ISSN 2581-7795

A REVIEW ON CONSTRUCTION AND DEMOLITION WASTE BASED LIGHTWEIGHT CONCRETE BLOCKS FOR SUSTAINABLE CONSTRUCTION.

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ABSTRACT: This paper's result focuses on preparing a model and cost estimation of C&D CLC blocks for sustainability in the construction field. The garbage produced during construction and demolition (C&D) contributes significantly to environmental contamination. Concrete, asphalt, plastic, metal, and glass are among the items that are produced during building and destruction and are included in this waste stream. The ecology may be significantly impacted by how C&D trash is disposed of. C&D garbage is typically disposed of by being placed in landfills. This garbage can overflow landfills, which can result in harmful air pollution and methane gas emissions. In addition, disposal in landfills can harm the environment by dispersing dangerous poisons into the air. Hence, we have decided to use RCA and NCA as materials to prepare a block. This allows us to prepare a C&D block that has already been prepared and used to provide good strength for framed construction. The prepared C&D blocks are quite heavy, which is not feasible for mobility and rapid construction, so to overcome this scenario, we would like to introduce foam concrete (CLC) technology into the C&D mix, which would make the blocks way lighter than their previous ones. We are even expecting better yield strength than the two individual C&D and CLC blocks that are in use now.

KEY WORDS: Disposal, Construction, and demolition waste (C&D Waste), Cellular lightweight concrete (CLC), Yield Strength.

1. INTRODUCTION

The construction, renovation, repair, and demolition of houses, large building structures, roads, bridges, piers, and dams generate construction and demolition (C&D) waste. Wood, steel, concrete, gypsum, masonry, plaster, metal, and asphalt are all components of C&D waste. Cement, water, and pre-formed foam make up cellular lightweight concrete (CLC). This substance is mixed and pumped into any void with a certain density. There has been much successful research done on Construction and Demolition Waste(C&D) and Cellular Light Weight Concrete (CLC) to make stabilized blocks. Construction and Demolition Waste blocks are normally heavy and their disposal becomes a great issue. Completely usage of C&D waste material makes the blocks heavier. The complete usage of CLC will not be economical and eco-friendly. The combination of C&D and CLC material composition mix would make the blocks lighter, stronger, economical, and eco-friendly.

SOURCING OF MATERIALS

1. The raw materials were collected from Rock Crystal's aggregate vendor in the outskirts of Bengaluru near Chikkjala.
2. The collected waste is called Recycled Concrete Aggregates (RCA) is generally produced by the crushing of concrete rubble, screening then removal of contaminants such as reinforcement, paper, wood, plastic and gypsum.
3. Fine recycled aggregates will not be considered for the production of RAC because its application in structural concrete is generally not recommended.

2. LITERATURE REVIEW

It has been determined that ceramic wastes can be utilized as a substitute for fine and coarse aggregates in the production of concrete. Waste tiles are being used as a partial substitute for fine and coarse aggregates in concrete in this study. Cast, cubed, cured, and crushed the control mix as well as other mixes (in proportions of 5%, 10%, 15%, and 20%) that contained cement, water, granite, and partial replacement for sand with crushed tiles. Additionally, a second mix of cement, water, sand, and crushed tiles were cast, cubed, cured, and crushed in proportions of 25%, 50%, and 75%, respectively. The Universal Testing Machine (UTM) was used to measure the compressive strengths of the specimens on the seventh, fourteenth, 21st, and 28th days of curing. At 28 days, the compressive strength value for replacing 5 percent of fine waste tiles was 20.12 N/mm2, while the values for replacing 10 percent, 15 percent, and 20 percent were 14.24 N/mm2, 11.04 N/mm2, and 10.12 N/mm2, respectively. In addition, the compressive strength of 25% of replacement coarse waste tiles increased to 22.45 N/mm2 after 28 days, while that of 50% and 75% was 18.4 N/mm2 and 12.2 N/mm2, respectively. As a result, it can be concluded that coarse aggregates can be substituted for 25 percent waste tiles and fine aggregates for 5 percent waste tiles.

