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# "UTILIZATION OF CONCRETE DEMOLISHED WASTE IN CEMENT CONCRETE"

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**Abstract** -*Recent advancement in construction & rapid development in past decades acts as a catalyst in generating enormous amount of construction waste. It is highly desirable to reutilize the demolished construction waste in an effective manner as well as the cost of aggregate in the concrete has the major proportion which has to be taken care of. In this project we aim to examine the effect of partial replacement of the coarse aggregate by demolished waste on properties of concrete. This project critically examines such properties in reused concrete and suggests suitable recommendation for further enhancing the life of structures, there by resulting in economy to the cost.*

## 1. Introduction -

Any construction activity requires several materials such as concrete, steel, brick, stone, glass, clay, mud, wood, and so on. However, the cement concrete remains the main construction material used in construction industries. For its suitability and adaptability with respect to the changing environment, the concrete must be such that it can conserve resources, protect the environment, economize and lead to proper utilization of energy. To achieve this, major emphasis must be laid on the use of wastes and by products in cement and concrete used for new constructions. The utilization of recycled aggregate is particularly very promising as 75 percent of concrete is made of aggregates. Recycling of concrete is needed from the viewpoint of environmental preservation and effective utilization of resources. Due to modernization, demolished materials are dumped on land & not used for any purpose. Such situations affect the fertility of land. As per report of Hindu online India generates 23.75 million tons demolition waste annually. As per report of Central Pollution Control Board (CPCB) Delhi, in India, 48million tons solid waste is produced out of which 14.5 million ton waste is produced from the construction waste sector, out of which only 3% waste is used for embankment. A large portion of concrete waste ends up at disposal sites. It is anticipated that there will be an increase in the amount of concrete waste, a shortage of disposal sites, and depletion in natural resources especially. These lead to the use of recycled aggregate in new concrete production, which is deemed to be a more effective utilization of concrete waste. However, information on concrete using recycled aggregate is still insufficient, and it will be advisable to get more detailed information about the characteristics of concrete using recycled aggregates. The global demand for construction aggregates exceeds 26.8 billion tons per year. In India there is a significant increase in the use of natural aggregates due to infrastructure and construction development. The use of recycled aggregate in construction can be useful for environmental protection and economical terms; it started since the end of World War II by using a demolished concrete pavement as recycled aggregate in stabilizing the base course for road construction. The annual amount of construction and demolition waste (CDW) in India is 4.0 million tons while the current method of managing such waste is through disposal in landfills causing huge deposits of construction and demolition waste and becoming an environmental problem. In other developing countries, laws have been brought into practice to restrict construction and demolition waste in the form of prohibitions or special taxes for creating waste areas. The heaviest materials found in construction and demolition waste in India are concrete, bricks, fine aggregate, mortar and tile residues in which concrete represents up to half of the total waste weight. This situation leads to a question about the preservation of natural aggregate sources and environment. The main reasons for increase of volume of demolition concrete / masonry waste are as follows:-

- Many old buildings, concrete pavements, bridges and other structures have overcome their age and limit of use due to structural deterioration beyond repairs and need to be demolished.
- The structures, even adequate to use are under demolition because they are not serving the needs in present scenario; New construction for better economic growth.
- Structures are turned into debris resulting from natural disasters like earthquake, cyclone and floods etc.

- Creation of building waste resulting from manmade disaster/war.

The primary objective is to foment the reuse and recycling of this waste and other forms of valorisation with a view to contributing to the sustainable development of activities in the construction sector.

One of the possible solutions to these problems is to recycle construction and demolition concrete waste to produce an alternative aggregate for structural concrete. Recycled concrete aggregate (RCA) is generally produced by the crushing of concrete rubble, screening then removal of contaminants such as reinforcement, paper, wood, plastics and gypsum. Concrete made with such recycled concrete aggregate is called recycled aggregate concrete Recycled concrete aggregate. The main purpose of this work is to determine the basic properties of Recycled concrete aggregate made of coarse recycled concrete aggregate then to compare them to the properties of concrete made with natural aggregate concrete. Fine recycled aggregate was not considered for the production of Recycled concrete aggregate because its application in structural concrete is generally not recommended.

## 1.1 Demolition –

The moving of buildings to new locations in order to reuse them has quite possibly been practiced in Europe first landed and built houses in this province. It does not seem possible to move structures built of brick, stone or concrete. However, wooden framed buildings within a certain size range can be picked up and transported with trucks or custom made trailers. While the reuse of whole buildings can greatly reduce the creation of construction and demolition waste, there are currently major constraints to moving buildings in all areas of the province. These constraints include the cost of picking up and moving the building, the cost of creating a foundation for the building in its new location, and the often significant cost of moving electric, telephone and fibre optic cables out of the way. In Nova Scotia today, single story wooden framed buildings are relatively affordable to move since they can often fit below electric and communications cables when they are transported down public roads. While the moving of multi-story wooden framed buildings is still practiced as well, more often than not the building is simply moved from one location on a property to another. Moves which involve transport along public roads are less common due to the high added cost of removing electric and communications cables to allow the passage of multi-story buildings.

