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A Review of Development of Black Cotton Soil Brick from Biodegradable Waste Material

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ABSTRACT

Over the past few decades, civil engineers are putting continuous efforts towards converting wastes to useful building construction material. An experimental investigation has been carried out to study the feasibility of producing bricks from locally available black cotton soil with biodegradable waste material such as sugar cane husk, saw dust, rice husk, coconut husk. This paper reviews recycling various waste materials in bricks production. This study describes the use of bio-degradable waste in the manufacturing of brick as an alternative resource rather than the conventional one. The effect of this waste on the properties of bricks will be reviewed and recommendations for future research as out comings of this review will be given. This reviewed approach on bricks made from waste is useful to provide potential and sustainable solution.

Keywords: Black Cotton Soil, Bricks, Rice Husk, Sugarcane Husk, Saw Dust, Coconut Husk.

I. INTRODUCTION

Brick is defined as an artificial material obtained by moulding clay in rectangular block of uniform size that are dried and burnt at high temperature to form a dense and compact product. The main ingredients of brick are clay, sand lime, fly ash etc. According to IS 2212 (1991) standard size of brick is 19 cm x 9 cm x 9 cm. India produces over 60 million clay brick annually resulting in strong impact on soil erosion and unprocessed emission. As per the press information bureau, every year with an average annual growth of 4% (PIB 2016),India generates 62 million tonnes of waste (waste containing both recyclable as well as non-recyclable waste). The generated waste can be divided into three major categories i.e.organic (biodegradable waste),dry (recyclable waste) and biomedical (sanitary waste). Biodegradable waste includes organic matter in waste.

Biodegradable waste materials can be divided into carbon dioxide, simple organic molecules by micro-organisms and other living things by composting and other similar process. On the other hand, the black cotton soil is very retentive of moisture. It great swelling property makes it almost impossible to work with it in rainy season. Whereas in the hot season, the moisture content present in the soil evaporates and the soil shrinks and it developes deep cracks, (10 to 15 cm wide and up to a meter deep). hence it is a difficult task to make bricks from BCS.

Therefore, this review is carried out to find the sustainable use of this biodegradable waste material for making eco-friendly bricks in order to increase its construction properties and to reduce the waste producing in India to some extent.

DEVELOPMENT OF BRICK FROM BIODEGRADABLE WASTE MATERIAL

Lusia Barbieri, fernanda Andreola et al. (2013) developed bricks by using different agriculture biomass waste like sawdust, cherry seeds, grape seeds, and sugar cane ash. The agriculture biomass waste added in brick is not more than 10% weight of clay. These bricks are compared with industrial red brick. It is found that the biomass waste contains organic substance that provides support in heating process. Grapes and cherries seeds act as a pour forming agents that are added as 5% of the weight of the bricks. Weight loss (WL %), Water absorption (WA %), MOR and heating values are measured for the bricks. It was found that MOR value is 21-23 mpa with weight loss 7-10%. Sugar cane ash shows slightly less shrinkage than the standard one and MOR value is around 28%. Addition of biomass waste up to 5% weight of brick results in increase of water absorption and decrease in mechanical properties.

Laxmikant Yadu, Rajesh Kumar Tripati et al. (2011) used fly ash and rice husk ash to stabilize black cotton soil. Laboratory test which were conducted on black cotton soil including fly ash and rice husk ash were Atterburg's limits, specific gravity, CBR, UCS (unconfined compressive strength) and characteristics were determined according to Bureau of Indian Standard (BIS). Addition of fly ash results in decrease of OMC and decrease in MDD and addition of rice husk ash results in increase in OMC and decrease in MDD. The optimum amount of fly ash and rice husk ash was found to be 12% and 9% on the basis of CBR and UCS test.

Mohammad Shahid Arshad & Dr. P .Y. Pawale , (2014) worked on formation of bricks prepared from natural waste material which comprises of orange peels and coconut waste. Clay is used as a binding material for natural waste and paper mill waste. From this study they found that coconut waste is most efficient than orange peel and paper mill waste. Coconut waste can be easily handled and utilised for making light weight bricks. In case of coconut waste, the shorter fibre gives better result as compared to longer fibre and up to 60 precent of the clay can be substituted by natural waste material for making bricks.

