

A

Project Report On

“E-WASTE BRICKES”

A Project Report is submitted to

Jawaharlal Nehru Technological University, Ananthapur (JNTUA)

In partial fulfilment of the requirement for degree of

BACHELOR OF TECHNOLOGY IN CIVIL ENGINEERING

During the academic year 2016-2020

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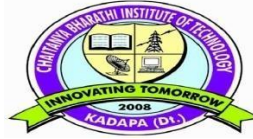
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We offered them the complete project guidance & assistance, we place our appreciation on records for their commitment and hard work done during the design & development of this project and the project was completed to our best satisfaction.

Thanks & Regards,



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ACKNOWLEDGEMENT

We acknowledge with appreciation on sincere gratitude to our secretary and correspondent Sri. **V. JAYA CHANDRA REDDY Sir** Chaitanya Bharathi Institute of Technology, Proddatur, for permitting us to facilities for during project work and boundless moral support.

We are thankful to our principal Sir. **Dr. G. SRINIVASULU REDDY Sir**, Chaitanya Bharathi Institute of Technology, for his help and encouragement during the project and his timely suggestions.

We are thankful to our project coordinator **Mr. Y.DASTHAGIRI sir**, Assistant professor of Department of Civil Engineering for helping project.

We record our sincere gratitude to **Mr. C. CHINNA SURESH BABU sir**, Assistant professor& Head of Department of civil engineering for according permission to present my thesis.

We take this opportunity to express our sincere gratitude and profound thanks to my guide **Mr. Y.DASTHAGIRI sir** Assistant professor, Department of Civil Engineering for his advice, guidance and reference material provided during the course for the preparation of our thesis work.

We are thankful to **Mr. V.SURYAPRAKASH sir**, Trylogic member and all other members of faculty of our college, whose appreciation has been a good motivation for us. Finally we would like to thank almighty, parents and friends and all the people who have helped us directly or indirectly in the successful completion of this project.

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DECLARATION

We hereby declare that the work which is being presented in this dissertation Entitled

“E-WASTE BRICKS”

Submitted towards the partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering Department, Chaitanya Bharathi Institute of Technology, Proddatur.

The matter embodied in this dissertation report has not been submitted by us for the award of the degree. Further, technical details furnished in the various chapters in this thesis are purely relevant to the project.

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ABSTRACT

Waste electrical and equipment (WEEE) is changing into major thread to the total world. Its toxic emissions mixed with virgin soil and air and inflicting harmful effects to the complete biology either directly or indirectly. Direct impacts embody unharnessed acids, hepatotoxic compounds as well as serious metals, malignant neoplastic disease chemicals and indirect effects like biomagnification of serious metals. Several non-public corporations are concerned in collecting, activity, and separation and mercantilism e-wastes for recyclers. Growth in technology enhances want and utilization of electronic and electrical equipment's (EEE) everywhere within the world.

As a result, e-waste acquires an outsized share within the typical solid waste stream. Limited recycling solutions out there push the requirement for e-waste disposal solutions. A comparison of assorted disposal solutions done on the premise of parameters likes disposal capability, damage to the surroundings and its resources cost and time constrain mentioned within the paper. Landfill marketing answer is most accepted, proving resolute is best among all solutions by acting as a reserve to be recovered in future with the event of additional utilisation facilities. At an equivalent time tremendous growth in use of ICT (Information Communication Technology) devices and services, quicker modification of technology and frequent innovations in ICT sector, had left the planet with a threat of degradation in environmental conditions and human health as the electronic and electrical instrumentation, that contains the-waste of risky parts, remains handled in Associate in Nursing environmentally unfriendly manner primarily in developing nations.

Keywords: Waste electrical and electronic equipment, Bricks, Environment, recycling, waste management.

CHAPTER-1

INTRODUCTION

General:

It is a tough undeniable fact that with the voluminous increase in use of ICT devices to bridge the digital divide there's additionally associated in nursing fearful growth of e-waste worldwide. E outlined as “waste electrical and equipment, whole or partly or rejects from their producing and repair method, that area unit meant to be discarded” whereas electrical and equipment has been outlined as ‘equipment that depends on electrical currents or electro-magnetic fields to There’s a necessity for e-waste management as e waste elements could cause severe health risks and environmental injury, when crude, unscientific strategies area unit applied for recovery of helpful elements. There’s a necessity to of all helpful and valuable material from e preserve the natural resources. Most of the developing countries area unit suffering with the speedily growing issues of e-waste and have to be compelled to have sound e-waste Management systems for finish of life ICT product to avoid the threat on surrounding sand grouping. The rise of ICT, Frequent innovation and technological changes area unit leading to shorter era of ICT instrumentality. Further more in developing countries the amount of foreign noncurrent Electrical and equipment (EEE) is uncontrolled .

So the volume of e-waste has additionally inflated drastically in developing and developed nations. At constant time, it's encouraging that each nation, together with going for the event within the ICT sector, is additionally operating for ‘going green’ by taking care of problems like economical use of natural resources, minimisation of e-waste, property utilisation of e-waste and development of product with minimum use of unsafe substances. Electrical and equipment (EEE) contain valuable moreover as unsafe materials and if at finish of lifetime of EEE, the unsafe materials aren't disposed of scientifically it should cause serious injury to the surroundings and public health. The presence of serious metals (like Arsenic, Cadmium, Barium, Lead, Lithium, Mercury, Nickel, metal Sulphide) and different virulent substances like PCB (Polychlorinated biphenyls) etc. could cause extreme damage, if not disposed of in surroundings friendly manner. Around the world, e- waste generation rates are rising. In 201, the worlds’ cities generated 1.5 billion tonnes of 2016 e-waste per year, amounting to a footprint of 1.2 kilograms per person per day.

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History of Bricks:

Brick, the most important tiny piece for construction works is used by human for many years back. Its history goes back to some of the earliest times in the civilization of men. Many world famous archaeological excavations provide much information about the brick uses in different parts of the world. Many years back, bricks were made at warm places and simply placed in the Sunlight for hardening. The hand-shaped, Sun-dried, mud bricks were made and used during the Pre-Pottery Neolithic Period. The oldest examples of brick use were first found in Southern Turkey. The Sumerian palace at Kish, in Mesopotamia, was another great example of the ancient use of bricks. In the 5th century B.C., burnt bricks were used in the wall of the city of Babylon. The ancient Egyptians also used Sun dried clay bricks in their numerous world famous historic monuments. During the period of the Roman Empire, the use of bricks spread throughout the Europe and spread in Italy and the Byzantine. In the 11th century, use of bricks in the construction work had spread from these lands to France. During the 12 century, bricks were reintroduced to northern Germany from northern Italy. This created the brick Gothic period which was a reduced style of Gothic architecture, previously very common in northern Europe. The buildings around this time were mainly built from fired red clay bricks. Brick Gothic style building can be found in Baltic countries Sweden, Denmark, Poland, Germany, Finland, Lithuania, Latvia, Estonia, Belarus and Russia. In England, the art of brick making was well advanced by the time of Henry VIII (1491-1547). After the great fire of London in 1666, the city was rebuilt with mainly brick structures. In America, bricks were used in Virginia since 1611 and also Sundried bricks were made and used for centuries in Central America, particularly in Mexico. During the renaissance and Baroque periods, exposed brick walls became unpopular and brickwork was generally covered by plaster .Only during the mid of 18th century visible brick walls again regain popularity. Beautiful examples of bricks have been found in the 20th century in India.

Brick production was done by hand until about 1885. In the middle of the 19th century brick manufacturers began the development of mechanical production. Due to the development in different sectors, enormous expansion of house and demand for bricks lead to mechanized production of bricks. Progress in making bricks was greater in England than in any other country .Brick manufacture commenced in America in the middle of the 17th century, but it was not until the latter half of the 19th that the industry began to develop in that continent, when the English machine makers went to seek a market. In Netherlands, Belgium and France no real technical progress was made in manufacture of bricks, until the end of World War I, although clay working in other artistic branches reached a high state of perfection in France before the end of the 19th century.(Encyclopedia Britannica) Though a common structural material, till now brick is the cheapest one.

This small unit is used very systematically by an expert hand for many different types of construction for long time. Technically, clay bricks fall under the category of heavy

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clay products. Heavy clay products are those that are mainly made from single clay with very little addition of other raw materials. Different types of bricks with different names in different parts of the world are being produced for structural purposes.

Generally the classifications were done on the basis of size, colour, use and quality. (Narayanswami,1993).Some of important bricks types are- FBS-Face Brick Standard: Clay bricks that are selected or produced for their durability and uniformity of size and shape. NFP-Non-Facing-Plastered:-Clay bricks suitable for general building work that is to be plastered.

FBX-Face-Brick-Extra: Clay bricks that are selected or produced for their durability and high degree of uniformity of size, shape and colour.

NFX --Non-Facing- Extra: Clay bricks suitable for use, plastered or un plastered, for general building work.

FBA-Face- Brick- Aesthetic: Clay bricks that are selected or produced for their durability and aesthetic effect deriving from non-uniformity of size, shape or colour.

E-Engineering Units: E bricks are manufactured at extremely high temperatures, forming a dense and strong bricks, allowing the bricks to limit strength and water absorption. E bricks offer excellent load bearing capacity and chemical resisting properties.

Concrete Bricks:-Concrete bricks are made from solid concrete .Concrete bricks are usually placed in facades, fences and provide an excellent aesthetic presence; these bricks can be manufactured in different colours.

Fly ash clay bricks: Fly sash clay bricks are manufactured with clay and fly ash, at about 1000 degree C. Some studies have shown that these bricks tend to fail poor produce pop-outs, when bricks come into contact with moisture and water, causing the bricks to expand. Sand **lime bricks:** Sand lime bricks are made by mixing sand, fly ash and lime followed by a chemical process during wet mixing and then moulded under pressure.

Common Burnt Clay Bricks:-Common burnt clay bricks are also called hard bricks and made of clay .Such bricks are formed by processing in moulds and then dried and fired in a kiln .These bricks are used in general works with no special attractive appearances. Sewerage Bricks: such bricks are specially designed to construct sewers. Sewerage brick can resist corrosion/abrasion and also bears load of passing traffic and hydrostatic pressure from ground or surface.

Brick Industry in India

Brick Kiln Industry is a demand based industry, which fulfills the growing demands for urban expansion and economic development. Such industries are categorized as

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small scale industries and traditionally situated in rural and peri-urban areas to fulfill local requirements of building construction. Brick kiln Industry is an important part of the rural and urban economy as it is based on local resources of the area. Like other rural based small industries, the Brick kiln Industry also provides income and employment opportunities by employing many people, both men and women during agricultural off season.(Gupta,1993). Brick making is an age-old small-scale industry and has been the main stay of construction since olden times.

The excavation of Mohenjodaro reveals the fact that the art and science of brick making were well known to the village people even that period. The villagers of that area have been practicing it for over 5000 years. (Mathur1995). Use of box shaping brick may be taken to be a technological advancement and firing of green brick may be considered to be another one. These technical improvements took shape in and around 3000BC (Damle1996).From different historical evidence, it is found that manufacturing of clay bricks is a very old industry in the human civilization. Good numbers of world famous very old historical buildings in India are still in existence and prove that brick was the predominant building material in different period of time. (Ghoshal, 2008).The design, shape and weight of bricks have undergone numerous historical changes.