**Fig.1 -** Demolition of structure.

## 1.2 Requirement –

Demolition of Pucca and Semi-Pucca buildings, on an average generates 500 & 300 kg/ sq.m of waste respectively. In India nearly 50% of Construction & Demolition waste is being re-used and recycled, while the remainder is mostly landfilled. The cost of construction materials is increasing enormously. In India, the cost of cement during 1995 was Rs. 125/kg and in 2019 the price increased to Rs. 295/bag. In case of bricks the price was Rs. 0.66 per brick in 1995 and the present rate is Rs. 6 per brick in 2019. With the environmental hazards caused by excessive and illegal extraction of river fine aggregate, the mining of river fine aggregate is banned since April 1, 2012. The raw materials used in construction are largely non-renewable natural resources hence meticulous use of these materials is essential. The demand for aggregates in 2007 has seen an increase.

**Fig.2 -** Solid waste of India.

**Fig.3 -** Construction waste distribution.


### 2. Aim–

As the earlier studies states the various uses of the demolished materials. The aim of our project is to use the demolished materials in such a way that it increases the strength of the mix and the mix design is economical, highly workable and durable.

The project aims on the use of materials in such a way that the course aggregates can be replaced with those demolished pieces which resembles the properties of a good aggregate and also to use the powdered material to replace the fine aggregate.

This replacement will help in creating highly economical mix design and will also help in disposing the demolished materials as the disposal of this material has become a major issue.

The project supports the **"Swachh Bharat Mission"** as the government has set up an individual section for the disposal and management of demolished construction waste.

### 3. Mix Design -

Let's consider a mix design with the following design parameter.

Design stipulations

Grade designation M-25 (moderate exposure)
i.e. $f_{ck}$= 25Mpa

Maximum nominal size of aggregates 20mm.

Fine aggregate confirming to Zone-II of IS:383-1983

Degree of workability medium.

Test Data

i. Cement used: PPC IS:1489
ii. Specific Gravity of -
Cement = 3.15
Fine Aggregate = 2.62
Course Aggregate = 2.78
iii. Water absorption of -
Fine Aggregate = 0.86%
Course Aggregate = 0.48%
iv. Free surface moisture -
Fine Aggregate = nil
Course Aggregate = nil
v. Grading of aggregates (IS:383)
Fine Aggregate = zone II
Course Aggregate = nominal 20 mm size

### Design as per IS:10262-2009

a) Target mean strength$f_t$=$f_{ck}$+k.S
=25+1.65 x 4.0 = 31.6 Mpa

b) Selection of water cement ratio -

Maximum water cement ratio for mild exposure condition from table 5 of IS: 450 is 0.55

For compressive strength = 31.6 Mpa, corresponding water cement ratio 0.44.

c) Water content -
For 20 mm nominal maximum size of aggregates and slump range 25 mm to 50mm, water content is 191.6 kg/m$^3$.(For compaction factor ranging between 0.8 to 0.9 maximum weight of water is increased by 3%, 186 x 1.03= 191.58 ≅ 191.6 kg/m$^3$.)

d) Cement content calculation -
Water cement ratio = 0.44
Cement quantity=191.6/0.44=435.45 kg

e) Entrapped air
= 2 % for 20mm aggregate.

f) Calculation of course aggregate and fine aggregate-

- Basic fine aggregate content = 35 %.

  For water cement ratio = 0.44 . The fine aggregate content is to be reduced by 3.2 %.

  The fine aggregate content taken is 31.8 %.

  Hence coarse aggregate =68.2%

- Volume of concrete = 0.98m$^3$(Entrapped air = 2 %)

- Volume of cement=435.45/3.15*1000=0.138 m$^3$

- Volume of water=191.6/1000=0.1916 m$^3$

- Volume ofall-in-aggregates
  =0.98 -(0.138+0.191)m³=0.651 m³

g) Mass of course aggregates
=0.682 x 0.651 x 2.78 x 980 = 1209kg/m³

f) Mass of fine aggregate
= 0.318 x 0.651x 2.62 x 980 =531.5 kg

**Table.1-** Quantity of material.

| **Particulars** | **Qty. in kg/ m³ of concrete** | **Mix proportions by mass** |
|---|---|---|
| **Water** | 191.6 | 0.44 |
| **Cement** | 436 | 1 |
| **Fine aggregate** | 531.5 | 1.22 |
| **Course Aggregate** | 1209 | 2.77 |
| **Total:- 2368.1 kg/ m³** | | |

## 4. METHODOLGY–

### 4.1 Research Materials & Methodology-

In order to accomplish the aim of the study an investigation was undertaken into the properties of recycled aggregate concrete collected from different sources then comparing the basic properties of concrete made with recycled aggregate concrete with others made with natural aggregate.

### 4.2 Cement–

Cement is a binder, a substance used in construction that sets and hardens and can bind other materials together. The most important types of cement are used as a component in the production of mortar in masonry, and of concrete which is a combination of cement and an aggregate to form a strong building material. In this study we are using OPC Grade cement.

Cement is seldom used on its own, but rather to bind fine aggregate and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with fine aggregate and gravel, produces concrete.

Cements used in construction are usually inorganic, often lime or calcium silicate based, and can be characterized as either hydraulic or non-hydraulic, depending on the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster).

Non-hydraulic cement does not set in wet conditions or under water. Rather, it sets as it dries and reacts with carbon dioxide in the air. It is resistant to attack by chemicals after setting.