Apurva Kulkarni, Samruddha Raje, Mamta Rajgor, (2013) used bagasse ash and lime as a replacement for fly ash brick. The bricks of size (230×100×75) mm were made with different proportions compressive test was conducted on brick. The load is applied axially at a uniform rate of 14 N/mm^2 and crushing load is noted. In result it was found that compressive strength of Bagasse ash as compared to the fly ash was more, it also solved the disposal problems. The compressive strength is obtained at 10% replacement of fly ash as bagasse ash.

Rahul R. Jichkar, Kunal R. Pokale, and Yogesh R. Borkar, (Aug 2015) for making bricks have used combination of black cotton soil and brick dust. They have varied the proportion of brick dust as 10%, 20%, 30%. They have performed the test for checking moisture content, Swelling index and unconfined compressive strength. They came to a conclusion that moisture content reduces after 7 days and 28 days. Swelling index of black cotton soil decreases brick dust up to certain limit & strength carrying capacity of sample bricks is increased.

Rushikesh Mirzapure, Gaurav Waghmare et al. (January 2016) used black cotton soil as a raw material for the bricks and also some other admixtures to alter the proportion of black cotton soil. Materials used are Black cotton soil, Rice husk, Salt. Tests performed were compressive strength test, water absorption test. Author came to a conclusion that good quality of bricks can be manufactured by using admixture, such as lime, salt, rice husk, coal, etc.

Mangesh V. Madurwar, Sachin A. Mandavgane et al., (2014) used bio-fuel by product, sugarcane bagasse ash (SBA) to manufacture brick and quarry dust as replacement of lime. The characteristics SBA is found

out by using X-ray fluoresce (XRP, thermos combination analysis (TGA), X-ray diffraction and scanning electron microscopy (SEM). This test confirms that SBA is cementitious material and it is stable till 650^0. SEM shows fine pore surface characteristic physical properties of quarry dust is determine by laboratory test. The SAB-QD-L bricks were compared with commercially available brick, and it was observed that it was light weighted, energy efficient and compressive strength met the requirement of IS 1077:1992.

(Panchal Darshan, Vivek Patel, et al (2014) made bricks by using adhesive materials, black cotton soil, rice husk and salt with different combinations. The size of brick was 190mm×90mm×70mm and various test which were conducted on bricks were compressive strength as per IS3495 water absorption test as per IS 3495(part 3) size, shape, colour, soundness , structure test. In result it was found that compressive strength is 60% more than normal brick, water absorption is 20%, it is less than normal brick and volumetric change is in the range of 3mm to 6mm. This brick provided economical solution where black cotton soil is available.

(Abdul El 2004) did his research on incorporation. From his research he found that sewage sludge from sewage treatment plants can be regarded as an interesting raw material for fabrication of clay bricks. As per the study about 10% to 40% weight can be utilized for advancement of normal clay. As per physical & chemical properties, bricks with more than 30% sludge addition are not recommended for use, since they are brittle & get easily broken even when handled gently. Sludge bricks may not be suitable as facing bricks due to their poor surface texture & finishing unless plaster is applied. Due to these reasons sludge aimed clay bricks are normally not exposed to view.

(Badr EI Din Ezzal, Hegazy, Hanan Ahmed 2012) Investigated the complete substitution of brick clay by sludge incorporated with some of the agricultural and industrial waste such as rice husk ash and silica fume. Three proportions of sludge to silica fume to SF to RHA were tried which were (50:25:25), (50:25:25), (25:25:50) respectively. It was fired at 900^0C, 1000^{0C}C, 1100^0C and 1200^0C. They found the best results with the proportion of 50% of sludge, 25% SF and 25% RHA were the optimum material proportion to produce brick from waste sludge incorporated with SF and RHA. They concluded that WTP sludge can be successfully used in brick manufacturing incorporated with agriculture and industrial waste materials, which contain high silica content, such as RHA & SF. The result are limited to the study conditions such as mixing proportion, firing temperature and manufacturing method used in study.

(Kuldeep Singh Chouhan, Prof Rajesh Jain 2015) worked to improve stability of black cotton soil by using fly ash to get the maximum strength and used the same content of fly ash with sugar cane fibre 1.5cm which gave decreased behaviour of expansion of black cotton soil. The CBR value is found in between 1.19 to 5.65 & unconfirmed compression ratio from 9.66 to 1.43 kg/cm^2. It was found that the optimum moisture content (OMC) decreases with the increase in % of fly ash and dry density is increased with increase in % of fly ash.