Indian Brick industry, the second largest producer of bricks in the world, is next to China and commands 60.45% share in the net domestic product of the country, but is “clearly” away from the ambit of state regulation and protection (Daniel.2009). Such informal, small-scale, often unlicensed (unregistered) and unregulated brick kiln industries are running as unorganized sector. (Daniel 2009, Maithel et.al 2010).The industry has an annual turnover of more than Rs140 million, with an estimated coal consumption of around 25 million tons per year, as the third largest consumer of coal after thermal power and steel sector of the country(Gupta and Narayan2010).Indian brick industry, the second largest producer of bricks, run as a small sector with more than 150,000 brick fields throughout the country, each unit manufacture on an average between 10-100 million bricks per year. Brick is the back-bone of construction activity In India, The Genetic plain of north India accounts for 65% of the total brick production. Punjab, Haryana, Uttar Pradesh, Bihar and west Bangle are the major brick producing states in this region. Gujarat, Maharastra,Orissa. Tamilnadu, Madhya Pradesh are the important brick producing states in the Peninsular Plateau and coastal area of India.(Gupta and Narayan2010). Bricks are prepared, processed and baked in kiln at the cottage, village and rural enterprise level. Being situated in the remote country side, the brick kiln industry portrays a unique model of industrial relations-“Tripartism”(Iqbal2006).Brick making is a low technology industry which is characterized by distinct division of labor, employing skilled and semi-skilled labor comprising men, women and children during agricultural off season. The bricks are handss-molded, sun dried and then fired in a pit or clamp kiln. Complete mechanization in production is yet to be taken place in India. In between the simple and the advanced methods of making bricks i.e. an intermediate technology is most commonly used. Brick kiln industry is the second largest sector after the construction sector with floating labor population; these workers are mostly seasonal migrants. They belong to the poorest and

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weakest sections of the rural society and they migrate to brick kiln industry in search of employment during the lean period of agriculture (Gupta 2003). Migrant brick kiln workers belonged to low caste and tribal communities and migrate with their family. The entire family lives on the site and work on one unit. (Kainth2009).Migrant brick kiln workers who are semi skilled workers, are one of the most exploited, un-organized and un-regulated labor force (Daniel2009).In the brick sector, labour is brought in through a contractor a from distance place. Since, they are not regular labour and not directly appointed by the owner, they are not covered under the current Labour Laws, like minimum wage act.

The characteristics of ‘Bonded Labor’—restricted freedom, hiring workers against advances, long working hours, under payment and physical and verbal abuse by contractors and employers are very common in Indian Brick industries. Labors involved in brick industries are bonded in the sense that they all take advance money and have to work to repay their debt (Bhukunth 2005).The brick kiln industry is a significant employer of women and children with a piece-rate-wage system through sarder in an advance payment mode (Gupta 2003).Brick kiln labours are paid on the basis of quantum of work and against completion of certain tasks such as moulding of 1000 bricks, transportation of 1000 green bricks etc. The seasonal nature of brick production generates employment for a limited period of 6-7 months in a year. Majority of workers has no option, but to engage as labours (generally as agricultural labour) for the rest of the year. (Danieal, K.2009).The employers usually employ more casual labourers in order to avoid the fixed cost of employing permanent workers. Such type of casualisation of workforce becomes a remarkable features of unorganized sector,(unorganized sector implies insecure, unprotected employment, labour-intensive output with poor value added production i.e. long hours of works with little reward).(Bandyopadhyay,2003) In India, brick kiln industry is the only industry where modernization has not taken up (Maithal et al 2010).

Most of the industries still follows the traditional manual brick making process and conventional kilns. The industries generally collect topsoil from nearby age old paddy fields and coal, fire wood, agricultural waste are used to burn the green bricks. The inefficient and age old method like hand moulding and sun drying bricks under open sunlight and the use of open clamp burning system force the Industry to operate for a period of 6 - 8 months only during a year, depending upon the climate conditions, which made it a seasonal one. Coal is major fuel of brick industry and burning of coal result in the release of several air pollutants in the form of GHG (mainly carbon dioxide) particulate matter, Sulphur dioxides, carbon monoxide etc. At local level (in the vicinity of a brick kiln) some of these gases are injurious to humen health, animal and plant life. At global level, pollutions like carbon dioxide contributes to the phenomenon of global warming and climate change(Maithe12010).This industry owing to its temporary, inefficient technology using and polluting nature together with total absence of professional management including quality control can't be termed to be “organized” sector in its true sense(Gupta2003). Brick production in India, is widespread

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and situated as cluster. Most units use continuous kiln, (mainly Bull's Trench).The remaining kilns are of the intermittent type like clamp, scoved, scotch kilns etc. On an average, all units produce 4 million bricks season, usually, has a pit measuring about 15 acres (from 5-35 acres).(Maithal, 1999).

As a raw material, local clay is used to produce bricks. Sand also sometimes uses to get the right properties. Generally, agriculturally fertile lands are consumed by each brick kiln (3-4 ha), which get converted into wastelands as a result of industrial operation in the life of a brick kiln from 8-12 years. (Gupta and Narayan 2010). Digging, mixing, molding etc are all manual operations. Both men and women are employed, but in general, the women workers are employed for unskilled works like carrying green bricks to the kiln. All workers works on piece rate system, except the skilled workers. Indian bricks are generally produced according to the recommendation of The Bureau of Indian Standards .7.5"x3.5" x3.5" and 7.5"x3.5"x1.5" as two recommended sizes for modular bricks and 9"x4.25"x2.75" size for non-modular bricks. In western part of India, the most acceptable size is 9"x6"x4" (called double size bricks) and other parts of India usually produce 10"x5"x3"size of bricks. Besides it, 1st class,2nd class and 3rd class bricks(grades) are some commonly practiced brick production in all over India.

Kiln Construction in India

Kiln is the most important part of brick manufacturing process and it is the place where bricks are burnt in large in permanent structures. In fixed chimney, the green bricks are burnt to make solid final product with very little change in the shape. The industry needs environmentally sound technologies for firing bricks, which primarily concern about local environment and at the same time which enhance energy efficiency and reduce GHG emissions. Local environmental concerns have led to the formulation of emission standards for brick kilns that were announced by the Government of India in April, 1996, the emission standards specify the permissible limits for suspended particulate matter in flue gases from brick kilns. The standards also propose ban on the use of moving chimney Bull's Trench Kiln (BTK) for firing brick by June 2000. (TERI, 1998.Stake emission and energy monitoring of fixed chimney brick kilns. Project Report No98IE 41.New Delhi: Tata Energy Research Institute, Google .com.) Green bricks are heated from 6000 to 11000 c in a kiln to get the finished product. The production capacity of kilns generally ranges from 50000-500,000 bricks per rotation. The arrangement of bricks in a kiln depends on the types of fuel used. The kilns are generally classified into (a) Intermittent Kilns. (b) Continuous Kilns.

An intermittent kiln without permanent kiln structure is commonly called as clamp. Clamps are generally used when production volume is small. Intermittent kilns have low energy efficiency and most of the unit remains unutilized.

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Continuous kilns include Bulls Trench Kilns with moving and fixed chimney, Hoffmann kiln, High Draught kiln and VSBK. Brick Kilns are also classified on the basis of production capacity. The Gazette Notification on “emission standard’ for the brick kilns into three categories (Maithel 2003)

- (1) Small (Production capacity less than 15000 bricks per day)
- (2) Medium (15000 to 30000 bricks per day)
- (3) Large (more than 30000 bricks per day)

Industrial area

Production of bricks increased massively with the onset of the Industrial Revolution and the rise in factory building in England. For reasons of speed and economy, bricks were increasingly preferred as building material to stone, even in areas where the stone was readily available. It was at this time in London that bright red brick was chosen for construction to make the buildings more visible in the heavy fog and to help prevent traffic accidents.

The transition from the traditional method of production known as hand-moulding to a mechanised form of mass-production slowly took place during the first half of the nineteenth century. Possibly the first successful brick-making machine was patented by Henry Clayton, employed at the Atlas Works in Middlesex, England, in 1855, and was capable of producing up to 25,000 bricks daily with minimal supervision.

His mechanical apparatus soon achieved widespread attention after it was adopted for use by the South Eastern Railway Company for brick-making at their factory near Folkestone. The Bradley & Craven Ltd 'Stiff-Plastic Brick making Machine' was patented in 1853, apparently predating Clayton. Bradley & Craven went on to be a dominant manufacturer of brick making machinery. Predating both Clayton and Bradley & Craven Ltd. however was the brick making machine patented by Richard A. Ver Valen of Haverstraw, New York in 1852.

The demand for high office building construction at the turn of the 20th century led to a much greater use of cast and wrought iron, and later, steel and concrete. The use of brick for skyscraper construction severely limited the size of the building – the Monadnock Building, built in 1896 in Chicago, required exceptionally thick walls to maintain the structural integrity of its 17 storeys.

Following pioneering work in the 1950s at the Swiss Federal Institute of Technology and the Building Research Establishment in Watford, UK, the use of improved masonry for the construction of tall structures up to 18 storeys high was made viable. However, the use of brick has largely remained restricted to small to medium-sized buildings, as steel and concrete remain superior materials for high-rise construction.

CHAPTER- 2

LITERATURE REVIEW

Introduction

Many researchers had given their insights and findings on e-waste and related topics since this problem under study start itching the society and intensity starts increasing exponentially. The purpose of this chapter is to understand their work, to gain more knowledge this issue and correlate their efforts to create a base for further study. This chapter also includes the following objectives; to understand the problem through literature review, Sources of E-waste, its categories and generations of E-waste, hazards, drivers and challenges with respect to global and Indian scenario.

E-waste Definition

Electronic-waste is also known as E-waste, very trendy yet casual name given to electrical and electronic appliances & gazettes, either discarded or of further use.

According to California Integrated Waste Management Board 2005 Computers, televisions, VCRs, Music Systems, Photo copier, wax and other printers fall under this category. It is not very clear to add home appliances in this solid waste or not. But yet they are considered as either electronic or electrical products.

Kohler, A., Erdmann, L.,(2004)¹⁰ explained that the home appliance like automatic ovens, fridge or chilling machines and many others which also work on programming and computer related activities are very difficult to differentiate from WEEE as they are also part of either electrical or electronic family.

According to UNEP, 2005; Greenpeace International, (2005) around 21,00,000 to 51,00,000 tones of e-waste produced annually around the globe and this number is very huge as well approximate as there is no clear cut method or technology to measure the actual quantity of waste produce and discarded. Further author said the percentage of e-waste of that of solid waste is around 5.

Widmer, R., Oswald (2005)⁹ stated in rich and developed nations the percentage of e-waste to solid waste is around 8.

Items	Weight	Age
PC	35	3
Reproduction M/c	3	5
Hi-fi M/c	10	10
Cell phones	0.1	2
Gaming M/c	3	5
Light printing M/c	60	8
Broadcasting M/c	2	10
TV	30	5
VCD	5	5
Washing M/c	65	8
Fridge	35	10
A.C	55	12
Oven	15	7

International Association of Electronics Recyclers predictable that according to existing development & slumping trends the all personal and public electronics instruments will find its way to landfills is approximately three billion. Interpretation of current financial drift, budding nations are also going to pour more and more electronic waste into the exist.

The Problem

Rapid Technology Changes and Slow Adaptation to Changes

According to guiding principle for proper management of e-waste⁴ the Utmost important reason of the e-waste creations in world and in India is rapid technological changes slow adaption to changes because today in the world thousands of new technology develops every day which generates new demand for that new technology which finally reduces demand less developed technology which generates tones of e waste in the world.