Hydraulic cements (e.g., Portland cement) set and become adhesive due to a chemical reaction between the dry ingredients and water. The chemical reaction results in mineral hydrates that are not very water-soluble and so are quite durable in water and safe from chemical attack. This allows setting in wet conditions or under water and further protects the hardened material from chemical attack. The chemical process for hydraulic cement found by ancient Romans used volcanic ash (pozzolana) with added lime (calcium oxide).

The word "cement" can be traced back to the Roman term opus caementicium, used to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick supplements that were added to the burnt lime, to obtain a hydraulic binder, were later referred to as cementum, cimentum, cäment, and cement. In modern times, organic polymers are sometimes used as cements in concrete.

### 4.3 Fine Aggregate-

It is a granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Fine aggregate can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent fine aggregate-sized particles by mass.

The composition of fine aggregate varies, depending on the local rock sources and conditions, but the most common constituent of fine aggregate in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or $SiO_2$), usually in the form of quartz. The second most common type of fine aggregate is calcium carbonate, for example, aragonite, which has mostly been created, over the past half billion years, by various forms of life, like coral and shellfish. For example, it is the primary form of fine aggregate apparent in areas where reefs have dominated the ecosystem for millions of years like the Caribbean.

Fine aggregate is a non-renewable resource over human timescales, and fine aggregate suitable for making concrete is in high demand.

It is the aggregate most of which passes 4.75 mm IS sieve and contains only so much coarser as is permitted by specification. According to source fine aggregate may be described as:

- Natural fine aggregate-it is the aggregate resulting from the natural disintegration of rock and which has been deposited by streams or glacial agencies.
- Crushed stone fine aggregate-it is the fine aggregate produced by crushing hard stone.
- Crushed gravel fine aggregate-it is the fine aggregate produced by crushing natural gravel.

### 4.4 Coarse Aggregate-

Coarse aggregate, is a broad category of coarse to medium grained particulate material used in construction, including fine aggregate, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. Aggregates are the most mined materials in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Due to the relatively high hydraulic conductivity value as compared to most soils, aggregates are widely used in drainage applications such as foundation and French drains, septic drain fields, retaining wall drains, and road side edge drains. Aggregates are also used as base material under foundations, roads, and railroads. In other words, aggregates are used as a stable foundation or road/rail base with predictable, uniform properties (e.g. to help prevent differential settling under the road or building), or as a low-cost extender that binds with more expensive cement or asphalt to form concrete.

Preferred bituminous aggregate sizes for road construction are given in EN 13043 as d/D (where the range shows the smallest and largest square mesh grating that the particles can pass). The same classification sizing is used for larger armor stone sizes in EN 13383, EN 12620 for concrete aggregate, EN 13242 for base layers of road construction and EN 13450 for railway ballast.
The American Society for Testing and Materials (ASTM) publishes an exhaustive listing of specifications including ASTM D 692 and ASTM D 1073 for various construction aggregate products, which, by their individual design, are suitable for specific construction purposes. These products include specific types of coarse and fine aggregate designed for such uses as additives to asphalt and concrete mixes, as well as other construction uses. State transportation departments further refine aggregate material specifications in order to tailor aggregate use to the needs and available supply in their particular locations.

Sources for these basic materials can be grouped into three main areas: Mining of mineral aggregate deposits, including fine aggregate, gravel, and stone; use of waste slag from the manufacture of iron and steel; and recycling of concrete, which is itself chiefly manufactured from mineral aggregates. In addition, there are some (minor) materials that are used as specialty lightweight aggregates: clay, pumice, perlite, and vermiculite.

It is the aggregate most of which is retained on 4.75 mm IS sieve and contains only so much finer material as is permitted by specification. According to source, coarse aggregate may be described as:

- Uncrushed Gravel or Stone– it results from natural disintegration of rock
- Crushed Gravel or Stone– it results from crushing of gravel or hard stone.
- Partially Crushed Gravel or Stone– it is a product of the blending of the above two aggregate.

### 4.5 Water–

Water is a transparent, tasteless, odour-less, and nearly colour-less chemical substance, which is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms. It is vital for all known forms of life, even though it provides no calories or organic nutrients. Its chemical formula is $H_2O$, meaningthat each of its molecules contains one oxygen and two hydrogen atoms connected by covalent bonds.

Water is the name of the liquid state of $H_2O$ at standard ambient temperature and pressure. It forms precipitation in the form of rain and aerosols in the form of fog. Clouds are formed from suspended droplets of water and ice, its solid state. When finely divided, crystalline ice may precipitate in the form of snow. The gaseous state of water is steam or water vapour.
Water moves continually through the water cycle of evaporation, transpiration (evapotranspiration), condensation, precipitation, and runoff, usually reaching the sea.

Fresh and clean water is used for casting and curing of specimen. The water is relatively free from organic matters, silt, oil, sugar, chloride and acidic material as per requirements of Indian standard. Combining water with a cementitious material forms a cement paste by the process of hydration.

Water covers 71% of the Earth's surface, mostly in seas and oceans. Small portions of water occur as groundwater (1.7%), in the glaciers and the ice caps of Antarctica and Greenland (1.7%), and in the air as vapor, clouds (formed of ice and liquid water suspended in air), and precipitation (0.001%).

