In this chapter finally we found after analysis:

- 14 days curing cylinder highest compressive strength come 10 % partial replacement and highest tensile strength come 10 % partial replacement.
- 28 days curing cylinder highest compressive strength come 20 % partial replacement and highest tensile strength come 20 % partial replacement.

# Chapter 5
# Conclusion & Recommendation

## 5.1 General

This chapter was set out to represent the conclusion of this project. Lastly, some testing investigation and studies were also recommended after the conclusion, to further the strength characteristics of partial replacement tiles chips against stone for the application in high strength concrete.

## 5.2 Conclusion

Research on the usage of waste construction materials is very important due to the materials waste is gradually increasing with the increased of population and increasing of urban development. The reasons that many investigations and analysis had been made on recycle aggregate are because recycle aggregate is easy to obtain, and the cost is cheaper than virgin aggregate. Virgin aggregate need to mine but recycle aggregate can ignore this process.

From the test results and analysis, the following conclusion may be drawn. It may be emphasized here that future investigations are necessary to these findings.

## 5.3 Effect of concrete strength by using tiles chips as partial replacement of stone.

- We have found that the compressive strength and split tensile strength response at different percentage of tiles chips & stone aggregate has significantly increased than the control sample.
- We found after 14 days curing, 0% compressive & tensile strength 3221 & 760.5 psi and high strength comes 10% replace compressive & tensile strength 3788&1118.5 psi. We found after 28 days curing, 0% compressive & tensile strength 4564 & 1208 psi and high strength comes 20% replace compressive & tensile strength 3788 & 1118.5 psi.
- We have also found that the sample which used 20% tiles chips aggregate has the highest compressive strength and split tensile strength thanes usual aggregate used sample after 28 days of curing.
- Finally, we found, no more than 20% replace can be used. Because using 30%, reduces the strength value.

## 5.4 Recommendation for future study

Considering previous discussion and limitations of results of the present study, the following further investigation may be recommended

- As present study is investigated can be performed tiles chips against coarse aggregate but limitation of percentage.
- The effect of curing method may also be studied in future. And different type of course and fine aggregate.

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