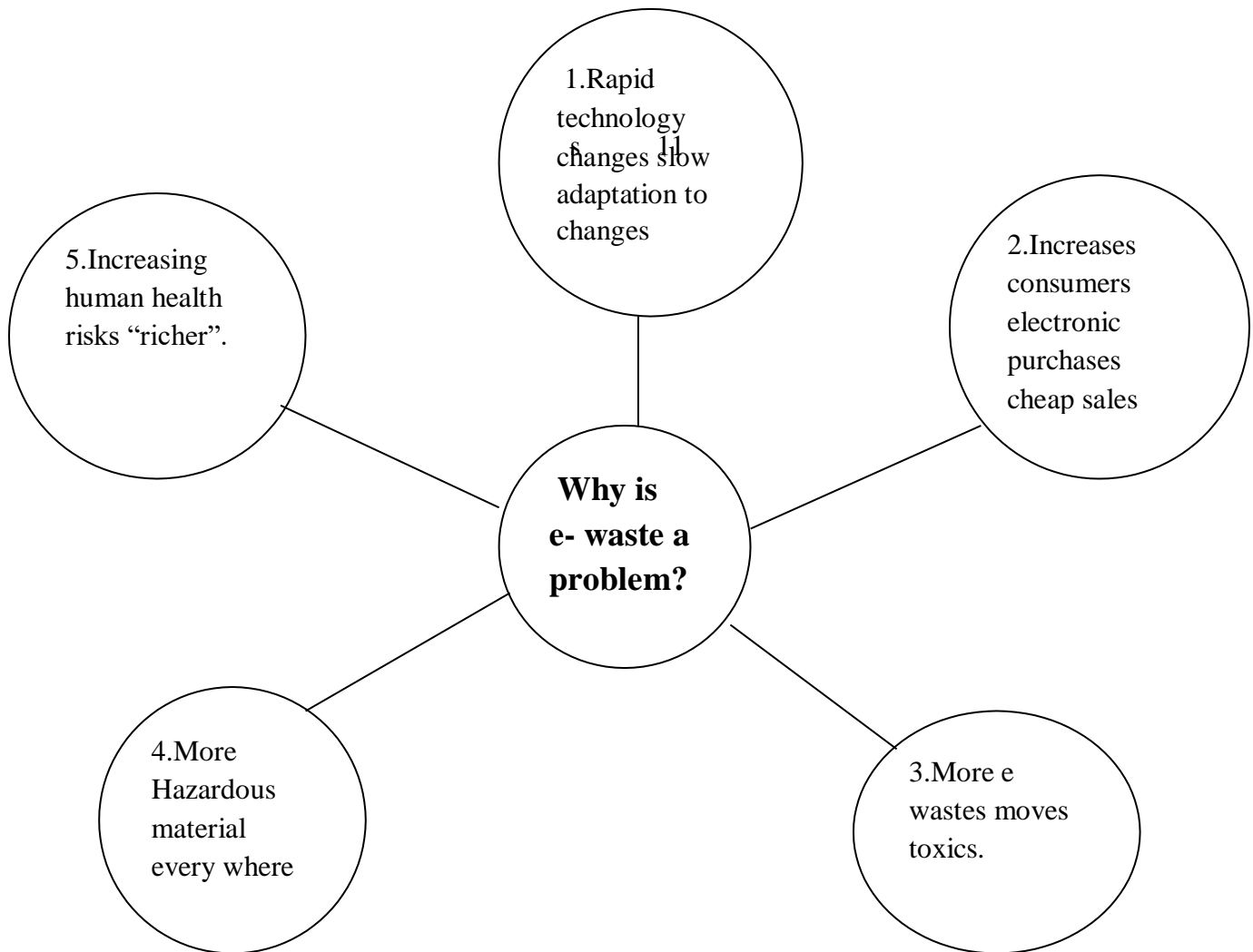


Fig2.1: Why e- waste is a problem

E-waste from Impoters:

Ongondo, F.O (2011)¹² explained that the developed nations are not only dumping their e-waste in dumping sites of their own countries but they also dump this waste to other areas, budding nations, under developed nations. Developed nations not only dump second hand products but also their parts like mouse, keyboards, printers, wires, motherboards etc. into under developed nations. And this dump part is of different variety as well.

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Derived shell of old PCS:

Derived sell is nothing but a area where used electronic and electrical parts and products are easily available, like television, PCs, mobile phone, electric boards etc.

Composition of e- waste:

Hilty L.M., (2005)⁸ explained in the below diagram composition of e-waste like ferrous, non-ferrous, plastic, plastic, glass, wood & other. The mobile & computer nearly generates same amount of hazards explain as follows.

Categories of e-waste:

ETC, Electronics Take Back Coalition, (2010)¹¹ narrated the electronic and electrical equipment's are separated into below types:

1. Big domestic equipments (Coolers, fridge, cooking machines, Cleaning M/c)
2. Undersized domestic equipments (watches, Home Cleaning M/c., Mixers)
3. ICT tools (Computers, phones, copiers)
4. Customer Appliances (Tele-Vision, Frequency Transmitters, Cam)
5. Illumination Systems (Tube Lights, Bulbs, Halogen lamps)
6. Automatic Mechanical tools (drilling M/c, Stitching M/c, Cutters)
7. Sports instruments, Recreation tools(Battery games, Consoles, Playing M/c)
8. Apparatus use for Medical Purpose
9. Observation and Disaster detection devices
10. Electrical devices for consumables like tea maker or coffee maker.

Generations of e-waste:

International scenario

a) ETC, Electronics Take Back Coalition, (2010) also mentioned developed nations viz. European countries and America are mainly responsible for generating highest e-waste i.e. around 4 million tons yearly. United States of America is leading in producing highest e-waste i.e. around 4% to its municipal waste. It also has proper segregation and treatment facilities.

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- b) Ongondo, F.O (2011) explained this e-waste problem can be a blessings in disguise as this huge solid waste has many sellable, attractive and important materials like silver, gold, platinum and other precious metals which can be easily extracted if the entire process get follows in a right direction.
- c) Ongondo, F.O (2011) further narrated But it is not easy to dig out and get bring out glitters from this waste business as cost associated with every process involved in this business is very huge and heavy investment is required and that's why many countries instead of providing a proper infrastructure or following proper management practices they just search a particular site or nation where laws related to this kind of waste is not so harsh and then they dump their waste in countries like India, China or many south Asian or African nations.
- d) Schlupe, M., Hagelüken (2009) write Europe is also not any way behind than America as growth rate of e-waste in Europe is also very high with almost 3-5 % annually.

CHAPTER-3

TYPES OF BRICKS

Brick:

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units lay in mortar. A brick can be composed of clay-bearing soil, sand, and lime, or concrete materials. Bricks are produced in numerous classes, Types, materials, and sizes which vary with region and time period, and are produced in bulk quantities. Two basic categories of bricks are fired and non-fired bricks.



Fig3.1:Brick

Types of Brick:

- Based on size, origin, quality, texture
- Based on place
- Mud bricks
- Fired bricks
- Moulded bricks
- extruded bricks
- Dry pressed bricks

Based on size ,origin ,quality ,texture:

There are thousands of types of bricks that are named for their use, size, forming method, origin, quality, texture, and/or materials.

Categorized by manufacture method:

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- Extruded – made by being forced through an opening in a steel die, with a very consistent size and shape.
- Wire cut – cut to size after extrusion with a tensioned wire which may leave drag marks.
- Moulded – shaped in moulds rather than being extruded.
- Machine-moulded - clay is forced into moulds using pressure.
- Handmade - clay is forced into moulds by a person.
- Dry-pressed - similar to soft mud method, but starts with a much thicker clay mix and is compressed with great force.
- Common or building – A brick not intended to be visible, used for internal structure.
- Face – A brick used on exterior surfaces to present a clean appearance.
- Hollow – not solid, the holes are less than 25% of the brick volume.
- Perforated – holes greater than 25% of the brick volume.
- Paving – brick intended to be in ground contact as a walkway or roadway.
- Thin – brick with normal height and length but thin width to be used as a veneer Specialized use bricks.
- Chemically resistant – bricks made with resistance to chemicals.
- Acid brick – acid resistant bricks.
- Engineering – a type of hard, dense, brick used where strength, low water porosity or acid (flue gas) resistance are needed. Further classified as type A and type B based on their compressive strength.
- Fire or refractory – highly heat-resistant bricks.
- Ceramic glazed – fire bricks with a decorative glazing.

Bricks named for place of origin:

- Cream City brick – a light yellow brick made in Milwaukee, Wisconsin
- Dutch – a hard light Coloured brick originally from the Netherlands
- Red brick – a type of construction brick.
- London stock – type of handmade brick which was used for the majority of building work in London and South East England until the growth in the use of machine-made bricks.
- Roman – a long, flat brick typically used by the Romans.
- Staffordshire blue brick – a type of construction brick (England).

Mud Bricks:

Unfired bricks, also known as mud bricks, are made from a wet clay-containing soil mixed with straw or similar binders. They are air-dried until ready for use.

Fires Bricks:

Fired bricks are burned in a kiln which makes them durable. Modern, fired, clay bricks are formed in one of three processes – soft mud, dry press, or extruded. Depending on the country, either the extruded or soft mud method is the most common, since they are the most economical.

Normally, brick contains the following ingredients:-

- Silica (sand) – 50% to 60% by weight
- Alumina (clay) – 20% to 30% by weight
- Lime – 2 to 5% by weight
- Iron oxide – $\leq 7\%$ by weight
- Magnesia – less than 1% by weight

Moulded bricks:

It starts with the raw clay, preferably in a mix with 25–30% sand to reduce shrinkage. The clay is first ground and mixed with water to the desired consistency. The clay is then pressed into steel moulds with a hydraulic press. The shaped clay is then fired ("burned") at 900–1000 °C to achieve strength

.3.2.6 Extruded Bricks:

For extruded bricks the clay is mixed with 10–15% water (stiff extrusion) or 20–25% water (soft extrusion) in a pug mill. This mixture is forced through a die to create a long cable of material of the desired width and depth. This mass is then cut into bricks of the desired length by a wall of wires. Most structural bricks are made by this method as it produces hard, dense bricks, and suitable dies can produce perforations as well. The introduction of such holes reduces the volume of clay needed, and hence the cost. Hollow bricks are lighter and easier to handle, and have different thermal properties from solid bricks. The cut bricks are hardened by drying for 20 to 40 hours at 50 to 150 °C before being fired. The heat for drying is often waste heat from the kiln.

European-style extruded bricks or blocks are used in single-wall construction with finishes applied on the inside and outside. Their many voids comprise a greater proportion of the volume than the solid, thin walls of fired clay. Such bricks are made in 15-, 25-, 30-, 42- and 50-cm widths. Some models have very high thermal insulation properties, making them suitable for zero-energy buildings.

3.2.7 Dry Pressed Bricks:

The dry press method is similar to the soft mud method, but starts with a much thicker clay mix, so it forms more accurate, sharper-edged bricks. The greater force in pressing and the longer burn make this method more expensive.

Bricks are more commonly used in the construction of buildings than any other material except wood. Brick and terracotta architecture is dominant within its field and a great industry has developed and invested in the manufacture of many different types of bricks of all shapes and colours. With modern Bricks are more commonly used in the construction of buildings than any other material except wood. Brick and terracotta architecture is dominant within its field and a great industry has developed and invested in the manufacture of many different types of bricks of all shapes and colours.

With modern machinery, earth moving equipment, powerful electric motors and modern tunnel kilns, making bricks has become much more productive and efficient. Bricks can be made from variety of materials the most common being clay but also calcium silicate and concrete. With clay bricks being the more popular, they are now manufactured using three processes soft mud, dry press and extruded. Good quality bricks have a major advantage over stone as they are reliable, weather resistant and can tolerate acids, pollution free. Bricks can be made to any specification in colour, size and shape which makes bricks easier to build with than stone. Brickwork is also much cheaper than cut stone work. However there are some bricks which are more porous and therefore more susceptible to dampness when exposed to water. For best results in any construction work, the correct brick must be chosen in accordance with the job specification.

Classification Based On Material:

- Waste utilization in construction industry
- Fly ash bricks
- Papercrete bricks
- Masonry in filled walls
- light weight bricks
- Cement bricks
- Clay bricks

Waste utilization in construction industry:

Human and his activities produce a lot of wastes. At the same time, man consumes many things. Amongst the various things man consumes, building materials happen to be the largest in terms of weight being about 5 tons per capita per year, next only perhaps to water. Out of the total cost of house construction, building materials contribute 70% cost in developing 14 countries like India. One of the construction sector's major contributions to the preservation of the environment and sustainable development is the reuse and recycling of the waste materials it generates, i.e. reducing, reusing, recycling and regenerating the residues that originate the constructive activity. This has increased the

E-WASTE BRICKS

life cycle of these materials, thereby reducing the amount of waste dumping and natural resource extraction.

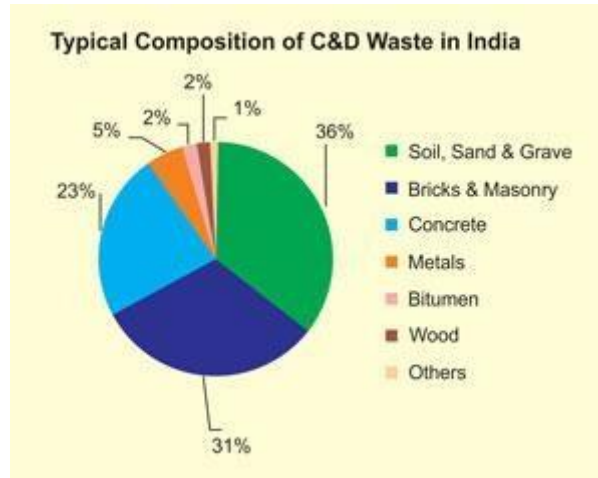


Fig.3.2 Waste utilization in construction industry

Flyash Bricks:

Based on a study, Tutuila and Antalya Omit (2001) reported the addition of flyash up to 60% at a firing temperature of 950°C and it did not have any harmful effects on the brick quality. Also they stated that the use of fly ash as a raw material for the production of building bricks was not only a viable alternative to clay but also a solution to a difficult and expensive waste disposal problem. Obada Kayali (2005) investigated the high performance of bricks from fly ash. He concluded that the fly ash brick had 24 % better compressive strength and 44% higher bond strength than the good quality clay brick. Also, he reported that the tensile strength of the fly ash brick was three times greater than the value for standard clay bricks. The addition of lime to the fly ash increases the cementations properties of fly ash and it was found that at 1.5% of lime, dry density was maximum and optimum moisture content was minimum.