Ecosystems and the natural environment's long-term viability are critically important. Construction waste necessitates the use of additional natural resources, which in turn necessitates the creation of new dumping grounds. This study was conducted to investigate the use of concrete waste in concrete blocks with a particular focus on the thermal and mechanical properties of the resulting products in order to address this issue. There were three different kinds of concrete mixtures made, each of which contained different amounts of concrete waste, which were 5%, 15%, and 0%, respectively. After being shaped into cubes, these mixtures were examined for ultrasonic pulse, density, and compressive strength. Each admixture and a control concrete block of the model design were subjected to thermal investigations. The results of the thermal data showed that, in comparison to the air around it, the 15% concrete waste mixture had the lowest temperature. At 28 days, the control mixture had the highest readings for density and compressive strength, with 2390 kg/m3 and 40.69 N/mm2. The pulse velocity of the 5% concrete waste mixture was 4016 m/s, indicating that it was of medium quality.

The amount of construction and demolition waste (CDW) is rising rapidly in Egyptian cities, harming the environment. The construction industry can benefit economically and environmentally by making use of waste like recycled aggregate in concrete. The possibility of substituting recycled concrete aggregate (RCA) for natural coarse aggregate (NA) in structural concrete is the subject of this study. Crushing and grading concrete rubble from various Cairo landfills and demolition sites is used to conduct an investigation into the properties of RCA. The study used the following aggregates: crushed concretes, dolomite, and natural sand from various sources Eight groups of fifty different concrete mixes were cast. The purpose of the groups was to investigate the effects of using superplasticizer, silica fume, cement dosage, and recycled coarse aggregates' quality and content. Tests were conducted for: elastic modulus, splitting strength, and compressive strength. The findings demonstrated that the concrete debris could be made into useful recycled aggregate and utilized in Egypt for the production of concrete with properties suitable for the majority of structural concrete applications. When compared to natural aggregate concrete (NAC), the properties of recycled aggregate concrete (RAC) made of 100% RCA showed a significant decrease, whereas the properties of RAC made of a blend of 75% NA and 25% RCA showed no significant change.

According to Kiksuet al. (2017), using industrial waste as a building material is a good, sustainable way to get rid of waste and keep resources for future generations. The construction industry is under more and more pressure to cut costs and make our environment better. The purpose of this paper is to investigate the properties of sustainable light-weight concrete made from sintered Ground Granulated Blast Furnace Slag (GGBS) and Construction Demolition Waste (CDW). Sintered artificial aggregates partially replace coarse aggregate in concrete, which improves the mechanical and durability properties of lightweight concrete. In a laboratory, the mixture of GGBS, Construction Demolition Waste, clay, and coke breeze was sintered at a sintering temperature of 1200°C to 1300°C in precise proportions to produce these aggregates. The sintered CDW GGBS aggregates resist sulphate, fire, and are lightweight. The prepared light weight aggregates were put through tests, and the results were confirmed in accordance with the specifications provided by the Central Building Research Institute (CBRI), Roorkee. Estimated amounts of sintered GGBS aggregate were used to replace 10%, 20%, 30%, 40%, and 50% of the weight in the prepared mixes, and their suitability for structural use was checked. The fundamental discoveries of this examination uncovered that two sorts of waste materials could be reused effectively as incomplete substitutes for coarse totals in substantial blends. Analyses and comparisons have been made between the concrete with sintered CDW GGBS aggregates and the nominal concrete. In conclusion, when compared to concrete made with natural granite aggregates, the 40% replacement of CDW GGBS aggregates has been used effectively for light-weight structural concrete works without compromising the strength parameters**.**

The construction industry generates a lot of mixed waste, most of which is classified as non-hazardous, and can be made up of a variety of materials. The United Kingdom has already met the waste targets set by the European Union for 2020. However, most of this waste is recycled through downcycling (backfilling), while only a small percentage is recycled through upcycling (like recycling new concrete batches). The purpose of this paper is to learn more about how upcycling can be improved by including recycled aggregates from construction and demolition waste (CDW) in concrete mixes. Concerning the production of concrete blocks, a review of the most recent research and UK legislation is developed. Initial tests were developed using a CDW recycled aggregate sample from a Swansea CDW plant as a case study. Two samples' composition was determined through visual inspection and sieving tests, and the results were compared to the original aggregates. Excavation soil made up more than 70% of the material, while mortar, concrete, ceramics, plaster, glass, and organic matter made up the remaining portion. With varying ratios of water to cement and 80 percent replacement of recycled aggregates, two concrete mixes were created. Slump, absorption, density, and compression strength were tested. When the results were compared to a reference sample, both mixes had significantly lower quality. Despite this, the discussion leads to the identification of various problems to solve, such as composition or heterogeneity, and their analysis for the purpose of utilizing these recycled aggregates effectively in the production of concrete blocks. The findings can assist in increasing the ratio of upcycling processes using mixed CDW as recycled aggregates in concrete mixes.