Water plays an important role in the world economy. Approximately 70% of the freshwater used by humans goes to agriculture. Fishing in salt and fresh water bodies is a major source of food for many parts of the world. Much of long-distance trade of commodities (such as oil and natural gas) and manufactured products is transported by boats through seas, rivers, lakes, and canals. Large quantities of water, ice, and steam are used for cooling and heating, in industry and homes. Water is an excellent solvent for a wide variety of chemical substances; as such it is widely used in industrial processes, and in cooking and washing. Water is also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, and diving.

### 4.6 Concrete Mixes-

M25 concrete mix was adopted with a ratio 1 : 1.24 : 2.82 : 0.44 of cement, coarse aggregate,fine aggregate and water respectively by weight. Half of the cubes were prepared by using coarse aggregate &rest were prepared by replacing a fraction of coarse aggregate with demolished material. To study the effect of demolished material in concrete, 50%, of natural coarse aggregate was replaced by demolished material was tested.

### 4.7 Production Of Concrete With Recycled Aggregates From Construction And Demolition Wastes –

The study of recycled aggregate concrete started in the 1970's. Initially, very basic observations and analysis were made relative to the behavior of this material. Since then, several progressively more complex 1 studies have been made, analyzing several variables for different replacement levels.

Within the Construction Demolished Waster, three main types of Recycled Aggregates have been identified; they may come from crushed concrete, building masonry or mixed debris. Generally, recycled concrete aggregates are composed of, at least, 90% of crushed concrete. The same amount is considered for recycled masonry aggregates, in which, instead of concrete, at least 90% must be composed of non-structural materials used for filling walls (ceramic bricks, lightweight concrete blocks, ground granulated blast furnace slag bricks, etc.). Mixed recycled aggregates are composed of the two aforementioned aggregates, in which their contents vary according to existing specifications.

## 5. Material Testing –

### 5.1 To Determine Fineness Of Cement -

**Conclusion -**

Total weight of cement = w1 = 100 grams
Total weight of residue = w2 = 10.6 grams
% age of fineness = 89.4 %
The fineness of a given sample of cement is **89.4%.**

### 5.2 Determination Of Consistency Of Standard Cement Paste Standard -

**Observation-**

Express the amount of water as a percentage by mass of the dry cement to the first place of decimal.

**Table.2-**Standard consistency of cement.

| S. No. | Weight of cement (gms) | % by water of dry cement | Amount of water | Penetrati-onfrom bottom |
|---|---|---|---|---|
| **1.** | 400 | 28 | 112 | 15 |
| **2.** | 400 | 30 | 120 | 12 |
| **3.** | 400 | 32 | 128 | 9 |
| **4.** | 400 | 34 | 136 | 5 |

**Conclusion -**

The normal consistency of a given sample of cement is **34%.**

### 5.3 Determination Of Initial And Final Setting Time Of Cement -

**Observation -**

1. Weight of given sample of cement is 300 gms.
2. The normal consistency of a given sample of cement is 34 %
3. Volume of water addend (0.85 times the water required to give a paste of standard consistency) for preparation of test block 90 ml.

**Table.3 -** Initial and final setting time of cement

| Sr. No | Setting time (sec) | Penetration (mm) |
|---|---|---|
| **1** | 300 | 3 |

| | | |
|---|---|---|
| **2** | 600 | 3.1 |
| **3** | 1200 | 5 |

**Conclusion -**

1. The initial setting time of the cement sample is found to be **300 sec**.
2. The final setting time of the cement sample is found to be **1200 sec**.

### 5.4 Determination Of Specific Gravity Of Fine Aggregate –

**Conclusion -**

The specific gravity of a given sample of fine aggregate is **2.62.**

### 5.5 Determination Of Specific Gravity Of Course Aggregate -

**Conclusion-**

The specific gravity of a given sample of course aggregate is **2.78.**

### 5.6 Determination Of Impact Value Of Course Aggregate -

**Observation-**

Total weight of course aggregate = 480gms
Aggregate passing through 2.36 mm sieve = 65gms
Impact value percentage= 65 x 100 / 480 = **13.54%**

**Conclusion:-**

The aggregate Impact value of given sample of coarse aggregate is **13.54%.**

The aggregate impact value should not be more than 45 per cent for aggregate used for concrete other than for wearing surfaces, and 30 per cent for concrete used for wearing surfaces such a runways, roads and air field pavement.

### 5.7 Determination Of Relative Consistency Of Freshly Mixed Concrete (Slump Cone Test) –

**Conclusion:-**

The slump of concrete **22 mm** has medium degree of workability.

### 5.8 Determination Of Particle Size Of Course Aggregate -

**Observation:-**

**Table.4** - Sieved readings of course aggregate

| IS sieve | Weight retained sieve (gms) | %wt retained | % wt passing |
|---|---|---|---|
| **80 mm** | 0 | 0 | 100 |
| **40 mm** | 0 | 0 | 100 |
| **20 mm** | 3926 | 78.52 | 21.48 |
| **10 mm** | 1052 | 21.04 | 0.044 |
| **4.75 mm** | 22 | 0.44 | 0.04 |
| **Total** | 5000 | 100 | - |

### 5.9 Determination Of Consistency Of Freshly Mixed Concrete -

**Observation-**

The time required for the shape of concrete to change from slump cone shape to cylindrical shape in seconds is known as Vee Bee Degree

Reading with mould = 5.5
Reading without mould = 5.7
Reading after vibration = 22.7
Vibration time = 14 sec

**Conclusion -**

The Vee Bee Degree of concrete **14 sec**indicate Medium Degree of workability.