Fly ash is a useful resource and not a waste product. However, major initiatives are needed in India to use it in large volumes in construction especially in housing and infrastructure projects. India should aggressively identify projects that can be registered with World Bank for carbon credits. The World Bank has cautioned India that by 2015, land disposal of coal ash would require about 1000 km of land. To overcome this problem and to encourage the utilization of fly ash, Government of India in 2003 made it mandatory to use at least 25% fly ash with soils on weight to weight basis for manufacture of bricks within a radius of 100 km from coal or lignite based thermal power plants. In the last several decades, attempts have been made to find a suitable method for the disposal and proper utilization of fly ash.



Fig.3.3 Flyash Bricks

Papercrete Bricks:

India's per capita consumption of paper is around 4.00 Kg. With the expected increase in literacy rate and growing economy, an increase in per capita consumption of paper is expected. The demand for upstream market of paper products like, tissue paper, tea bags, filter paper, lightweight online coated paper, medical grade coated paper etc., is shooting up. Due to this tremendous increase in use of paper, 1600 m³ papers are wasted in India per day. Even though the waste papers are recycled in paper industry only 29% of waste paper is recycled. It is lower in comparison to the global average of 36%. Paper is principally wood cellulose, which is considered as fibrous material. Cellulose is the second most abundant material on earth after rock. Even though the chemical behaviour of paper is suitable for Papercrete, the physical behaviour of paper is having an impact on physical behaviour of Papercrete. The tensile strength of paper also seems to be sufficient for the task. When applying a pull on a single sheet of paper on its edges, it has great strength. Ripping a piece of paper is easier than pulling it apart. So it denotes the shear strength of paper is not as great as its tensile strength. But ripping hundreds of sheets of paper is not an easy task. So it shows that it has more shear strength.

Millions of people lived in substandard housing or have no housing at all. When wastepaper is recycled as Papercrete to construct houses for these people and when landfills are removed, these problems can be solved. The challenge facing engineers now is the lack of information about Papercrete and meaningful research is needed in order to learn more about the material and its properties. Only then, the full potential of this recycled material can be realized.



Fig.3.4 Papercrete Brick

Masonry in filled walls:

The masonry infill wall is the supported wall that closes the perimeter of a building constructed with a three-dimensional framework structure (generally made of steel or reinforced concrete). Therefore, the structural frame ensures the bearing function, whereas the infill wall serves to separate inner and outer space, filling up the boxes of the outer frames. The infill wall has the unique static function to bear its own weight. The infill wall is an external vertical opaque type of closure. With respect to other categories of wall, the infill wall differs from the partition that serves to separate two interior spaces, yet also non-load bearing, and from the load bearing wall. The latter performs the same functions of the infill wall, hygro-thermically and acoustically, but performs static functions too. The use of masonry infill walls, and to some extent veneer walls, especially in reinforced concrete frame structures, is common in many countries. In fact, the use of masonry infill walls offers an economical and durable solution. They are easy to build, attractive for architecture and has a very efficient cost-performance. Today, masonry enclosures and partition walls are mainly made of clay units, but also natural bricks units (dense and lightweight bricks) and autoclaved aerated bricks units are used. More recently, industry is also trying to introduce wood blocks. Partition walls, made with both vertically and horizontally perforated clay blocks, represent two third of the corresponding market.

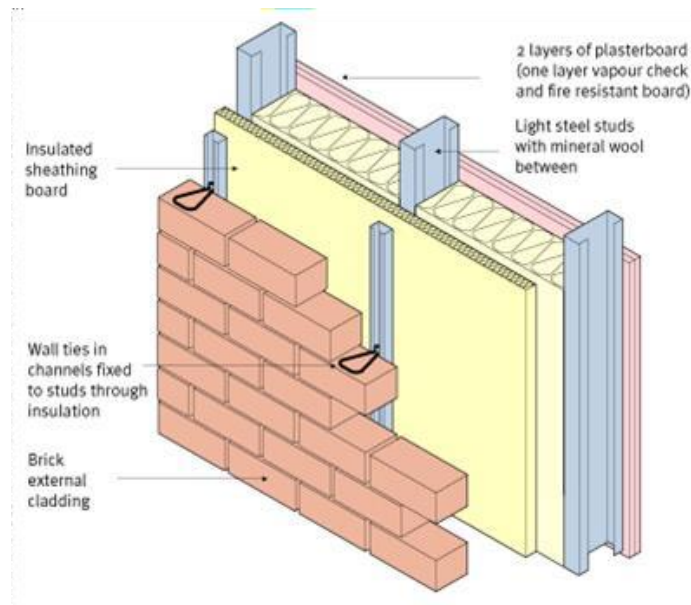


Fig.3.5 Masonry in filled walls

Light Weight Bricks:

Lightweight brick are much lighter and its low density reduces the permanent load. It also means easier handling and fixing which will reduce the labor cost. Its very low elasticity module is half of that of a heavy brick which greatly reduces internal tensions. Its linear coefficient of thermal dilatation is 30% lower than the normal concrete. They are user-friendly (drilling, filing, sawing...) and their light weight means fast handling and low fixing cost. So they easily adapt to all types of walls, inner and dividing walls, stiffening walls, firewalls, acoustic walls. The general compressive strength of a block is 2.0 to 7.0 N/mm². Advantages of light weight brick. light weight bricks are lightweight having density range from 650 Kg/m³ to 1250 Kg/m³ as compared to 1800 Kg/m³ to 2400 Kg/m³ for conventional brick respectively.



Fig.3.6 Light Weight Bricks

Cement Bricks:

Hollow and dense cement concrete blocks known as hollow blocks, have been developed as an alternative to bricks. The products are widely used in construction activity. The hollow blocks are made of cement, stone chips, stone dust and sand are not only cheaper than bricks but have other specialties as well. These blocks have more tensile strength, the walls constructed from these blocks act as thermal insulators because of their hollowness. As the construction activity is growing day by day, there is a good demand for hollow and cement concrete bricks. These blocks find wide applicability and construction cost is largely reduced. It is also observed that there is good demand for housing activity among tribal's.



Fig 3.7 Cement Bricks

Clay Bricks:

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar. A brick can be composed of clay-bearing soil, sand, and lime, or concrete materials. Bricks are produced in numerous classes, types, materials, and sizes which vary with region and time period, and are produced in bulk quantities. Two basic categories of bricks are fired and non-fired bricks. Brick is a similar term referring to a rectangular building unit composed of similar materials, but is usually larger than a brick. Lightweight bricks (also called lightweight blocks) are made from expanded clay aggregates.

Fired bricks are one of the longest-lasting and strongest building material, sometimes referred to as artificial stone, and has been used since circa 5000 BC. Air-dried bricks, also known as mud brick, have a history older than fired bricks, and have an additional ingredient of a mechanical binder such as straw.

Bricks are laid in courses and numerous patterns known as bonds, collectively known as brickwork, and may be laid in various kinds of mortar to hold the bricks together to make a durable structure.



Fig.3.8 Clay Brick

Classification Based On Method Of Manufacturing:

Bricks can broadly be categorized into two types as follows on the basis of how it's manufactured

1. Unburnt or sun-dried bricks
2. Burnt brick

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1. Unburnt bricks:

Unburnt bricks or sun-dried bricks are the types which are dried with the help of heat received from sun after the process of moulding. These bricks can only be used in the construction of temporary and cheap structures. Such bricks should not be used at places exposed to heavy rains. Bunt bricks are prepared by burning the brick-mould in the kiln inside the factory.

2. Burnt Bricks:

These are the most commonly used bricks for construction works. They can be further classified into following four categories

a) First class bricks:

These bricks are table-moulded and of standard shape and they are burnt in kilns. The surface and edges of the bricks are sharp, square, smooth and straight. They comply with all qualities of good bricks. These bricks are used for superior work of permanent nature. These bricks are ground-moulded and they are burnt in kilns. The surface of these

b) Second class brick:

Somewhat rough and shape is also slightly irregular. These bricks may have hair Cracks and their edges may not be sharp and uniform. These bricks are commonly used at places where brickwork is to be provided with a coat of plaster.

c) Third class bricks:

These bricks are ground- moulded and they are moulded in kilns. These bricks are not hard and they have rough surfaces with irregular and distorted edges. These bricks give du sound when struck together. They are used for unimportant and temporary structures and are places where rainfall is not heavy.

d) Fourth class bricks:

These are over-burnt type of brick with irregular shape and dark colour. These bricks are used as aggregate for concrete in foundations, floors, roads, etc. because of the fact that the over-burnt bricks have a compact structure and hence they are sometimes found to be stronger than even the first class bricks.

Classification based on shape:

The ordinary bricks are rectangular solids. But sometimes the bricks are given different shapes to make them suitable for particular type of construction. Here we have enlisted different types of bricks available with various shapes:

1. Bull nose brick:

A brick moulded with a rounded angle is termed as a bull nose. This type of brick is used for a rounded quoin. A connection which is formed when a wall takes a turn is known as quoin. The centre of the curved position is situated on the long centre-line of brick.

2. Channel bricks:

These types of bricks are moulded to the shape of a gutter or a channel and they are often glazed. These bricks are used to function as drains.

3. Coping bricks:

These bricks are made to suit the thickness of walls on which coping is to be. Provided. Such bricks take various forms such as chamfered, half round or saddle-back.

4. Cow nose bricks

A brick moulded with a double bull nose on end is known as a cow nose.

5. Curved sector bricks:

These bricks are in the form of curved sector and they are used in the construction of circular brick masonry pillar, brick chimneys, etc.

6. Hollow bricks:

These are also known as the cellular or cavity bricks. Such bricks have wall thickness of about 20mm to 25mm. They are prepared from special homogeneous clay. They are light in weight about one-third the weight of the ordinary brick of the same size. These types of bricks can be laid almost about four times as fast as the ordinary bricks and thus the use of such bricks leads to speedy construction. They also reduce the transmission of heat, sound and damp. They are used in the construction of partitioning.

7. Paving bricks:

These bricks are prepared from clay containing a higher percentage of iron. The excess iron vitrifies the bricks at a low temperature. Such bricks resist better the abrasive action of traffic. The paving

E-WASTE BRICKS

bricks may be plain or chequered. These bricks are extensively used for garden walks, street pavements, stable floors, etc. These types of bricks also render the floor less slippery.

8. Perforated bricks:

These bricks contain cylindrical holes throughout their thickness. These bricks are light in weight and they require less quantity of clay for their preparation. The drying and burning of these bricks are also easy. If perforated bricks of large size are used, it will result in the increase of output of mason. The perforated bricks are used in the construction of panels for lightweight structures and multi-storied framed structures. They may be circular, square rectangular or any other regular shape in cross-section. The distance between the side of brick and edge of perforation should not be less than 15mm. The distance between the edges of successive perforations should preferably be not less than 10mm. The water absorption after immersion for 24 hours in water should not exceed 15 percent by weight. The compressive strength of perforated bricks should not be less than 7 N/mm² on gross area.

9. Purpose-made bricks:

In order to achieve certain purpose, these types of bricks are made. The splay or cant bricks are made for jambs of doors and windows. The arch bricks are made of wedge shape to keep mortar joint of uniform thickness. The ornamental bricks are prepared for corbels, cornices, etc. Similarly, engineering bricks are prepared for constructions where high durability, compression strength and adequate resistance to sudden shocks are required. These types of bricks are usually more costly than the ordinary bricks. But they grant safe, clean and quick construction. Hence, their cost is justified by their excellent performance in situation for which they are purposely prepared.

