LMFS-99-29
TECHNICAL EVALUATION OF RAMMED EARTH BUILDING PRODUCTS

CONTRACTOR: Energy and Environmental Research Center

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PARTICIPANTS

Sponsor	Cost Share
Energy & Environmental Research Center (U.S. DOE JSRP)	$24,720
ND Industrial Commission	$35,800
Total Project Costs	$60,520

Project Schedule - 12 Months
Contract Date - 6/1/99
Start Date – 6/1/99
Completion Date – 9/19/00

Project Deliverables
Status Report – 12/15/99 ✓
Status Report – 5/1/00 ✓
Final Report – 9/19/00 ✓

OBJECTIVE / STATEMENT OF WORK

The objective of this study is to evaluate the performance and durability of rammed earth (RE) construction. Specific objectives are: 1) to determine a design mix based on local materials, 2) to perform a test of environmental acceptability, 3) to determine long-term durability, and 4) to perform a preliminary market and economic evaluations.

The rammed earth evaluation is based on material and a site designated by Nagel Construction of New Town, North Dakota. The design proposes the use of coal combustion byproducts from Great River Energy's Coal Creek Station (CCS).

STATUS

Placing premixed soil inside a form and compacting the soil with appropriate ramming equipment is used to accomplish rammed earth construction. This procedure was simulated in the laboratory by mixing soil from the proposed rammed earth demonstration construction site, bottom ash and fly ash from Coal Creek Station and cement and then compacting the

mixture. Samples of soil, bottom ash, fly ash and cement and selected mixtures were evaluated for compressive strength, durability testing, trace metals, environmental performance (chemical composition, mobility/leachate analysis) radon, and R-Value. The feasibility of RE construction in North Dakota was evaluated.

The mixtures were evaluated for strength using the standard ASTM D698-91. The addition of bottom ash does not increase compressive strength. The addition of fly ash increases compressive strength slightly. The addition of cement produced material meeting strengths in excess of 200 pounds per square inch (psi). Strengths of 200 to 300 are recommended in the New Mexico Adobe and Rammed-Earth Building Code. Mixtures containing cement have acceptable compressive and durability strength performance.

Boron is a potential issue of environmental concern. Boron leaching might be an issue in the use of some fly ash in RE mix designs because of its high degree of mobility and its potential to hinder plant growth. Radon emanated from the soil but was not identified in the bottom ash, fly ash or cement.

R-values (m^2K/W) determined on 1-inch cubes of RE samples with and without 15% added bottom ash are 0.079 and 0.091 respectively. Published values for RE materials are 0.25 m^2K/W compared to glass wool with a value of 15 m^2K/W. The addition of bottom ash does improve RE R-value, but the value is significantly inferior to traditional insulation materials.

It is projected that the use of bottom ash and fly ash in RE construction is very limited in North Dakota. Transportation costs, lack of significant benefits, wet weather, cold climate, lack of a trained labor force and builder choice are factors limiting the use of bottom ash and fly ash for RE construction.