### 5.10 Determination Of Crushing Strength Of Course Aggregate -

**Conclusion -**

Total weight of course aggregate = 1.5 kg
Aggregate passing through 2.36 mm sieve = 279gms =0.279 kg
Impact value percentage= {279 x 100} / 1500 = **18.6%**

## 6. RESEARCH ANALYSIS –

### 6.1 Rebound Hammer Testing –

**Table.5-** Rebound hammer readings for M 25 grade cement concrete cubes.

| M 25 Cement Concrete | | | |
|---|---|---|---|
| **Sample No.** | **Grid No.** | **Rebound No.** | **Compressive strength (MPa)** |
| **Cube No. 1** | **Grid No. 1** | 31.06 | 29.87 |
| | **Grid No. 2** | 30.87 | 28.94 |
| **Cube No. 2** | **Grid No. 1** | 29.43 | 29.77 |
| | **Grid No. 2** | 30.14 | 29.48 |
| **Cube No. 3** | **Grid No. 1** | 30.89 | 29.00 |
| | **Grid No. 2** | 31.46 | 30.14 |
| **Cube No. 4** | **Grid No. 1** | 32.01 | 31.77 |
| | **Grid No. 2** | 31.74 | 31.16 |
| **Cube No. 5** | **Grid No. 1** | 34.8 | 28.71 |
| | **Grid No. 2** | 37.61 | 31.09 |

**Table.6-** Rebound hammer readings for cement concrete cubes with demolished material of wall.

| Cement Concrete With Demolished Material Of Wall | | | |
|---|---|---|---|
| **Sample No.** | **Grid No.** | **Rebound No.** | **Compressive strength (MPa)** |
| **Cube No. 1** | **Grid No. 1** | 29.07 | 25.67 |
| | **Grid No. 2** | 32.56 | 29.98 |
| **Cube No. 2** | **Grid No. 1** | 31.43 | 23.77 |
| | **Grid No. 2** | 30.97 | 25.48 |
| **Cube No. 3** | **Grid No. 1** | 36.89 | 29.00 |
| | **Grid No. 2** | 32.46 | 31.14 |
| **Cube No. 4** | **Grid No. 1** | 32.01 | 31.77 |
| | **Grid No. 2** | 31.74 | 31.16 |
| **Cube No. 5** | **Grid No. 1** | 28.09 | 24.67 |
| | **Grid No. 2** | 31.65 | 27.52 |

**Table.7-** Rebound hammer readings for cement concrete cubes with demolished material of slab.

| Cement Concrete With Demolished Material Of Slab | | | |
|---|---|---|---|
| **Sample No.** | **Grid No.** | **Rebound No.** | **Compressive strength (MPa)** |
| **Cube No. 1** | **Grid No. 1** | 27.01 | 27.87 |
| | **Grid No. 2** | 29.57 | 27.44 |
| **Cube No. 2** | **Grid No. 1** | 29.43 | 28.77 |
| | **Grid No. 2** | 32.14 | 27.48 |
| **Cube No. 3** | **Grid No. 1** | 34.89 | 29.00 |
| | **Grid No. 2** | 32.46 | 28.14 |
| **Cube No. 4** | **Grid No. 1** | 32.01 | 30.27 |
| | **Grid No. 2** | 31.74 | 26.16 |
| **Cube No. 5** | **Grid No. 1** | 34.67 | 30.57 |
| | **Grid No. 2** | 28.97 | 28.52 |

**Table.8-** Rebound hammer readings for M 25 grade cement concrete beams.

| M 25 Cement Concrete | | | | |
|---|---|---|---|---|
| **Sample No.** | **Face No.** | **Grid No.** | **Rebound No.** | **Compressive strength (MPa)** |
| **Beam No. 1** | **Face No.1** | **Grid No. 1** | 31.82 | 28.54 |
| | | **Grid No. 2** | 27.88 | 24.52 |
| | **Face No.3** | **Grid No. 3** | 31.25 | 28.7 |

| | | | | |
|---|---|---|---|---|
| | | Grid No. 4 | 29.9 | 26.54 |
| Beam No. 2 | Face No.1 | Grid No. 1 | 27.52 | 24.5 |
| | | Grid No. 2 | 36.66 | 25.75 |
| | Face No.3 | Grid No. 3 | 31.05 | 27.90 |
| | | Grid No. 4 | 29.56 | 31.05 |
| Beam No. 3 | Face No.1 | Grid No. 1 | 28.56 | 25.55 |
| | | Grid No. 2 | 36.89 | 25.67 |
| | Face No.3 | Grid No. 3 | 32.34 | 28.9 |
| | | Grid No. 4 | 28.93 | 31.85 |

**Table.9-**Rebound hammer readings for cement concrete beams with demolished material of wall.

| | | | | |
|---|---|---|---|---|
| | | Grid No. 4 | 38.79 | 39.77 |
| Beam No. 2 | Face No.1 | Grid No. 1 | 26.98 | 24.4 |
| | | Grid No. 2 | 32.34 | 28.90 |
| | Face No.3 | Grid No. 3 | 38.90 | 32.54 |
| | | Grid No. 4 | 37.76 | 31.90 |
| Beam No. 3 | Face No.1 | Grid No. 1 | 32.34 | 29.77 |
| | | Grid No. 2 | 34.56 | 29.09 |
| | Face No.3 | Grid No. 3 | 36.54 | 27.90 |
| | | Grid No. 4 | 35.55 | 29.89 |