Classification based on usage of bricks:

The ordinary bricks are rectangular solids. They may be circular, square rectangular or any other regular shape in cross-section. The distance between the side of brick and edge of perforation should not be less than 15mm. The distance between the edges of successive perforations should preferably be not less than 10mm. The water absorption after immersion for 24 hours in- water should not exceed 15 percent by weight. The compressive strength of perforated bricks should not be less than 7 N/mm² on gross area. The splay or cant bricks are made for jambs of doors and windows. The arch bricks are made of wedge shape to keep mortar joint of uniform thickness. The ornamental bricks are prepared for corbels, cornices, etc. Similarly, engineering bricks are prepared for constructions where high durability, compression strength and adequate resistance to sudden shocks are required. These types of bricks are usually more costly than the ordinary bricks. But they grant safe, clean and quick construction.

Characteristics Of Good Bricks:

The following are the main characteristics of a good brick.

Appearance:

A good brick should possess perfect rectangular faces with sharp and strong edges. Brick should be free from flaws, cracks, pebbles, lumps, roots of vegetation and traces of lime etc., it should have uniform colour and shape with or without frog.

Hardness:

A good brick should be hard enough to avoid scratches on the surface. It can be tested by a nail. No mark should be left on the face of the brick when scratched with a nail.

Strength:

A good brick should be strong enough to receive the required load of the structure. It should consist of a minimum crushing strength of 35kg/cm² and superior bricks 70 to 140 kg/cm. A good brick should not break when it is dropped on the ground from a height of 1.2 meters.

Soundness:

A good, bricks should give a metallic ringing when two bricks are struck together without any breakage.

Structure:

A good brick should have a uniform compact and homogeneous, particles of brick earth.

Porosity or Water Absorption:

A good brick should be less porous in such a way that it should not absorb water more than 20% weight of the dry brick, when immersed in water for more than 10 hours.

Durability:

A good brick should be able to withstand the ill effects of weathering agencies like rain, temperature, wind and snow.

Efflorescence:

A good brick should not contain more salts. Salts allow the spalling off surface of the brick (efflorescence).

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Resistance to Fire:

A good brick should have enough resistance to fire or heat. Usually bricks should stand the temperature up to 1000° C.

CHAPTER-4

BRICK MANUFACTURING PROCESS

Work Procedure:

The evaluation for use as a replacement of fly ash material begins with the brick testing. Brick contains fly ash, Lime, water, and Quarry dust. With the control brick, i.e.5%, 10% and 15%of the fly ash is replaced with Bagasse ash, the data from the fly ash brick is compared with data from a standard fly ash brick without bagasse ash.

The following are the steps involved for the preparation of bricks are as follows:-

1. Mixing
2. Moulding
3. Curing

Mixing:

Thorough mixing of the materials is essential for the production of uniform brick. The mixing should ensure that the mass becomes homogeneous, uniform in colour and consistency. There are two methods adopted for mixing brick

- (i) Hand mixing
- (ii) Machine mixing

Hand Mixing:

There are two methods adopted for mixing bricks:-

- ❖ Dry mix
- ❖ Wet mix

Dry Mix:

Spread out the measured quantity of fly ash, bagasse ash, cement, quarry dust and lime in alternate layers. Pour the cement on the top of it, and mix them dry by shovel, turning the mixture over and over again until uniformity of colour is achieved. This operation is continued till such time a good uniform, homogeneous brick is obtained.



Fig.4.1 Dry Mix

Wet Mix:

Spread out the measured quantity of fly ash, bagasse ash, cement, lime and quarry dust in alternate layers. Pour the cement on the top of it, and mix them dry by Shovel, turning the mixture over and over again until uniformity of colour is achieved. The required amount of water is added to the dry mix. Mix the mixture continuously until it get good uniform. This operation is continued till such time a good uniform, homogeneous brick is obtained.



Fig.4.2 Wet Mix

Machine Mixing:

The measured quantity of fly ash, bagasse ash, cement, quarry dust and lime are poured in to the machine drum after some start the machine and add the water continuously in to the machine drum until it makes the uniform mix.



Fig.4.3 Machine Mixing

Moulding:

Bricks are moulded in many ways depending on the quality of the product to be made.

Generally the moulding is done in the following two ways

- Hand moulding
- Machine moulding

For hand moulding the tempered clay is forced in the mould in such a way that it fills all the corners of the mould. Extra clay is removed either by wooden strike or frame with wire. Mould is then lifted up and raw brick is left on ground.

Machine moulding is used where large numbers of bricks are to be made. Machines used for moulding is generally of two types.

- Plastic clay machines
- Dry clay machines

In plastic clay machine the clay in plastic state is forced to rectangular openings of a size equal to the length and breadth of the bricks and are then cut into strips of thickness of the brick with wires in frames.

In dry clay machines, dry clay is reduced to powder, filled dry into mould by the machine and then are subjected to high pressure to form hard and well-shaped bricks.



Fig.4.4 Moulding

Curing:

Good Curing gives strength and dimensional stability to Bricks. Bricks are cured either by air curing or high-pressure steam curing procedure. Because of great Engineered properties, bricks have become popular in wide range of applications in construction sector. Curing compound would be the costly alternative. Standards call for a 24 day curing period for cement-based building members.

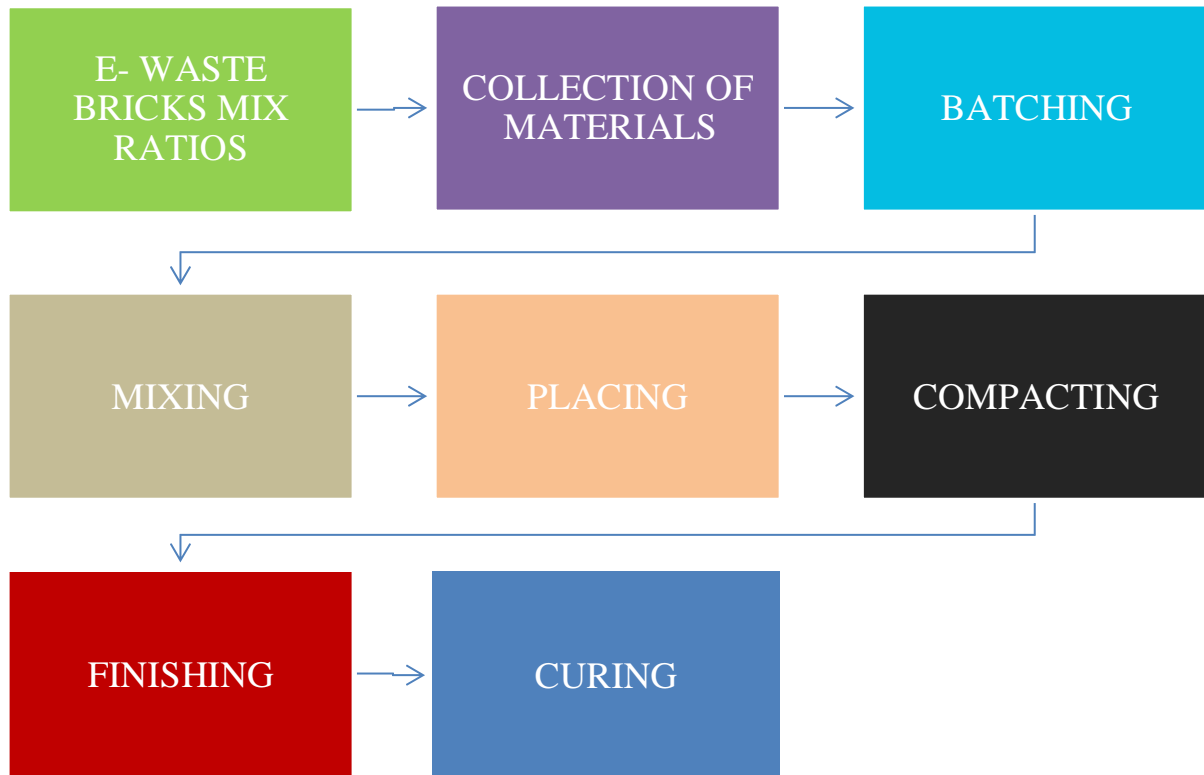


Fig.4.5 Curing

CHAPTER-5

PROCEDURE & MAKING OF E-WASTE BRICKS

Projects are about doing things. To do something requires a procedure, a methodology, a process and so on. The methodology/procedure one uses is always extremely important to actually accomplishing the goals of any project. The key is to find/use processes that are designed for the type of project you are doing and are compatible with the people who are doing the doing. Google Maps directions from Philadelphia to New York will not get you from San Francisco to Los Angeles. Likewise, the procedure which we followed for the preparation of this E-waste bricks has been explained in this chapter.



Collection of Materials:

Material needed for the e-waste bricks such as cement, fine aggregate (sand), water and e-waste is collected from various sources. In this study, for the replacement of aggregate which is e-waste.

Cement:

Ordinary Portland cement (OPC) of 53 grade of used as per the code book IS: 8112-1989. Fresh cement should be used without lumps.

Sand:

Sand is used as fine aggregate which is sieved through 600 μ IS sieve. It is mainly used as filling material. It should be free from moisture and any other foreign matters.

e-waste:

It is a waste or mainly generated from electrical and electronic E-waste, information and communication systems in the industries, in this mother boards and key boards are cutting in to small pieces, in this pieces are passing 4.75mm and retained on 0.15mm are taken.

Water:

Water having pH of 6 to 7 should be used for the preparation of this bricks.

Mix proportion 1:3 :

Volume of brick mould = $23 \times 10.3 \times 7.5 \text{cm} = 1.776 \times 10^{-3} \text{m}^3$

Density of cement = 1440 kg/m^3

Density of sand = 1800 kg/ m^3

Water cement ratio = 0.45

E-WASTE BRICKS

Conventional Bricks :

$$\text{Quantity of cement} = \frac{1}{4} * 1.776 * 10^{-3} * 1.52 * 1440 = 0.97 \text{kg}$$

$$\text{Quantity of sand} = \frac{3}{4} * 1.776 * 10^{-3} * 1.52 * 1800 = 3.64 \text{ kg}$$

$$\text{Quantity of water} = 0.97 * 0.45 = 436 \text{ ml}$$

For 3 Bricks

$$\text{Quantity of cement} = 0.97 * 3 = 2.91 \text{kg}$$

$$\text{Quantity of sand} = 3.64 * 3 = 10.92 \text{ kg}$$

$$\text{Quantity of Water} = 436 * 3 = 1308 \text{ ml}$$

E- Waste Bricks

For 1%

$$\text{Quantity of cement} = \frac{1}{4} * 1.776 * 10^{-3} * 1.52 * 1440 = 0.97 \text{kg}$$

$$\text{Quantity of E- Waste} = \frac{1}{100} * 3.64 = 0.0364 \text{ kg}$$

$$\text{Quantity of sand} = 3.64 - 0.0364 = 3.603 \text{ kg}$$

$$\text{Quantity of water} = 0.97 * 0.45 = 436 \text{ ml}$$

For 6 Bricks

$$\text{Quantity of cement} = 0.97 * 6 = 5.82 \text{ kg}$$

$$\text{Quantity of E- Waste} = 0.0364 * 6 = 0.218 \text{kg}$$

$$\text{Quantity of sand} = 3.603 * 6 = 21.62 \text{ kg}$$

$$\text{Quantity of water} = 436 * 6 = 2616 \text{ ml}$$

E-WASTE BRICKS

For 1.5 %

$$\text{Quantity of cement} = \frac{1}{4} * 1.776 * 10^{-3} * 1.52 * 1440 = 0.97 \text{kg}$$

$$\text{Quantity of E- Waste} = \frac{1.5}{100} * 3.64 = 0.0546 \text{ kg}$$

$$\text{Quantity of sand} = 3.64 - 0.0546 = 3.585 \text{ kg}$$

$$\text{Quantity of water} = 0.97 * 0.45 = 436 \text{ ml}$$

For 6 Bricks

$$\text{Quantity of cement} = 0.97 * 6 = 5.82 \text{ kg}$$

$$\text{Quantity of E- Waste} = 0.0546 * 6 = 0.327 \text{ kg}$$

$$\text{Quantity of sand} = 3.585 * 6 = 21.51 \text{ kg}$$

$$\text{Quantity of water} = 436 * 6 = 2616 \text{ ml}$$

For 2%

$$\text{Quantity of cement} = \frac{1}{4} * 1.776 * 10^{-3} * 1.52 * 1440 = 0.97 \text{kg}$$

$$\text{Quantity of E- Waste} = \frac{2}{100} * 3.64 = 0.0728 \text{ kg}$$

$$\text{Quantity of sand} = 3.64 - 0.0728 = 3.567 \text{ kg}$$

$$\text{Quantity of water} = 0.97 * 0.45 = 436 \text{ ml}$$

For 6 Bricks

$$\text{Quantity of cement} = 0.97 * 6 = 5.82 \text{ kg}$$

$$\text{Quantity of E- Waste} = 0.0728 * 6 = 0.437 \text{kg}$$

$$\text{Quantity of sand} = 3.567 * 6 = 21.40 \text{ kg}$$

Quantity of water = $436 \times 6 = 2616$ ml

Batching

Batching of brick means measuring the different ingredients of brick (i.e., cement, sand, E- waste and water). This can be done in 2 methods.