Due to the fact that a significant amount of this waste has been delivered to public landfills as well as to illegal locations, research into the possibility of reusing construction and demolition debris is of particular concern in Brazil. Reusing this material in building components such as bricks or blocks has been suggested by some researchers. There are a lot of studies on physical and mechanical characterization, but little work has been done to describe the thermal properties of recycled construction and demolition waste blocks (RCDW). In order to provide subsidies for the thermal performance analysis of a building, the purpose of this work was to characterize the RCDW's thermal resistance and conductivity. The RCDW thermal properties were determined by adapting the hot-box method and employing heat flow meter measurement methods. The overall thermal resistance and thermal conductivity of the RCDW block in the solid region were found to be within the ranges of 0.33RT0.41m2 KW-1 and 0.600.78Wm-1K-1, respectively. The presence of aggregate with a lower density and lower thermal conductivity than natural aggregate justifies the lower resistance and conductivity values.

Since the Roman era, lightweight concrete (LWC) has been utilized with success. Due to its superior thermal insulation and lower density, it has gained popularity. When compared to normal weight concrete, LWC can significantly reduce the dead load of structural concrete elements. Concrete made with recycled aggregates is referred to as "green concrete" due to its positive environmental impact. The purpose of this study was to determine how effectively recycled aggregates as coarse aggregates can be used to produce structural LWC cast. The primary variables in this study are; the dosage of lightweight aggregate used (ADDIPOR-55" as 0, 10, 20, and 30% of coarse aggregate volume) and the recycled coarse aggregates used (crushed light brick, crushed glass, and crushed red brick in comparison to dolomite). The main mechanical properties of hardened concrete in terms of compressive, tensile, flexural, and bond strengths were among the investigated physical properties, as were the unit weight and slump values.

The thermal and acoustic insulation, fire resistance, and light weight of foam concrete are excellent physical properties. In the past, only non-structural applications could make use of FC. However, in recent times, structural applications of FC have also been included in its scope of application. As, the plan and evaluation of brick work structures need mechanical and actual properties of brick work units. As a result, CLC blocks have been the subject of a series of experiments. In addition, the compressive and flexural strengths were found to be significantly lower than those of conventional blocks. However, in comparison to standard blocks, there was very little thermal insulation and a lot of water absorption. As a result, low-density CLC blocks can be very useful as an infill material.

India's economy is now recognized as one that is expanding rapidly. After agriculture, the construction industry is the second largest. Over the next five years, approximately 239.68 billion will be invested in the construction sector, which accounts for nearly 11% of GDP. Rapid urbanization necessitates the optimization of land for the population, and shifts in construction trends necessitate the demolition of existing structures for the construction of new high-rise buildings. As a result, there is a significant amount of construction and demolition waste produced annually. Concrete is one of the most common construction demolition wastes with a high reproductive value. These days, it is only used as filler, which not only loses its value but also causes problems for the environment. The proper breaking of such concrete, which requires a lot of effort, poses a major obstacle to the reuse of demolition waste concrete. Because the compressive strength of masonry blocks used to build masonry walls is very low, they can be cast from recycled concrete with finer recycled concrete particles. This makes it easier to crush demolished concrete, meets structural requirements, and is good for the environment. Casting, testing, and comparing the performance of recycled concrete masonry blocks are the focus of the current work. In order to modify the Gabion wall, which was one of the goals of the author's PhD research, this recycled concrete block was used in place of standard stone.

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

Conservation of resources, like using as little material, energy, or water as possible, is the foundation of sustainable building practices. The municipal administration of developing nations faces a significant obstacle when it comes to disposing of construction waste. These nations' rapid urbanization and construction have produced a significant amount of construction waste. Construction waste can be disposed of in a variety of ways. Utilizing these wastes as aggregates for concrete is one of these options. Reusing these aggregates in concrete would, on the one hand, lower the cost of disposing of construction waste and, on the other, lessen the impact on natural resources through resource harvesting. The municipally collected construction wastes have been separated, graded, and used as aggregates in cement concrete in this study. Various concrete mixtures with various recycled aggregate percentages were prepared and tested to assess their suitability for construction purposes by determining their compressive strengths. The results of the tests show that the recycled aggregates can be used to make plain concrete mixtures for mass concreting and building walkways and pavements.