**Table.10-** Rebound hammer readings for cement concrete beams with demolished material of slab.

| Cement Concrete With Demolished Material Of Wall | | | | |
|---|---|---|---|---|
| **Sample No.** | **Face No.** | **Grid No.** | **Rebound No.** | **Compressive strength (MPa)** |
| Beam No. 1 | Face No.1 | Grid No. 1 | 36.65 | 31.52 |
| | | Grid No. 2 | 32.45 | 29.08 |
| | Face No.3 | Grid No. 3 | 37.80 | 29.07 |

| Cement Concrete With Demolished Material Of Slab | | | | |
|---|---|---|---|---|
| **Sample No.** | **Face No.** | **Grid No.** | **Rebound No.** | **Compressive strength (MPa)** |
| Beam No. 1 | Face No.1 | Grid No. 1 | 26.96 | 25.6 |
| | | Grid No. 2 | 31.55 | 26.7 |
| | Face No.2 | Grid No. 3 | 34.67 | 31.08 |
| | | Grid No. 4 | 31.76 | 28.97 |
| Beam No. 2 | Face No.1 | Grid No. 1 | 30.89 | 27.66 |
| | | Grid No. 2 | 29.77 | 25.05 |
| | Face | Grid | 32.55 | 29.75 |

| | | | | |
|---|---|---|---|---|
| | No.2 | No. 3 | | |
| | | Grid No. 4 | 31.45 | 28.65 |
| Beam No. 3 | Face No.1 | Grid No. 1 | 35.67 | 31.06 |
| | | Grid No. 2 | 32.88 | 26.06 |
| | Face No.2 | Grid No. 3 | 28.87 | 25.75 |
| | | Grid No. 4 | 29.05 | 26.79 |

### 6.2 Ultra-Sonic Pulse Velocity-Upv Test –

**Table.11-** Ultra-sonic pulse velocity readings for M 25 grade cement concrete cubes.

| M 25 Cement Concrete | | |
|---|---|---|
| **Sample No.** | **Spot No.** | **Ultrasonic Pulse Velocity** |
| **Cube No. 1** | **S1/S3** | 5172 |
| | **S2/S4** | 5300 |
| | **S5/S6** | 4950 |
| **Cube No. 2** | **S1/S3** | 4500 |
| | **S2/S4** | 4890 |
| | **S5/S6** | 5177 |
| **Cube No. 3** | **S1/S3** | 5000 |
| | **S2/S4** | 5150 |
| | **S5/S6** | 5100 |
| **Cube No. 4** | **S1/S3** | 5179 |
| | **S2/S4** | 5200 |
| | **S5/S6** | 5088 |
| **Cube No. 5** | **S1/S3** | 4862 |
| | **S2/S4** | 5208 |
| | **S5/S6** | 4986 |

**Table.12-** Ultra-sonic pulse velocity readings for cement concrete cubes with demolished material of wall.

| Cement Concrete With Demolished Material Of Wall | | |
|---|---|---|
| **Sample No.** | **Spot No.** | **Ultrasonic Pulse Velocity** |
| **Cube No. 1** | **S1/S3** | 4558 |
| | **S2/S4** | 4235 |
| | **S5/S6** | 4355 |
| **Cube No. 2** | **S1/S3** | 4470 |
| | **S2/S4** | 4349 |
| | **S5/S6** | 4517 |
| **Cube No. 3** | **S1/S3** | 4585 |
| | **S2/S4** | 4460 |
| | **S5/S6** | 4485 |
| **Cube No. 4** | **S1/S3** | 4476 |
| | **S2/S4** | 4450 |
| | **S5/S6** | 4200 |
| **Cube No. 5** | **S1/S3** | 4450 |
| | **S2/S4** | 4515 |
| | **S5/S6** | 4867 |

**Table.13-** Ultra-sonic pulse velocity readings for cement concrete cubes with demolished material of slab.

| Cement Concrete With Demolished Material Of Slab | | |
|---|---|---|
| **Sample No.** | **Spot No.** | **Ultrasonic Pulse Velocity** |
| **Cube No. 1** | **S1/S3** | 4438 |
| | **S2/S4** | 4447 |
| | **S5/S6** | 4597 |
| **Cube No. 2** | **S1/S3** | 4820 |
| | **S2/S4** | 4375 |
| | **S5/S6** | 4986 |
| **Cube No. 3** | **S1/S3** | 4437 |
| | **S2/S4** | 4820 |
| | **S5/S6** | 5080 |
| **Cube No. 4** | **S1/S3** | 4699 |
| | **S2/S4** | 4980 |
| | **S5/S6** | 4700 |
| **Cube No. 5** | **S1/S3** | 4740 |
| | **S2/S4** | 4460 |
| | **S5/S6** | 4698 |

