Satbilized Rammed Earth Construction Using Natural Fibers

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Abstract - **Rammed earth is an ancient building technique used in many regions of the world. Due to the low embodied energy of the material and diminished transportation costs, rammed earth offers an economical and sustainable alternative to concrete. Along with other advantages like sustainable construction, architectural quality & flexibility, contribution to building health and performance, ease & speed of construction etc. The main weakness of earth as a building material lies in its low resistance to water. Because of the clay fraction, which is necessary for cohesion, walls built of unstabilised soil will swell on taking up water and shrink on drying. This may lead to severe cracking and difficulty in getting protective renderings to adhere to the wall. There are some issues which needs to be addressed like shrinkage, proper soil selection, low compressive strength, cracking, durability aspects etc., for rammed earth construction. From the available literatures and research works done earlier, it is evident that one way to address these problems is to stabilize rammed earth with cement. The primary objective of this study is to make use of the Fly ash (waste material) with NS and understand its effects on the geotechnical properties & compressive strength.**

I. INTRODUCTION

Earth has been a tried and tested natural construction material for thousands of years, and in combination with modern methods can be used for modern ecological buildings. Rammed earth construction gives a strong and durable monolithic wall by dynamically compacting sub- soil. For a couple of year's earth building techniques have been growing in Iran, USA and all over Europe and Middle East. The reason for this increase is the interest in ecologically friendly construction. In many developing countries where the properties of earth construction are more widely appreciated, earth is utilized in the construction of floors and roofs, in addition to walls. Buildings made with earth are energy saving, environmental friendly, economical, and sustainable. Earth undoubtedly is the oldest building material known. Even though building with earth once fell out of popularity when the modern building materials and methods were discovered, but then it gains its revival time following the energy crisis. Moreover, growing concern and interest about environmental and ecological issue globally also increased the use of earth as a building material. Rammed earth has evolved as a versatile medium of commercial and domestic building construction, catering a healthy and safe environment. Rammed earth is highly benefits it provides in terms of temperature and noise control, strength, durability, low maintenance, fire proofing. The mechanical properties of rammed earth block can be improved to a great extent by using stabilizers such as cement and Fly ash in low proportions. The suitability of soil as rammed earth, high organic content is unsuitable for construction, as it biodegrades and results in more water consumptions. Natural fibres are used in earthen block construction to improve the reduction of shrinkage cracking, tensile strength, durability and ductility in tension. The idea of rammed earth to improve the quality and performance of earthen blocks and it was with wooden tamps that the first compressed earth blocks were produced. This process is still used in some parts of the world. In these experiment we have used cement, fly ash and coconut coir to prepare a building blocks. we have taken the waste soil as a main source to prepare the blocks which are thrown as a waste in the environment after it is successfully used in the sub grade of the road construction. so that we can convert that type of soil into useful material for the contraction purpose.

In this study, the following objectives are being carried out:

1. To investigate local soils to identify their suitability in stabilized earth block production.
2. To study the viability of rammed earth construction with locally available soil, by optimizing the quantity of cement and water to be added for stabilizing the soil.
3. Determination of axial compressive strength characteristics of cement stabilized rammed earth

II. LITERATURE REVIEW

Study of Compressed Stabilised Earth Block [1]

B. N. Patowary, N. Nath, I. Hussain, H. J. Kakoti

The Compressed Stabilized Earth Blocks (CSEB) was taken for strength determination after 28 days. The blocks were un-burnt. After breaking the blocks strengths for various CSEBs were determined. The maximum strength obtained was 3.11 N/mm2 for

CSEB 1 i.e. Mix of Sand (70%), Clay (20%) &OPC (10%). The minimum strength obtained was0.63 N/mm2 (CSEB 2) i.e. the block without stabilizer. But if we see the CSEB 7, with stabilizer and mix with Sand (70%), Clay (20%), Fly ash (5%) & OPC (5%), strength obtained was 0.832 N/mm2. The standard block which was brought from manufactured factory and which was also burnt and used for construction of building, the strength for that block was found to be 3.21 N/mm2. Maintaining the Integrity of the Specification

A Study on Stabilized Rammed Earth for Sustainable Construction [2]