An important goal of the building materials and construction industries is to protect the environment by getting rid of waste and using raw materials in a responsible way. Eco-concrete, geopolymer concrete, eco-composites, and other new materials have been produced by utilizing various waste types as components. In non-traditional concretes, fly ash, ground granulated blast furnace slag, silica fume, tire waste, plastics, glass, agro-waste, and other materials were used in place of cement or aggregates. Wastes can also be used to prepare lightweight concretes. The authors of the article present a few studies that used a variety of wastes to make lightweight concrete in the article.

To achieve environmental sustainability, it is sufficient to make use of waste crushed bricks (WCB), which are obtained from brick factories and demolition waste, as coarse and fine aggregate for the preparation of concrete. This study looks into the possibility of producing environmentally friendly structural lightweight concrete (SLWC) that completely replaces WCB. As a replacement for cement by weight, various contents (5%, 10%, and 15%) of supplementary cementitious materials like silica fume, fly ash, metakaolin, and slag were examined. Evaluations included the slump test, dry density, mechanical properties (compressive, splitting, and flexural strengths), elevated temperature resistance, and water absorption. X-ray diffraction, thermogravimetric analysis, and scanning electron microscopy (SEM) were used to examine the microstructure. The developed concrete's performance was evaluated at high temperatures of 200 °C, 400 °C, and 600 °C. According to the findings of the experiments, SLWC can be made by replacing all aggregate with WCB and using 15 percent metakaolin and 15 percent silica fume in place of cement, with compressive strengths of 39.5 and 41.5 MPa, respectively. When compared to other fine materials, the cement replacement that included 15% slag performed the best after being exposed to 600 °C. The SEM images revealed enhanced bonding between coarse aggregate and cement paste and improved transition zone characteristics.

This survey paper orders and assembles the accessible distributed writing on reuse and reuse of development and destruction squander materials. Waste from construction and demolition is produced whenever residential buildings, roads, bridges, flyovers, subways, remodelling, and so on are constructed or demolished. Natural resources are used in the production of building materials. During the manufacturing process of building materials, numerous toxic substances are also released into the air. These wastes have been produced as a result of rapid urbanization and industrialization, and they are being dumped in open and low-lying areas. These exercises present difficult issues to people and the climate. In addition to helping to conserve natural resources, recycling materials used in construction and demolition can be the best alternative to open dumping.

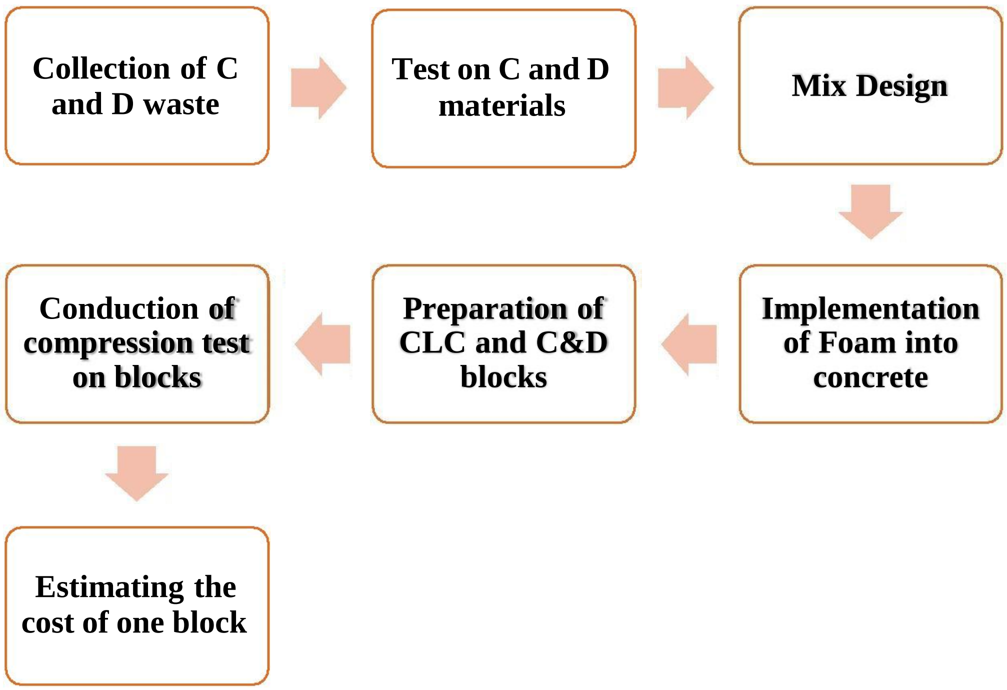
Construction and demolition (C&D) waste is not recycled in Tanzania, and little is known about how to recycle it into valuable products like building materials. On the other hand, the amount of C&D waste produced continues to rise, putting financial, social, and environmental burdens on its disposal. However, C&D waste has the potential to be recycled. This study set out to find out if C&D waste, which is mostly cementitious rubble, could be recycled into building materials like concrete blocks that can be separated at the building's end of life and meet Tanzanian structural wall requirements. The Cradle to Cradle (C2C) concept, a novel idea for sustainable construction, is theoretically mentioned in this study. The idea of cradle to cradle considers cementitious waste from C&D activities as a resource—equal to food—for regenerating new building materials rather than throwing it away or using it for low-grade purposes. New and creative products can be made by applying this idea.