Volume batching:

When this measurement is done on the basis of volume, we call it as volume batching. Volume batching is not a good method for proportioning the material because of the difficulty it offers to measure granular material in terms of volume. Volume of moist and in a loose condition weighs much less than the same volume of dry compacted sand. The effect of bulking should be considered for moist fine aggregate. For unimportant concrete or for any small job, concrete may be batched by volume.

Weight batching:

When this measurement is done on the basis of weight, we call it as weight batching. Weight batching is the correct method of measuring the materials. Use of weight system in batching, facilitates accuracy, flexibility and simplicity. Large weight batching plants have automatic weighing equipment on large work sites. So, we are followed this method for batching.

Mixing :

Thorough mixing of the materials is essential for the production of uniform brick. The mixing should ensure that the mass becomes homogeneous, uniform in colour and consistency. There are two methods adopted for mixing brick:-

Machine mixing

Hand mixing

Machine mixing:

PCB is produced like regular bricks- which in fact, it is by identical raw materials used, namely, cement, sand, e-waste and water. PCB also hardens like regular bricks increasing its strength infinitely as long as exposed to humidity in the atmosphere. It hardens by hydration as regular bricks or concrete and can be

E-WASTE BRICKS

accelerated by either high early strength cement, using warm water in the mix, by applying steam, or by using an additive which has to be tested on its compatibility. PCB is readily integrated into existing prefab and concrete works - even produced in truck mixers.

Hand mixing:

There are two methods adopted for mixing bricks:-

- 1) Dry mix
- 2) Wet mix

1) Dry mix:

Spread out the measured quantity of cement, sand, e-waste and cement in alternate layers. Pour the cement on the top of it, and mix them dry by shovel, turning the mixture over and over again until uniformity of colour is achieved. This operation is continued till such time a good uniform, homogeneous brick is obtained.



Fig 5.1: Dry mix

2) Wet mix:

Spread out the measured quantity of cement, sand, e-waste and water in alternate layers. Pour the cement on the top of it, and mix them dry by shovel, turning the mixture over and over again until uniformity of colour is achieved. Water is taken in a water-can fitted with a rose-head and takes that water into measuring jar and adds the water to the mixture in various levels and simultaneously turned over it and mixes thoroughly. This operation is continued till such time a good uniform, homogeneous brick is obtained. We followed this method because of less preparation of mix.



Fig.5.2. Wet mix

Placing:

After preparing the mix, the moulds of size 230 x 105 x 75mm, are to be filled with this mix immediately, the mix is placed in the moulds by three layers and compaction should be done uniformly by using tamping rod. Level the top surface of the mould. Leave the mould for 24hrs to setting.



5.3 Placing

Compacting:

In the process of placing mortar mix, air is entrapped. The entrapped air reduces the strength of brick up to 30%. Hence it is necessary to remove this entrapped air. This is achieved by compacting the paste, after placing it in its final position. Compaction can be carried out either by hand or with the help of vibrators.

(a) Hand Compaction:

In this method, mortar mix is compacted by ramming, tamping, spading or by slicing with tools. In intricate portions, a pointed steel rod is used for poking the mix.

(b) Compaction by Vibrators:

Mortar mix can be compacted by using high frequency vibrators. Vibration reduces the friction between the particles and set the motion of particles. As a result, entrapped air is removed and the mortar mix is compacted. The use of vibrators reduces the compaction time. When vibrators are used for compaction, water cement ratio can be less, which also helps in improving the strength of concrete. Vibration should be stopped as soon as cement paste is seen on the surface of concrete. Over vibration is not good for the brick.

The following types of vibrators are commonly used for vibratory compaction:

- (a) Needle or immersion vibrators
- (b) Surface vibrators
- (c) Form or shutter vibrators
- (d) Vibrating tables.

Finishing:

The smoothness, texture, or hardness of a brick surface. Floors are troweled with steel blades to compress the surface into a dense protective coat. Walls that are exposed to the weather are often ground with a carborundum stone or wheel, with cement then added to fill the small voids. A smooth surface is desired so that water cannot enter the small holes, freeze, and deteriorate the surface.

The most commonly used techniques for finishing are:

Troweling or Floating

Edging , Broom Finishing

CHAPTER-6
MATERIALS IN BRICKS

Materials in Bricks:

Materials used in bricks are;

1. Cement
2. Fine aggregate (sand)
3. Water

Cement:



Fig 6.1 .Cement

The cement is a product obtained by crushing of clinkers formed by burning of desired proportions of calcareous and argillaceous materials at high temperature when it is mixed with water,

E-WASTE BRICKS

it forms a paste, which hardens and binds aggregates together to form a hard durable mass called concrete. In general the natural cement resembles in many aspects to eminently hydraulic lime in binding properties. Cement is the main component of concrete. It's an economical, high quality construction material used in construction projects.

Cement is a binding material it consists of various ingredients like lime, silica, alumina, iron oxide, magnesium oxide, sulphur trioxide, alkalis of raw materials during the manufacture of cement.

Magnesium oxide:-

It provides hardness and colour to the cement when present in small quantity. The magnesium oxide in excess quantity makes the cement unsound.

Sulphur trioxide:-

It makes the cement sound when present in very small quantity. The sulphur trioxide in excess quantity makes the cement unsound.

Lime:-

It makes the cement sound and strong. The lime in excess quantity makes the cement unsound and causes the cement to expand and disintegrate.

Silica:-

It provides strength to the cement due to the formation of di-calcium and tri-calcium silicates. The silica in excess quantity causes the cement to set slowly.

Alumina:-

It provides quick setting property to the cement and lowers the clinkering temperature.

Alkalies:-

This should be present in small quantities. The alkalies in excess quantity will cause effloresces.

Fine Aggregate:



Fig 6.2 Fine aggregate

Fine aggregates are the aggregates whose size is less than 4.75mm. Example: sand is used as fine aggregate in the preparation of concrete and Cement mortar. Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than slit. Sand can also refer to a textural class of soil or soil type; i.e. soil containing more than 85% sand-sized particles (by mass).

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand is silica (silicon-dioxide), usually in the form of quartz.

Water:



Fig 6.3 Water

The purpose of using water with cement is to cause hydration of the cement. Water in excess of that required for hydration acts as a lubricant between coarse and fine aggregates and produces a workable and economical concrete. There is a definite optimum water requirement for a particular concrete and mortar. In case of excess water, the cement along with water comes to the surface by capillary action and forms a thin layer over surface known as laitance. Thus weakens bond between the successive lifts of concrete. The excess water may leak through the form work, resulting in honeycombed concrete and on evaporation makes the concrete porous. On the other hand lesser water makes it difficult to work with concrete and because of non-uniform mixing the resultant concrete is weaker in strength. The amount of water therefore be limited to produce concrete of the quality required for a job.

Almost any potable water that has no pronounced taste or odour is acceptable for the concrete mix. Many sources of water unsuitable for drinking may also be used. In case of a doubt, water samples should be tested for suitability. Excessive impurities may affect setting time, strength, durability and may cause efflorescence, surface discolouration and corrosion of steel.

Physical and Chemical properties of Materials:

Cement Properties:

TABLE -1 : Physical properties of cement

SL.NO.	Particulars	Properties
1	Colour	Grey
2	Shape texture	Irregular
3	Mineralogy	Non Crystalline
4	Particle size	<150 microns
5	Odour	Odour less
6	Specific gravity	3.15
7	Appearance	Very fine

TABLE-2 : Chemical composition of cement

S.NO	COMPOSITION	CEMENT
1	CaO	50.7%
2	SiO ₂	0.09%
3	Al ₂ O ₃	0.03%
4	Fe ₂ O ₃	0.02%
5	MgO	0.01%
6	K ₂ O,Na ₂ O ₃	0.19%
7	SO ₃	0.57%

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TABLE-3 : IS CODES AND SPICIFICATIONS:-

1	IS:383-1970	Indian standard specifications for coarse and fine aggregates from natural sources for concrete.
2	IS:10262-2009	Concrete mix proportioning-guidelines
3	IS:12269-2013	Indian standard specifications for 53 grade ordinary Portland cement.

CHAPTER-7

TESTS ON MATERIALS

Tests On Cement:

Fineness of Cement by Dry Sieving Method:

The degree of fineness of cement is a measure of the mean size of grains in cement. The finer cement has quicker action with water and gains early strength though its ultimate strength remains unaffected. However, the shrinkage and cracking of cement will increase with the fineness of cement. Apparatus used to determine the sieve analysis are I.S. Sieve No. 9 (90 Microns), Weighing Balance capacity 5 kg as per IS: 4031(part 1)-1996. Weigh 400 grams of the given cement and sift it continuously for 15 minutes on IS. Sieve 9 no. Air set lumps may be broken down by fingers but nothing should be rubbed on the sieves. Find the weight of residue of the sieved after the sifting is over and report the values as a percent of the original sample taken.



Sieve Lid



Weighing Balance



Sieve with Pan



Sieve Shaking Machine

Fineness of Cement Apparatus

Fig 7.1 Fineness Test

TABLE -1: Observation of fineness of cement test

Trial no.	Weight of cement (in grams)	Weight of residue on IS sieve no.9 (gms)	% of weight retained
1	400	17	4.25
2	400	19	4.75

Consistency Test:

This is a test to estimate the quantity of mixing water to form a paste of normal consistency defined as that percentage water requirement of the cement paste, the viscosity of which will be such that the Vicat's plunger penetrates up to a point 5 to 7 mm from the bottom of the Vicat's mould.

Importance: The water requirement for various tests of cement depends on the normal consistency of the cement, which itself depends upon the compound composition and fineness of the cement.

Test procedure: 400g of cement is mixed with 25 percent water. The paste is filled in the mould of Vicat's apparatus and the surface of the filled paste is smoothed and levelled. A square needle 10mmX10mm attached to the plunger is then lowered gently over the cement paste surface and is release quickly. The plunger pierces the cement paste. The reading on the attached scale is recorded. When the reading is 5-7mm from the bottom of the mould, the amount of water added is considered to be the correct percentage of water for normal consistency.