**Table.14 -** Ultra-sonic pulse velocity readings for M 25 grade cement concrete beams.

| M 25 Cement Concrete | | | |
|---|---|---|---|
| **Sample No.** | **Face** | **Spot No.** | **Ultrasonic Pulse Velocity** |
| **Beam No. 1** | **1st Face & 3rd Face** | **S1** | 4800 |
| | | **S2** | 4600 |
| | | **S3** | 4140 |
| | **2nd Face & 4th Face** | **S1** | 4500 |
| | | **S2** | 4650 |
| | | **S3** | 4200 |
| | **Top / Bottom** | | 4968 |
| **Beam No. 2** | **1st Face & 3rd Face** | **S1** | 4800 |
| | | **S2** | 4949 |
| | | **S3** | 4460 |
| | **2nd Face & 4th Face** | **S1** | 4600 |
| | | **S2** | 4400 |
| | | **S3** | 4343 |
| | **Top / Bottom** | | 4707 |
| **Beam No. 3** | **1st Face & 3rd Face** | **S1** | 4810 |
| | | **S2** | 4921 |
| | | **S3** | 4160 |
| | **2nd Face & 4th Face** | **S1** | 4592 |
| | | **S2** | 4374 |
| | | **S3** | 4302 |
| | **Top / Bottom** | | 4686 |

**Table.15-** Ultra-sonic pulse velocity readings for cement concrete beams with demolished material of wall.

| Cement Concrete With Demolished Material Of Wall | | | |
|---|---|---|---|
| **Sample No.** | **Face** | **Spot No.** | **Ultrasonic Pulse Velocity** |
| **Beam No. 1** | **1st Face & 3rd Face** | **S1** | 4237 |
| | | **S2** | 4148 |
| | | **S3** | 4164 |
| | **2nd Face & 4th Face** | **S1** | 4196 |
| | | **S2** | 4020 |
| | | **S3** | 4436 |
| | **Top / Bottom** | | 6656 |
| **Beam No. 2** | **1st Face & 3rd Face** | **S1** | 4590 |
| | | **S2** | 4600 |
| | | **S3** | 4347 |
| | **2nd Face & 4th Face** | **S1** | 4786 |
| | | **S2** | 4244 |
| | | **S3** | 4430 |
| | **Top / Bottom** | | 4736 |
| **Beam No. 3** | **1st Face & 3rd Face** | **S1** | 4285 |
| | | **S2** | 4765 |
| | | **S3** | 4418 |
| | **2nd Face & 4th Face** | **S1** | 4100 |
| | | **S2** | 4556 |
| | | **S3** | 4342 |
| | **Top / Bottom** | | 4817 |

**Table.16 -** Ultra-sonic pulse velocity readings for cement beams with demolished material of slab.

| Cement Concrete With Demolished Material Of Slab | | | |
|---|---|---|---|
| **Sample No.** | **Face** | **Spot No.** | **Ultrasonic Pulse Velocity** |
| **Beam No. 1** | **1st Face & 3rd Face** | **S1** | 4488 |
| | | **S2** | 4300 |
| | | **S3** | 4560 |
| | **2nd Face & 4th Face** | **S1** | 3988 |
| | | **S2** | 3897 |
| | | **S3** | 3816 |
| | **Top / Bottom** | | 4916 |
| **Beam No. 2** | **1st Face & 3rd Face** | **S1** | 4243 |
| | | **S2** | 4618 |
| | | **S3** | 4398 |
| | **2nd Face & 4th Face** | **S1** | 4344 |
| | | **S2** | 4126 |
| | | **S3** | 4436 |
| | **Top / Bottom** | | 4210 |
| **Beam No. 3** | **1st Face & 3rd Face** | **S1** | 4382 |
| | | **S2** | 4200 |
| | | **S3** | 3964 |
| | **2nd Face & 4th Face** | **S1** | 4162 |
| | | **S2** | 4344 |
| | | **S3** | 4886 |
| | **Top / Bottom** | | 3800 |

### 6.3 Compressive Strength Of Cubes -

**Table.17-** Compressive strength readings for M 25 grade cement concrete cubes.

| M 25 Cement Concrete | |
|---|---|
| **Sample No.** | **Compressive Strength** |
| **Cube No.1** | 580 |
| **Cube No.2** | 660 |
| **Cube No.3** | 640 |
| **Cube No.4** | 610 |
| **Cube No.5** | 680 |

**Table.18-** Compressive strength readings for cement concrete cubes with demolished material of wall.

| Cement Concrete With Demolished Material Of Wall | |
|---|---|
| **Sample No.** | **Compressive Strength** |
| **Cube No.1** | 880 |
| **Cube No.2** | 920 |
| **Cube No.3** | 870 |
| **Cube No.4** | 930 |
| **Cube No.5** | 850 |

**Table.19-** Compressive strength readings for cement concrete cubes with demolished material of slab.

| Cement Concrete With Demolished Material Of Slab | |
|---|---|
| **Sample No.** | **Compressive Strength** |
| **Cube No.1** | 840 |
| **Cube No.2** | 810 |
| **Cube No.3** | 690 |
| **Cube No.4** | 790 |
| **Cube No.5** | 750 |

### 6.4 Flexural Strength Of Beam -

**Table.20-** Flexural strength readings for M 25 grade cement concrete beams.

| M 25 Cement Concrete | |
|---|---|
| **Sample No.** | **Flexural Strength** |
| **Beam No.1** | 75.6 |
| **Beam No.2** | 74.2 |
| **Beam No.3** | 69.6 |

