1975

Low-cost construction materials, presented at Low-Cost Housing Conference, Cairo, Egypt, April 1975

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Since economical factors have influenced the construction industry dramatically in recent years and in many parts of the world steel is scarce and expensive, many researchers are searching for low-cost materials as a substitute or alternative for the present situation. Recently, polymer concrete has shown promise for future use as a major construction material. Based on laboratory studies, the strength of polymer concrete is three to four times that of ordinary concrete with very high corrosion resistance and durability. The cost for polymer concrete is about six cents per pound compared with 39 cents per pound of steel, and it is particularly suitable for areas with high corrosion problems, such as locations of offshore structures, sewage pipes, pavement in cold regions, railway ties, nuclear power plants, and numerous other possible applications (2). However, the polymer substance is a by-product of oil and may be influenced by the current energy crisis and needs improvement in the techniques for large scale commercial production. Other materials such as sulfur concrete and fiber concrete also can be considered as useful for future construction material.

The purpose of this paper is to summarize some highlights of studies on relatively low-cost materials for possible use in low-cost housing in developing countries in addition to the polymer, sulfur and fiber concrete currently being studied at Fritz Engineering Laboratory, Lehigh University which are as follows:

1. Stabilized waste-disposal material
2. Polymer-bamboo reinforced concrete
3. Random-straw or coconut fiber stabilized soil.

Waste-Disposal Material
The nature of waste-disposal material is highly nonhomogeneous. It consists of anything that cannot be further used or recycled economically. Thus,

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1 To be presented at the Low-Cost Housing Conference, Cairo, Egypt, April 20-25, 1975.

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its composition varies from community to community and from country to country. The density varies from 50 pcf to 500 pcf depending on the amount of metal and debris. Usually, waste-disposal material is used for landfill and fuel and in some countries, it has been used for building block, however, due to human psychological effects regarding the use of this material, this use has not been wide spread. The most economical way to dispose of waste at the present time (8) is for use as landfill.

The scope of this study is the further application of waste-disposal material to foundations and highway subbase courses. Laboratory studies have been made on compacted natural waste and stabilized waste disposal material. The compacting method for natural waste material has been developed by the American Solid Waste System Inc. of Minnesota which is a three-compaction system using pressures in the region of 2000 to 3600 psi with steel baling strips holding the bale together. Tests conducted at Fritz Laboratory on these bales included the double punch tensile (3) and unconfined tests. The modified Fang-Hirst method (4) was used to determine the strength parameter, c and µ for estimating the bearing capacity of the block (approximately 3' x 3' x 4'). The stabilized waste disposal material using silty clay (LL = 36; P. I. = 10), lime, fly ash, and bentonite was tested with the standard AASHTO Compaction method. Results show that 25% by weight of the waste disposal material received high strength. The stress-strain relationship was analyzed from the tensile and unconfined compression tests. Other tests included wet-dry, freeze and thaw, and hydraulic conductivity tests. Since this is a highly nonhomogeneous material, random statistical techniques (5) and stochastic processes were applied. Based on the preliminary results, it is feasible to use waste-disposal material for future highway subbase course.

Random-straw or Coconut Fiber Stabilized Soil

Straw-soil mix is an ancient construction material and has been used in many countries for years. Application of modern geotechnical techniques to this material can further improve both strength and durability. Results with silty clay using the standard AASHTO Compaction procedure applied with the tensile test show that for 1% by weight of straw, the tensile strength increases three times than that soil with no straw and also the soil-straw mix gives a high ductility behavior. The percent of straw increase to the tensile strength increase reaches an optimum condition approximately around 1.6% by
weight and further increases of straw will decrease tensile strength. From wet-dry test results, the coconut fiber gives better durability. If a sulfur coating is applied to the compacted straw-soil mix, better water resistance is gained.

Straw-soil mix can also simulate the soil-root system. The bearing capacity and stress-strain relationship for soil-root systems were also studied as use for erosion protection of highway embankments, earth dams and river banks.

**Polymer-bamboo Reinforced Concrete**

The problem of bamboo reinforced concrete includes high volume change, (expansion and shrinkage due to water content), low bond strength between bamboo and concrete, low modulus which precipitate cracks at service loads in tensile zone of concrete beams, and decay (1). Many researchers have attempted to use many techniques to improve this low-cost material by use of bitumen, paint, cement, etc. However, studies done at Fritz Laboratory using polymer and sulfur give better results in comparison with previous techniques. Impregnation techniques and increasing the bond strength for this material with sulfur are being developed. It is feasible that this type of material can be used for secondary structures when steel is not available.

Other low cost materials such as sulfur treated brick or masonry block are also being studied. The ultimate stress for untreated bricks ranges from 7,540 psi to 12,180 psi as compared with 15,620 to 25,230 psi for treated bricks. Compressive stress and secant modulus also increases significantly (6,7). Using the fracture mechanics concept analysis, the fatigue behavior and crack growth of treated and untreated bricks have been evaluated under various loading and environmental conditions.

Utilization of the locally available material especially waste material for developing low-cost material for low-cost housing is important. Using modern geotechnical technology (9,10) which can improve the strength and durability of much of the existing low-cost material should be encouraged.

**Acknowledgments**

Sincere thanks are extended to Dr. R. G. Slutter and Messrs. J. Wheeler, G. Stuebben and H. C. Mehta.
References