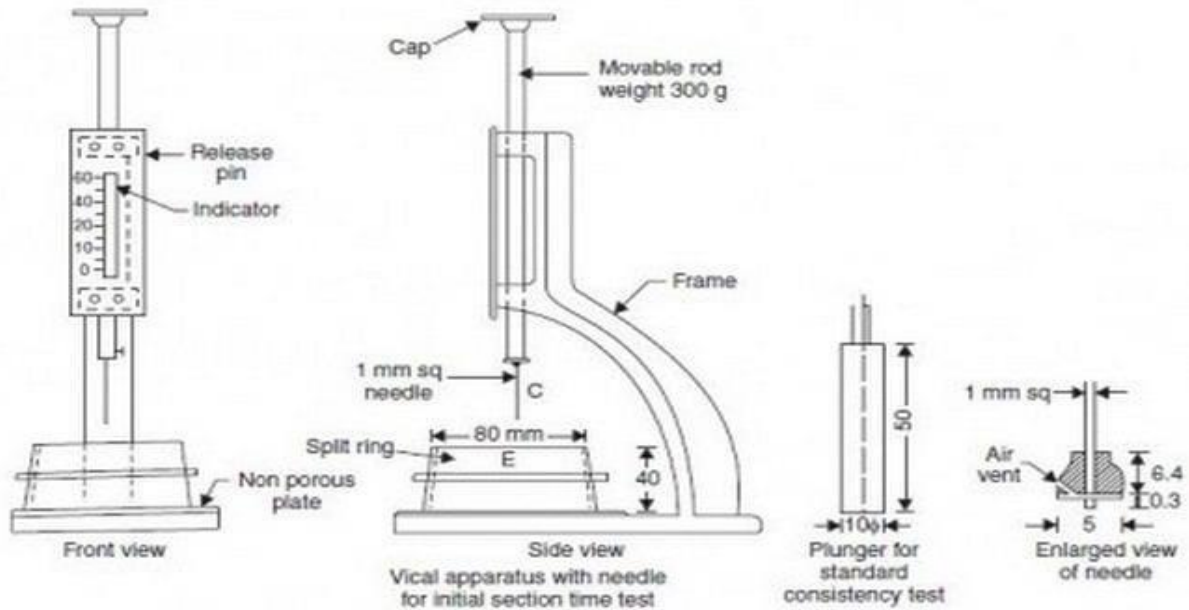


Fig 7.2 Vicat's apparatus

TABLE-2 : Observation of consistency of cement test

S.NO.	Weight of cement taken in gms (a)	Weight of water taken in ml (b)	Plunger penetration in mm	Consistency of cement in % (bx100/a)
1	400	88	43	22
2	400	100	22	25
3	400	112	6	28

Normal consistency of cement=28%

Setting time of cement test:

In actual construction dealing with cement paste, mortar or concrete certain time is required for mixing, transporting, placing, compacting and finishing. During this time cement paste, mortar, or concrete should be in plastic condition. The time interval for which the cement products remain in plastic condition is known as the initial setting time. Normally a minimum of 30 minutes is given for mixing and handling operations. The constituents and fineness of cement is maintained in such a way that the concrete remains in plastic condition for certain minimum time. Once the concrete is placed in the final position, compacted and finished, it should lose its plasticity in the earliest possible time so that it is least vulnerable to

damages from external destructive agencies. This time should not be more than 10 hours which is often referred to as final setting time.

The Vicat's Apparatus is used for setting time test also. The following procedure is adopted. Take 400 gm. of cement sample and gauge it with 0.85 times the water required to produce cement paste of standard consistency (0.85 P). The paste shall be gauged and filled into the Vicat's mould in specified manner within 3-5 minutes. Start the stop watch the moment water is added to the cement. The temperature of water and that of the test room, at the time of gauging shall be within $27^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

a) Initial setting time:



Fig 7.3 Initial setting time of cement

Lower the needle gently and bring it in contact with the surface of the test block and quickly release. Allow it to penetrate into the test block. In the beginning, the needle will completely pierce through the test block. But after some time when the paste starts losing its plasticity, the needle may penetrate only to a depth of 20-25 mm from the top. The period elapsing between the time when water is added to the cement and the time at which the needle penetrates the test block to a depth equal to 20-25 mm from the top is taken as initial setting time.

b) Final Setting Time:

Replace the needle of the Vicat's apparatus by a circular attachment. The cement shall be considered as finally set when, upon, lowering the attachment gently cover the surface of the test block, the Centre needle makes an impression, while the circular cutting edge of the attachment fails to do so. In other words the paste has attained such hardness that the center needle does not pierce through the paste more than 0.5 mm.



Fig 7.4 Final Setting Time Apparatus

Specific gravity of cement: Weight a clean specific gravity bottle with its stopper (W_1). Place cement up to half of the flask (about 40 gm) and weigh it with its stopper (W_2). Add kerosene (Polar liquid) to cement in flask about half full. Mix thoroughly with glass rod to remove entrapped air. Continue stirring and add more kerosene till it is flush with graduated mark. Outer surface of flask is dried and weight is taken (W_3). Empty the flask, clean it and refill with clean kerosene flush with graduated mark. Outer surface of flask is dried and weight is taken (W_4).

TABLE-3 : Observation of specific gravity of cement test

Weight of empty bottle W_1 (gms)	75
Weight of bottle + cement W_2 (gms)	115

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Weight of bottle + cement + water W ₃ (gms)	187
Weight of bottle + full water W ₄ (gms)	158

Specific gravity of cement = $\frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)} * \text{Specific gravity of diesel}$

$$= \frac{(115 - 75)}{(115 - 75) - (187 - 158)} * 0.85$$

$$= 3.09$$

TABLE-4 : Test results of cement

S.No	DESCRIPTION	TEST RESULTS	ISCODE LIMITS	IS CODES
1	Specific gravity	3.09	3.10-3.6	IS:269-1989
2	Fineness modulus	4.25%	<10%	IS:4031-1988
3	Normal consistency	28%	>26%	IS:4031-1988 (part 4)
4	Initial setting time	45 minutes	>30 minutes	IS:269-1989
5	Final setting time	9.5 hours	<10 hours	IS:269-1989

Tests On Fine Aggregates:

Specific gravity:

In concrete technology, specific gravity of aggregates is made use of in design calculations of concrete mixes. With the specific gravity of each constituent known, its weight can be converted into solid volume and hence a theoretical yield of concrete per unit volume can be calculated. Specific gravity of aggregate is also required in calculating the compacting factor in connection with the workability measurements. Similarly, specific gravity of aggregate is required to be considered when we deal with light weight and heavy weight concrete. Average specific gravity of the rocks vary from 2.6 to 2.8.



Fig 7.5 Specific gravity Using Pycnometer

TABLE-5 : Observation of Specific gravity of fine aggregate test

S. No	Description	Trail 1(gm)
1	Weight of pycnometer (W_1)	648
2	Weight of pycnometer + dry sand(W_2)	1456
3	Weight of pycnometer + dry sand +water(W_3)	2052
4	Weight of pycnometer + water(W_4)	1706

$$\text{Specific gravity of sand (G)} = \frac{(W_4 - W_1)}{(W_2 - W_1) - (W_3 - W_4)}$$

$$= \frac{(1706-648)}{(1456-648)-(2052-1706)} = 2.29$$

The specific gravity of given fine aggregate is obtained as 2.29

Bulking of sand

Take 1000ml measuring jar. Fill it with dry loose sand up to 500ml without tamping at any stage of filling. Then pour that sand on a pan and mix it thoroughly with water whose volume is equal to 2% of that of dry loose sand. Fill the wet loose sand in the container and find the volume of the sand which is in excess of the dry volume of the sand. Repeat the procedure for moisture content 4%, 6%, 8% etc, and note down the readings. Continue the procedure till the sand gets completely saturated i.e. till it reaches the original volume of 500ml.

TABLE-6 : Observation of bulking of sand test results

S. No	Volume of dry loose sand (V₁) ml	% moisture content added	Volume of wet loose sand (V₂) ml	% bulking (V₂-V₁)x100 /V₁
1	500	2	560	12
2	500	4	580	16
3	500	6	600	20
4	500	12	600	22
5	500	14	590	18
6	500	16	580	16
7	500	18	570	14
8	500	20	560	12

Maximum bulking of given sand =28%

Sieve analysis:

The sieves are arranged in their order and place the sieve set in a mechanical sieve shaker machine. Switch on the system for 5minutes (or) this can be done manually by shaking the sieves.

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This is used to differentiate the particles of different sizes in different sieves. The sizes of sieves used for fine aggregate are 4.75mm, 2.36mm, 1.18mm, 600 microns, 425microns, 300 microns, 150 microns and pan.



Fig 7.6 Different Sizes of Sieves

TABLE-7 : Observation of sieve analysis test

S. No	Sieve size in Mm	Wt. retained in gms.	% wt. retained	Cum.% wt retained	% finer
1	4.75	39	1.95	1.95	98.05
2	2.36	48	2.4	4.35	95.65
3	1.18	506	25.3	29.65	70.35
4	0.6	623	31.15	60.8	39.2
5	0.45	460	23	83.8	16.2
6	0.3	133	6.65	90.45	9.55

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7	0.15	136	6.8	97.25	2.75
8	Pan	55	2.75	100	0

From the table the fineness modulus of the sand =%.

Hence it is within permissible limits

CHAPTER-8

TESTS ON BRICKS

Test-1

Water Absorption Test:

Water absorption test on bricks are conducted to determine durability property of bricks such as degree of burning, quality and behaviour of bricks in weathering.

A brick with water absorption of less than 7% provides better resistance to damage by freezing. The degree of compactness of bricks can be obtained by water absorption test, as water is absorbed by pores in bricks.

The water absorption by bricks increase with increase in pores. So, the bricks, which have water absorption less than 3 percent can be called as vitrified.

This test provides the percentage of water absorption of bricks and procedure of the same is discussed below.

Apparatus:

1. A sensitive balance capable of weighing within 0.1% of the mass of the Specimen
2. ventilated oven

Specimen:

Three numbers of whole bricks from samples collected for testing should be taken.

Procedure of Water Absorption Test:

1. Dry the specimen in a ventilated oven at a temperature of 105 °C to 115°C till it attains substantially constant mass.
2. Cool the specimen to room temperature and obtain its weight (M_1) specimen too warm to touch shall not be used for this purpose.
3. Immerse completely dried specimen in clean water at a temperature of $27 \pm 2^\circ\text{C}$ for 24 hours.
4. Remove the specimen and wipe out any traces of water with damp cloth and weigh the specimen after it has been removed from water (M_2).



Fig 8.1 Water Absorption of Bricks

Calculation of Water Absorption of Bricks:

Water absorption, % by mass, after 24 hours immersion in cold water is given by the formula,

$$W = \frac{M_2 - M_1}{M_1} * 100$$

For 1%

$$\frac{3.831 - 3.758}{3.758} * 100 = 1.94\%$$

$$\frac{3.780 - 3.708}{3.708} * 100 = 1.94\%$$

For 1.5%

$$\frac{3.942 - 3.872}{3.872} * 100 = 1.806\%$$

For 2%

$$\frac{4.115 - 4.042}{4.042} * 100 = 1.806\%$$

Result:

Water absorption of the given 1% bricks = 1.94 %

Water absorption of the given 1.5% bricks = 1.806 %

Water absorption of the given 2% bricks = 1.806 %

Water Absorption Values for Bricks:

When tested as above, the average water absorption shall not be more than 20% by weight up to class 12.5 and 15% by weight for higher class.

Test-2

Compressive Strength Test:

Compressive strength test on bricks are carried out to determine the load carrying capacity of bricks under compression with the help of compression testing machine.

Bricks are generally used for construction of load bearing masonry walls, columns and footings. These load bearing masonry structures experiences mostly the compressive loads. Thus, it is important to know the compressive strength of bricks to check for its suitability for construction.

Apparatus, sampling, procedure and calculations to determine the compressive strength of bricks are discussed below.

Apparatus:

Compression testing machine, the compression plate of which shall have ball seating in the form of portion of a sphere centre of which coincides with the centre of the plate.

Specimens:

Three numbers of whole bricks from sample collected should be taken. The dimensions should be measured to the nearest 1mm.

Procedure of Compressive Strength Test on Bricks:

1. Place the specimen with flat face s horizontal and mortar filled face facing upwards between plates of the testing machine.
2. Apply load axially at a uniform rate of 14 N/mm^2 (140 kg/cm^2) per minute till failure occurs and note maximum load at failure.
3. The load at failure is maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.