This study therefore focuses on recycling C&D waste and reusing building material components for the creation of novel products. This is because, like other countries in the world, Tanzania will never live in a waste-free environment and construction will never achieve a zero-waste status. Eight samples of C&D waste were collected from C&D building sites, and two natural aggregates were also used as a reference in the research on the recycling process. To obtain recycled aggregates, the rubble was manually crushed and screened or sieved to the required particle sizes. The recycled aggregates were then used to make concrete blocks by mixing them with cement, water, and any additives (if any). Mega Flow P4 and sisal fibers were added to concrete blocks as additives. Before being put to use, the materials underwent a series of tests and analyses in the laboratory to ascertain their quality. In addition, the amount of C&D waste produced in Tanzania was looked into.

Unless it is sustainable, development as a standalone feature has no status. The medical field, information technology, education, and other fields can all play a role in development. The construction industry, on the other hand, is a fundamental component of every industry. Construction activities are everywhere as a result of society's development and for society's development on every front. It is necessary to demolish any existing structures that have outlived their usefulness or that need to be replaced in addition to the construction activities. It is assessed that the development business in India produces around 10-12 million T of waste yearly. Delhi's waste production is estimated to be around 5000 T per day. As a result, a solution for its sustainable disposable is required. Not only is it illegal to dump C&D waste, but it is also bad for the environment. Finding long-term, safe ways to reuse or recycle materials so that nothing needs to be discarded or disposed of illegally is a huge challenge for humanity. The construction industry also has a significant gap between demand and supply for natural aggregates, which can be slightly reduced by recycling construction and demolition waste. By reducing the use of natural resources, proper handling, storage, and treatment of C&D waste has a significant impact on sustainability and prevents environmental degradation. The paper discusses a variety of issues related to the reuse and recycling of C&D waste, as well as the necessary regulatory mechanisms and procedures for achieving the goal of environmental sustainability.

CHAPTER-3

METHODALOGY



CHAPTER-4

4.1MATERIALS AND PROPERTIES

RECYCLED FINE AGGREGATES (R.F.A)

- The recycled fine aggregates were collected from Rock Crystals aggregate vendor in outskirts of Bengaluru near Chikkjala.
- The collected waste is called Recycled Concrete Aggregates (RCA) is generally produced by the crushing of concrete rubble, screening then removal of contaminants such as reinforcement, paper, wood, plastics and gypsum.
- Fine recycled aggregates will not be considered for the production of RAC because its application in structural concrete is generally not recommended.

Procurement of Recycled Fine Aggregates at Rock Crystals

PROPERTIES OF RECYCLED FINE AGGREGATES

Bulk Specific Gravity	3.02
Apparent Specific Gravity	3.53
Water Absorption %	7.52%

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

CEMENT (ULTRA TECH OPC 53 GRADE)

A binder, or chemical substance that sets, hardens, and attaches to other materials to bind them together, is what cement is in construction. In most cases, cement is used to bond sand and gravel (aggregate), not on its own. Mortar for masonry is made from cement mixed with fine aggregate, and concrete is made from cement combined with sand and gravel. The most utilised substance in existence and the second most consumed resource on earth is concrete.

When initial higher strength is a requirement, ordinary Portland cement (OPC) 53 Grade is utilised in RCC, pre-stressed concrete of higher grades, cement grouts, quick plugging mortars, etc.

Advantages of OPC 53 Grade:

• Speedy construction

• Durable concrete

• Economic concrete mix designs

• Low percentages of alkalis, chlorides, magnesia and free lime leads to the production of durable concrete.