(Ushma Gwale and Prof Y.P Joshi 2018) This research was carried out to analyse the strength of black cotton soil using coconut fibre black cotton soil which was mixed with coir fibre in range of 0.5% and 2.5%. During which they observed the properties like change in optimum moisture content & Maximum dry density of black cotton soil due to addition of coir, changes in UCS result due to addition of coir fibre & find the optimum fibre content, & change in free swelling characteristics of black cotton soil with an addition of coir fibre was observed. As a result of their research they found that it is eco-friendly waste material & easily used. At the end they concluded that

the use of coconut is found to be effective & eco-friendly method of stabilizing the weak sub-grade soil.

(Prashantha T.R, Dr.Anupam Mittal 2017) used coir as an addition with black cotton soil in different percentage (0.2%, 0.3%, 0.4%, and 0.5%) .Various tests that were conducted on the specimen included CBR, Unconfined compressive strength (UCS), free swell test, plastic and liquid limit test . It was found that soil density decreases when compacted fibre content increases, cohesion increases and it reaches its peak at 0.4% which is optimum fibre content. When core fibre increases to more than 0.4% it results into reduction in cohesion. Almost 40% reduction is found in black cotton soil.

(C.C. Ikeagwuoni 2016) used Saw dust, Ash and Lime to improve the compressibility characteristic of the black cotton soil. Test which was conducted are atterburg's limit, specific gravity, particle size distribution. Sawdust was used as 0 to20% by weight of soil, and lime as 4% by weight of soil. A significant improvement in the compressibility characteristic was found when a combination of 16% SDA and 4% weight of black cotton soil were added to it. The specific gravity is improved from 2.34 to 2.37. Liquid limit decreases 84.2% to 40.6%. Plastic limit is increase from 28 to 33%. Overall plastic limit was down from 56.2 to 7.3%. Free swell is decreases from 79 to25.2%.

II. DISCUSSION

From the paper studied, it was found that different materials impacts on different properties of bricks. It was observed from different research conducted on the bricks manufactured from waste bricks properties like physical & mechanical properties can be improved by adding different waste material in brick composition as well as swelling and drying properties of black cotton soil can be overcome.

According to Lusia Barbieri, fernanda Andreola etc. (2013) Addition of biomass waste up to 5% weight of brick results in decrease in weight and increase in porosity or increase in water absorption and decrease in mechanical properties. Laxmikant Yadu, Rajesh Kumar Tripati, (2011)found from their research that Addition of fly ash result in decrease of OMC and decrease in MDD for addition of rice husk ash result in increase in OMC and decrease in MDD. According to (Mohammad shahid Arshad and Dr.P.Y.pawale, (2014)) up to 60% of the clay can be reduced by natural waste material (orange peels & coconut waste) for making bricks. Vaidya Dipesh (2014) concluded from his research that water absorption of the brick made from the black cotton soil with the various admixtures is about 20% less than water absorption of the normal brick.

According to (Rushikesh Mirzapure, Gaurav Waghmare, Shrikant Rathod,etc(January 2016) good quality of bricks of BCS, can be manufacture by using admixture, such as lime, salt, rice husk, coal, etc. According to (Panchal Darshan, Vivek Patel, Rona Vishesh, Sukhadia Hardik, Vaidya Dipesh, 2014) Bricks made by using adhesive materials, black cotton soil, rice husk and salt with different combinations possesses compressive strength of 60%, water absorption is 20% more than normal brick. (Kuldeep Singh Chouhan, Prof Rajesh Jain 2015) found that the optimum moisture content (OMC) decreases with increase in % of fly ash and dry density increases with increase in % of fly ash in bricks. (Ushma Gwale, Prof Y.P Joshi 2017) As a result of their research they found that coconut fibre eco-friendly waste material & easily used. The optimum moisture content decrease 12-08 maximum dry density is 1.55%. At the end they conclude that the use of coconuts fibre is found to be effective & eco-friendly method of stabilizing the weak sub-grade soil.

Whatever study we have done yet from that, we can say that biodegradable waste material can be also used as an ingredient in brick making of good quality of bricks possessing good bricks qualities can be expected.

III. CONCLUSION

Different papers based on black cotton soil brick manufacturing & use of bio-degradable waste for the same has been reviewed. There effect change in properties, reuse as an ingredient in brick making are reviewed. It was found that different materials provides & enhance properties of bricks in different manner & hence they can be used to overcome the swelling & drying property of Black cotton soil. Hence rice husk, coconut husk, sugar cane husk & fine saw dust are selected & experimental study will be done on brick made by adding these bio degradable waste materials.

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