Abhirami Suresh, Dr. K B Anand

From the ancient time onwards humans have adopted various building materiaLS WHICH COMPRISES STONES, WOOD, mud, soil, bricks, concrete, steel, glass etc. which have been changing with the developing technologies. In this modern world, where the conventional building techniques which causes immense environmental hazards, there is an urge for sustainable building technologies. Earthen buildings have proved to be suited for an economical, energy efficient, environmentally friendly and sustainable construction method. This paper gives a review on stabilized rammed earth construction which gives an overview of the efficiency of rammed earth over earth block and other conventional building materials. The objective of this study is to explore the suitability of locally available soil for Rammed Earth construction and optimization of stabilizer and the mixing water. Compressive strength characteristics are assessed by rammed earth prism.

STABILIZATION OF RAMMED EARTH [3]

MIHIR VORA, ANKIT PATEL, MOHAMMAD SOYAB SHAIKH

This research will draw a comparison between the NS available locally in Ahmedabad & available literatures thereby indicating the suitability of NS for the use of RE. Since there are very few guidelines available for rammed earth when combined with a waste material like RHA The primary objective of this study is to make use of the RHA (waste material) with NS and understand its effects on the geotechnical properties, compressive strength & weathering. The study also intends to quantify the amount of RHA to be added to the NS according to the values of soil properties measured, in order to enhance the properties of rammed earth

III. MATERIALS USED

- Soil
- Cement
- Fly ash
- Coconut coir

Industrial waste soil

It is regarded as a waste soil because it is already used in sub-grade of the road and thrown away as waste. we have collected this soil near the R V college of architecture

fig 3.1 Collection of soil sample

Fly ash

Fly ash, also known as "pulverised fuel ash" in the United Kingdom, is a coal combustion product that is composed of the particulates (fine particles of fuel) that are driven out of coalfired boilers together with the flue gases. Ash that falls to the bottom of the boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline), aluminum oxide (Al_2O_3) and calcium oxide(CaO), the main mineral compounds in coal-bearing rock strata

In the past, fly ash was generally released into the atmosphere, but air pollution control standards now require that it be captured prior to release by fitting pollution control equipment. In the United States, fly ash is generally stored at coal power plants or placed in landfills. About 43% is recycled [4] often used as a Pozzolanic to produce hydraulic cement or hydraulic plaster and a replacement or partial replacement for Portland cement in concrete production. Pozzolans ensure the setting of concrete and plaster and provide concrete with more protection from wet conditions and chemical attack

Fig 3.2 Fly ash

Coconut coir

Coconut fiber is extracted from the outer shell of a coconut. It is the natural fiber of the coconut husk where it is a thick and coarse but durable fiber. The common name, scientific name and plant family of coconut fiber is Coir. There are two types of coconut fibers, brown fiber extracted from matured coconuts and white fibers extracted from immature coconuts. Brown fibers are thick, strong and have high abrasion resistance. White fibers are smoother and finer, but also weaker. Both brown and white coir consist of fibers ranging in length from 4-12 in (10-30 cm). In this experiment we have used 1cm long fibers.

Fig 3.3 Coconut coir

Experiments conducted on soil

In this project we have conducted various experiment to find the stabilization soil using the industrial waste (fly ash) and cement the various test conducted are listed below.

1. Sieve Analysis
2. Liquid Limit
3. Plastic Limit
4. Specific Gravity
5. Moisture content
6. Standard Proctor Compaction Test

IV. METHODOLOGY

4.1 PREPARATION OF SPECIMEN

Procedure for Making SREB (Stabilized Rammed Earth Blocks)

1. Take the soil and sieve the soil in the 4.75mm IS sieve.

Fig 4.1 Sieved soil

2. Take 8% of cement and fly ash by weight of the soil.

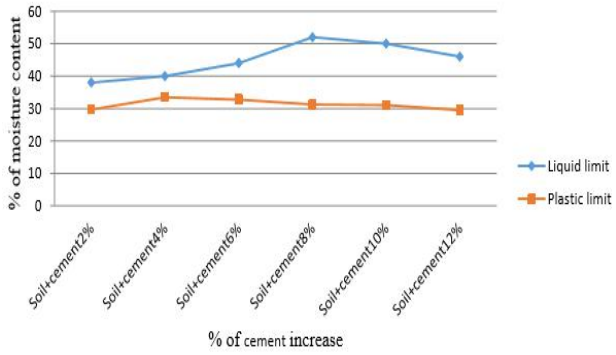


Fig 4.2 Mixing of soil and cement

4. Then take (2%,4% & 6%) of coconut fiber of length 10mm and mix the proportion well for dry. If the percentage of fiber increases, then the workability cannot be achieved.