PROPERTIES OF ULTRA TECH OPC 53 GRADE CEMENT

Some physical properties of OPC 53 grade cement: -

- Specific gravity: - 3.10 to 3.15
- Standard consistency (%): - 30 to 35%
- Initial setting time (hours, min): -30 min
- Final setting time (hours, min): - 600 min
- Compressive strength- 7 days: - 43 N/mm2
- Compressive strength- 28 days: -53 N/mm2
- Bulk density: - 1440 kg/m3

MARJANOL FOAMING AGENT

One of the most important components of foam concrete is foam, and blowing agents are used in its production. Blowing agents affect the density, porosity, stability and flowability of foamed concrete. Their main task is to introduce air bubbles into foam concrete. Foam can be produced in two different ways: the pre-foaming process and the mixed foaming process. Blowing agents include synthetic, adhesive resins, protein-based, detergents, resin soaps, saponins, and hydrolyzed proteins. However, the most commonly used foam concentrates are synthetic and protein-based. A protein-based active ingredient allows for a stronger pore structure and a more closed cavity network. A more stable air cavity network is created. Synthetic active ingredients, on the other hand, are less dense, as they allow greater expansion. Synthetic active ingredients are more economical, easier to use, and require less energy to store than protein active ingredients.

PROPERTIES OF MARJANOL FOAMING AGENT

Specific Gravity: 1.0-1.05.

pH: > 7.5

Foam density: 50-60gm

International Research Journal of Education and Technology
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ISSN 2581-7795

CHAPTER-5

MIX DESIGN

PROPORTIONS OF MATERIALS USED

Proportion- cement: RFA 1:2

Water cement ratio 0.35 weight of cement

Foaming agent 1.5% weight of cement

Dilution Factor for foaming agent 1:30

PROCEDURE OF CASTING

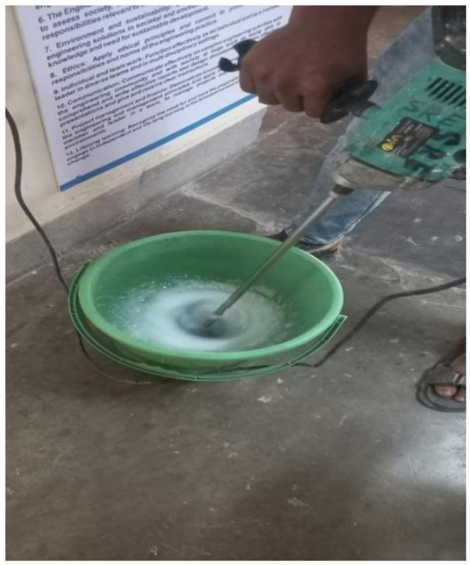
- Preparations of moulds
  - Moulds were prepared by a help of a carpenter.
  - Fresh plywood sheets were given to the carpenter to prepare moulds.

Carpenters preparing moulds

- Preparation of cement mortar mix
  - Cement and recycled fine aggregates were taken 1:2 proportions respectively
  - The amount of water taken is calculated by 0.35 times the amount of cement used by weight(kg).
  - The cement mortar mix is prepared by above proportions.

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

- Preparation of foam
  - Foaming agent is taken by 1.5% the weight of cement used
  - The taken foaming agent is mixed with 40 times the weight of the foaming agent.
  - The foaming agent mixed with water is churned using an agitator.
  - The foam is created due to air voids.



Churning of foam

- Implementation of foam into cement mortar mix
  - The foam which is agitated is mixed into cement mortar mix.
  - The mix is later stirred with agitator machine for 1-2 minutes to mix well.

Mixing foam and cement mix

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

➢ Casting of moulds

- The inner walls of the moulds were greased for an easy method of unmolding.
- The foam cement mix was poured into moulds and gently tapped at the bottom.

Casting of moulds

QUANTITY OF MATERIALS REQUIRED OF ONE BLOCK

1) Cement – 3.52 Kilogram
2) Recycled Fine Aggregates – 7.04 Kilogram
3) Water for water cement ratio – 1.232 Liters
4) Foaming Agent – 0.036 Kilograms
5) Water for foam dilution 1.080 Liters
6) Total quantity of water used – 2.312 Liters

POST CASTING OBSERVATIONS

Achieved density – 880 kgm^{-3}

Weighed after 24 hours – 11.094kg

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

CHAPTER-6

RESULTS

COMPRESSION TEST METHOD

RESULTS

COMPRESSIVE STRENGTH VALUE – 2.5 Nmm^{-2}

CONCLUSION

C&D Blocks with compressive strength of 2.5 Nmm-2 can be used as Non-structural members such as partition wall, compound wall and parapet walls etc.

These blocks can be used in low-cost housing and temporary structures.

These blocks being light weight can effectively reduce the dead load of the structure and Hence decreasing the cost of construction significantly.