Fig 8.2 Compression test

Calculation

Compressive Strength of Bricks = Maximum Load at Failure (N)/Average area of bed face (mm²)

For 7 days:

Conventional Brick

Load = 430 KN

Surface area = 230*103 mm

Compressive Strength = $\frac{430*1000}{230*103} = 18.15 \text{ N/mm}^2$

E- waste bricks

1%

Sample 1

Load = 390 KN

Surface area = 230*103 mm

Compressive Strength = $\frac{390*1000}{230*103} = 16.46 \text{ N/mm}^2$

Sample 2

Load = 520 KN

Surface area = 230*103mm

E-WASTE BRICKS

$$\text{Compressive Strength} = \frac{520 \times 1000}{230 \times 103} = 21.95 \text{ N/mm}^2$$

$$\text{Mean} = \frac{16.46 + 21.95}{2} = 19.2 \text{ N/mm}^2$$

1.5%

Sample 1

Load = 320 KN

Surface area = 230*75 mm

$$\text{Compressive Strength} = \frac{320 \times 1000}{230 \times 75} = 18.5 \text{ N/mm}^2$$

Sample 2

Load = 600 KN

Surface area = 230*103 mm

$$\text{Compressive Strength} = \frac{600 \times 1000}{230 \times 103} = 25.32 \text{ N/mm}^2$$

$$\text{Mean} = \frac{18.5 + 25.32}{2} = 21.91 \text{ N/mm}^2$$

2%

Sample 1

Load = 450 KN

Surface area = 230*103 mm

$$\text{Compressive Strength} = \frac{450 \times 1000}{230 \times 103} = 18.995 \text{ N/mm}^2$$

Sample 2

Load = 650 KN

Surface area = 230*103 mm

$$\text{Compressive Strength} = \frac{650 \times 1000}{230 \times 103} = 27.43 \text{ N/mm}^2$$

$$\text{Mean} = \frac{18.995 + 27.43}{2} = 23.21 \text{ N/mm}^2$$

Result:

For 7 Days

Average compressive strength of the given 1% bricks = 19.2 N/mm²

Average compressive strength of the given 1.5% bricks = 21.91 N/mm²

Average compressive strength of the given 2% bricks = 23.21 N/mm²

For 14 Days

Average compressive strength of the given 1% bricks = 19.42 N/mm²

Average compressive strength of the given 1.5% bricks = 22.35 N/mm²

Average compressive strength of the given 2% bricks = 23.85 N/mm²

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For 28 Days

Average compressive strength of the given 1% bricks = 20.47 N/mm²

Average compressive strength of the given 1.5% bricks = 23.57 N/mm²

Average compressive strength of the given 2% bricks = 24.9 N/mm²

TABLE-1: Compressive Strength Values on 1% E-Waste

No. of days	Cubes	Load (KN)	Compressive strength(N/MM ²)	Avg. Compressive Strength(N/MM ²)
7	1	390	16.46	19.2
	2	520	21.95	
14	1	430	18.15	19.42
	2	490	20.68	
28	1	450	18.99	20.47
	2	520	21.95	

TABLE-2: Compressive Strength Values on 1.5% E-Waste

No. of days	Cubes	Load (KN)	Compressive strength(N/MM ²)	Avg. Compressive Strength(N/MM ²)
7	1	320	18.5	21.91
	2	600	25.32	
14	1	400	23.18	22.35
	2	510	21.52	
28	1	420	24.35	23.57
	2	540	22.79	

TABLE-3: Compressive Strength Values on 2% E-Waste

No. of days	Cubes	Load (KN)	Compressive strength(N/MM ²)	Avg. Compressive Strength(N/MM ²)
7	1	450	18.99	23.21
	2	650	27.43	
14	1	550	23.21	23.85
	2	580	24.48	
28	1	570	24.06	24.9
	2	610	25.74	

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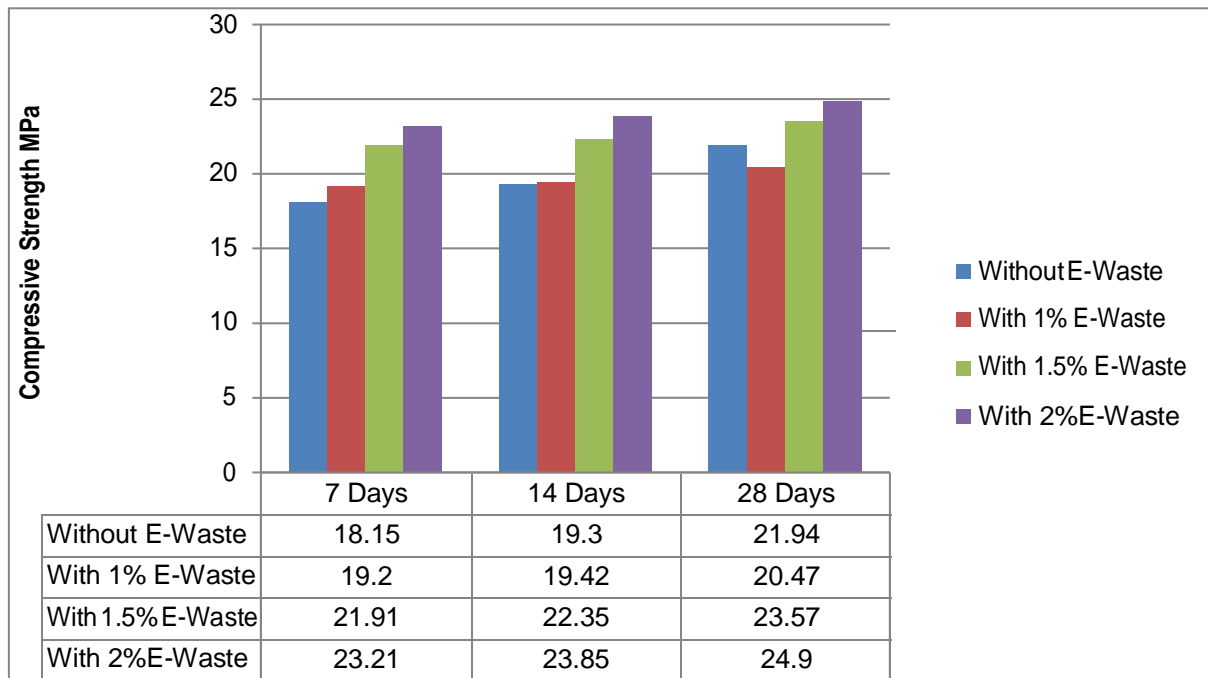


Fig 8.3 Final Analysis Of E- waste Brick

Test-3

Efflorescence Test:

Efflorescence is a whitish crystalline deposit on surface of the bricks. Usually magnesium sulphate, calcium sulphate and carbonate of sodium and potassium are found in efflorescence. The movement of groundwater into the foundations of buildings and by capillary action into brickwork is very often the cause of efflorescence.

Remedies for Efflorescence:

Well fired bricks should use for construction.

Sand testing should do before starting construction work.

Proper DPC should provide in building.

Efflorescence should be removing by dry brushing and washing repeatedly. This efflorescence may reappear in dry season but are in less intensity.

Apparatus:

A shallow flat bottom dish containing sufficient distilled water to completely saturate the specimens. The dish shall be made of glass, porcelain or glazed stoneware and of size 180 mm x 150 mm x 40 mm depth for square shaped and 200 mm diameter x 40 mm depth for cylindrical shaped.

Distilled water

Brick specimens

E-WASTE BRICKS

Procedure:

1. Fill distilled water in shallow dish and place one end of brick in dish. Water should fill in dish such that bricks should immersed in water up to 25 mm depth.
2. Place this whole arrangement in a warm ventilated room such that whole water is absorbed by the specimen and the surplus water will get evaporated.
3. Cover the dish containing brick with suitable glass cylinder so that there will not excessive evaporation from dish.
4. When whole water gets absorbed and brick appears to be dry, place a similar quantity of water in the dish and allow it to evaporate as before.
5. After this process examine the bricks for efflorescence and report results.

Results:

Results of efflorescence test shall be reported as nil, slight, moderate, heavy or serious.

1. Nil- If there is no noticeable deposit of efflorescence.
2. Slight- when less than 10% of exposed area of brick is covered by a thin layer of salt.
3. Moderate- When there is a heavier deposit than under 'slight' and covering up to 50 percent of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.
4. Heavy – When there is a heavy deposit of salts covering 50 percent or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

Serious-when there is heavy deposit of salt acquired by powdering and/or flaking of exposed surface.



Fig 8.4 Efflorescence test on Bricks

Test-4

Hardness Test:

A good brick should resist scratches against sharp things. So, for this test a sharp tool or finger nail is used to make scratch on brick. If there is no scratch impression on brick then it is said to be hard brick.



Fig 8.5 Hardness Test on Bricks

Test-5

Soundness Test:

Soundness test of bricks shows the nature of bricks against sudden impact. In this test, 2 bricks are chosen randomly and struck with one another. Then sound produced should be clear bell ringing sound and brick should not break. Then it is said to be good brick.



Fig 8.6 Soundness Test on Bricks

Test-6

Shape & Size on Bricks:

Shape and size of bricks are very important consideration. All bricks used for construction should be of same size. The shape of bricks should be purely rectangular with sharp edges. Standard brick size consists length x breadth x height as 23cm x 10.3cm x 7.5cm.

To perform this test, select 20 bricks randomly from brick group and stack them along its length, breadth and height and compare. So, if all bricks similar size then they are qualified for construction work.



Fig 8.7 Shape & Size of Brick

Test-7

Structure Of Bricks:

To know the structure of brick, pick one brick randomly from the group and break it. Observe the inner portion of brick clearly. It should be free from lumps and homogeneous.



Fig 8.8 Structure of Bricks

Test-8

Fire Resistance:

This test was conducted to know the property of a e-waste brick to prevent or retard the passage of excessive heat, hot gases or flames under conditions of use.

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1. First, the e-waste bricks of each proportion were wiped with cloths and all the foreign matters were removed. These bricks were weighed in a well-conditioned electronic weighing machine.
2. Then the flammable sticks and charcoal were fired. After that, the bricks were hold on the flame for one hour.
3. After one hour firing was stopped and the bricks were observed.



Fig 8.9 Fire Resistance Test

From the fire resistance test of e-waste bricks, we have noticed that these bricks have good thermal insulation properties. The mother boards have great insulating properties when bonded with cement. Hence, e-waste bricks have good fire resistance compared to conventional bricks.

CHAPTER -8

CONCLUSION

From the results obtained, the subsequent conclusions were made: Considering the fascinating compressive strength shown by the tested specimen, it's clear that e-brick have the power to supply an eco-friendly, light-weight weight concrete block with the employment of less variety of natural resources. Although the results obtained throughout compression take a look at showed that e-bricks are acceptable for non load bearing walls solely. As per analysis the bricks mustn't absorb water quite two hundredth. The water absorption capability of e-brick was found to be quite two hundredth that makes it not appropriate for water work and external walls. However, by providing a water-proof coating. it also can be used as external wall. The weight of the e-brick was 1/3rd to 2/5th lesser than the standard clay brick. Owing to less weight of e- bricks, the total burdens of the building are going to be reduced. Due to lesser weight and a lot of flexibility, these bricks are probably ideal material for earthquake prone regions So these bricks are lightweight and thus helpful to reduce the total cost of construction due to are duction in total dead load of the structure . E-bricks contains a high fireplace resistance, good sound absorbent, smart thermal resistance with an worth between two to three per in. In walls twelve to sixteen inches thick, the long energy saving of e-brick are going to be an excellent advantage for the house owner and environmental. This e- brick doesn't expand nor shrinks therefore, sheets of glass or glass block are often mounted in and cut with-brick. Since, e-brick primarily consists of waste product; it'll cut back the landfills and pollution. Hence, the overall price is extremely low as compared to traditional brick. It's been seen that by victimization e-bricks during a building construction, the full price was reduced from two hundredth to five hundredth.

CHAPTER-9

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Waste Management: Collection of Carbage:



E-Waste Bricks (CBIT –Civil Students Project):

Dry Mix



Wet Mix:



Placing



Different Sizes of sieves:



Water Absorption of Bricks

Compression Test

CERTIFICATE

This is to certify that following team members **B.TECH (CIVIL)** (2016-20) studying final year from **CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY, Proddatur, YSR Kadapa (dist.), A.P., (Affiliated to J.N.T. UNIVERSITY – Anantapur, A.P. India)**, have been successfully completed their **ACADEMIC MAJOR PROJECT** titled **"E- WASTE BRICKS"** under the guidance of this organization. The following is the list of students who were involved with the design, develop and deployment of the above mentioned project:

S.No	Roll No	NAME	CLASS
1	172P5A0103	B. SUREKHA	CIVIL IV YEAR
2	162P1A0124	P. GURU VISHNU	CIVIL IV YEAR
3	162P1A0106	B. RAJENDRA PRASAD	CIVIL IV YEAR
4	162P1A0136	T. VENKATA SUBBAIAH	CIVIL IV YEAR
5	162P1A0131	S. MOHAMMED VASIULLAH	CIVIL IV YEAR

We offered them the complete project guidance & assistance, we place our appreciation on records for their commitment and hard work done during the design & development of this project and the project was completed to our best satisfaction.

Thanks & Regards,



Ravi Kumar Sirimalla
(DIRECTOR)