Aspect ratio = (l/d)

100 = (l/0.1)

l =10mm

coconut fiber length = 10mm

Fig 4.3 Mixing of soil cement and fibers

4. Add 14.45%(Optimum moisture content) of water by the weight of the soil mix the proportion well for easy workability.

Fig 4.4 Wet mix of soil cement and fibers

5. Then pour the mixed proportion to the mould in layer wise, Rammed the each layer tell we hear the clear ringing sound.

SIZE OF THE MOULD - 190*90*90 MM

DENSITY OF SOIL - 0.0017 KG/CM3

VOLUME - 1539 CM3

DENSITY - (MASS/VOLUME)

0.0017 - (MASS/1539)

MASS OF EACH BRICK - 2.616 KG

Fig 4.5 Standard brick mould

Fig 4.6 Preparing the block

6. Prepared blocks are cured inside a room for 10 to 12 days.

Fig 4.7 Rammed bricks

4.2 COMPRESSION TEST ON BLOCK

Block kept under compression testing machine

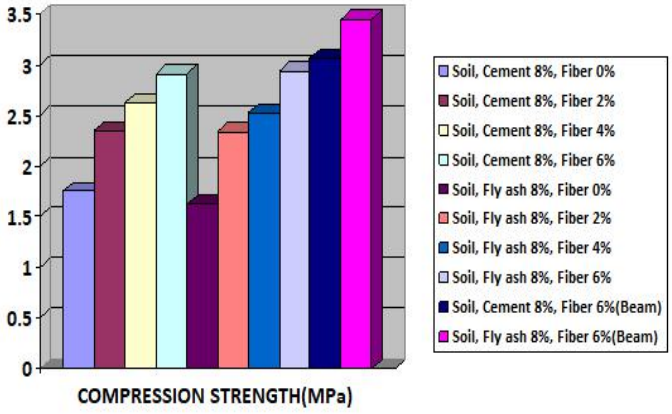
Fig 4.8 Testing the bricks

Failure of the block after compression test

Fig 5 Failure of the bricks

V. RESULTS & DISCUSSIONS

Sl. No	MIX PROPORTION	COMPRESSION STRENGTH(MPa)
1	Soil, Cement 8%, Fiber 0%	1.75
2	Soil, Cement 8%, Fiber 2%	2.35
3	Soil, Cement 8%, Fiber 4%	2.63
4	Soil, Cement 8%, Fiber 6%	2.91
5	Soil, Fly ash 8%, Fiber 0%	1.62
6	Soil, Fly ash 8%, Fiber 2%	2.34
7	Soil, Fly ash 8%, Fiber 4%	2.52
8	Soil, Fly ash 8%, Fiber 6%	2.94
9	Soil, Cement 8%, Fiber 6%(Beam)	3.06
10	Soil, Fly ash 8%, Fiber 6%(Beam)	3.45



CONCLUSION

1. Stabilized rammed earth blocks has improved strength than conventional building blocks which consume more natural resources and increased carbon emission
2. BIS guidelines suggests 2Mpa as minimum compressive strength of the blocks.
3. The compressive strength of the blocks increased with increase in cement content and increase in fiber content (upto 2.91 Mpa)
4. Addition of more fiber increased difficulty in handling and workability
5. Similar strength was observed with addition of fly-ash (upto 2.52 Mpa)
6. The use of fly-ash can be advised for more economical and eco-friendly rammed earth blocks
7. Weight of the rammed earth blocks was found to be 2.5kgs and the conventional block was found to be 3.2 kgs

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