**Table.21-** Flexural strength readings for cement concrete beams with demolished material of wall.

| Cement Concrete With Demolished Material Of Wall | |
|---|---|
| **Sample No.** | **Flexural Strength** |
| **Beam No.1** | 87.5 |
| **Beam No.2** | 75.8 |
| **Beam No.3** | 84.6 |

**Table.22-** Flexural strength readings for cement concrete beams with demolished material of slab.

| Cement Concrete With Demolished Material Of Slab | |
|---|---|
| **Sample No.** | **Flexural Strength** |
| **Beam No.1** | 73.2 |
| **Beam No.2** | 70.2 |
| **Beam No.3** | 69.3 |

**Fig.4 -** Bar graph for compressive strength of cubes.

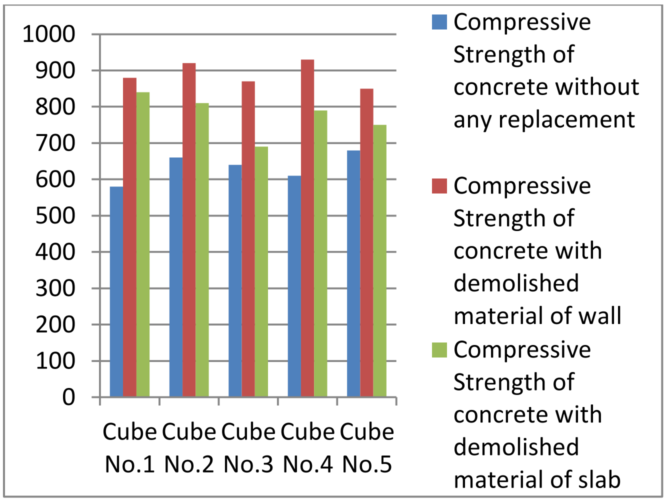
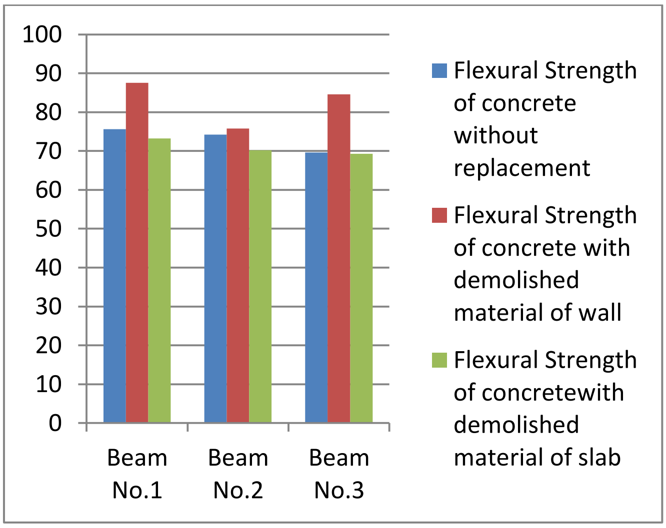



**Fig.5 -** Bar graph for flexural strength of beams.




### 7. Conclusions –

After analysing the importance of concrete in the present era. The requirement for the replacement of aggregate is on the zenith due to limited availability of aggregates. In this project partial replacement of aggregates was done to compare the effect on the strength of concrete.

On the basis of test result, it is concluded that the strength of concrete with partial replacement in aggregates is almost equal on lightly on the lower side as compared to the strength of concrete without any replacement. But there is a huge difference in the cost required for the preparation of them.

Concrete prepared with the demolished slab material has shown better results than the concrete prepared with the demolished wall material and too with concrete prepared with-out any replacement in some aspects like compressive strength.

It is concluded from the experimental studies that the compressive strength of concrete prepared with partial replacement of aggregate with the demolished waste is greater though variable than the compressive strength of concrete without replacement.

- The minimum compressive strength of cube prepared by concrete without partial replacement is 580 KN/M2.

- The minimum compressive strength of cube prepared by concrete with partial replacement of aggregate with the demolished material of wall is 850 KN/M2.i.e 46.55% greater than the compressive strength of cube prepared by concrete without partial replacement

- The minimum compressive strength of cube prepared by concrete with partial replacement of aggregate with the demolished material of slab is 750 KN/M2.i.e 29.31% greater than the compressive strength of cube prepared by concrete without partial replacement

## 7.1 Future Scope -

The difference in the cost of production of concrete and abundant availability of demolished waste overlays the slight difference in strength of concrete, thus demolished waste can be successfully used as an replacement of aggregates.

The project is hereby successful and can be considered for construction of concrete structure as it poses high strength and is compatible for construction where cost is a parameter. This type of project will reduce the cost involved as will as the burden of demolished waste.

Behaviour of different extent of partial replacement of aggregate by the demolished waste in the preparation of concrete has to be studied to get the best possible result.

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## 9. IS Codes –

- **IS 10262-2009** :- Concrete Mix Proportioning

- **IS 10086-1982** :- Specification For Moulds For Use In Tests Of Cement And Concrete.

- **IS 460-1962** :- Specification For Test Sieves.

- **IS 4031(PART IV)-1988** :- Methods For Physical Tests For Hydraulic Cement (Part 4 Determination Of Consistency Of Standard Cement Paste)

- **IS 5513-1976** :- Vicat Apparatus – Specification
- **IS 13311-2 (1992)**: Method of non-destructive testing of concrete-methods of test, Part 2: Rebound hammer [CED 2: Cement and Concrete]

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