Nepal Masonry and Earth Mortar Research

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Random stone masonry construction with earth mortar is unable to withstand the dynamic forces of earthquakes.

Cost and access to materials is a constraint for low income and remote communities.
Government and the Shelter Cluster and partners developed guidance on construction.
CRS Dissemination – Sensitisation
Skills training within communities provides an opportunity of building on existing good practice and to introduce innovation.
In each community demonstration have been constructed and technical information is provided through help-desks and direct contact with engineers.
Innovation and Research

CRS, along with other NGOs and Government have looked to develop and disseminate options for safer building and innovations using local materials.
Earth mortar is an integral part of masonry construction in most of the affected areas. There is little information being provided about the quality of mortar in the guidelines or building code. CRS saw an opportunity to investigate this.
Earth Mortar in Masonry Construction

Issues with mortar are evident.
• Excessive proportion of mortar
• Quality of soils for mortar
• Issues of micro-cracking due to high clay content and quantity of water
• Lack of tensile strength
Earth Mortar in Masonry Construction - Improvement

Considerations for improvement:

- Selection of material
- Proper preparation and water content
- Inclusion of fibers (natural and manmade)
- Correct use of mortar in construction

Soil test 1
- Put a sample of soil in your hand and add some water and rub with your fingers.
- If it gives off a smell it has organic matter in it and is not good.
- If it is very gritty, then there is too much sand and is no good.
- If it is slimy and turns to fine dust as it dries, it has too much silt and is no good.
- If it is sticky with some grit in it and does not smell then it may be the right type of soil.

Soil test 2
- Add water to a sample and roll into a ball and leave for 1/2 Hour. This is so the sample can soak up the water.
- Roll out into a cigar shape 3cm Diameter and 30cm long.
- Slide the ‘cigar’ off the edge of piece of glass, plastic, or smooth card.
- Measure the point at which the sample breaks.
- If it breaks between 10 and 15cm it is good for adobe.
- Repeat the test 3 times to check results.
- If it has too much clay, sand can be added to correct.

Soil test 3
- Roll 3 5cm Diameter balls of soil. Leave them in a shaded dry area for 1-2 days until they have dried.
- Try and crush between finger and thumb.
- If it crumbles into dust then it is not strong enough.
- If it breaks into large pieces, this is reasonable soil.
- If it cannot be broken, it is very good soil for adobe.
As part of the initial investigation, interns and volunteers with CRS made a control mix of mortar and added different fibers to the mix.
Earth Mortar in Masonry Construction - Improvement

Tiles were produced and then air dried.
A local primary school assisted with simple static load testing. This was also to see how to introduce Safer Building through schools by integrating into the curriculum. These basic tests demonstrated a 25% improvement when fibers were added.

Oxford Brookes University volunteered to repeat the tests in laboratory conditions.
Earth Mortar in Masonry Construction – Oxford Brookes
Research Question

Guidelines and standards offer interventions to increase seismic resistance of stone masonry construction,
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Hypothesis: addition of fibrous materials to earth mortar will increase seismic resistance.
Literature Review and Expert Advice

Strength of earth mortar can be increased by ‘stabilising’
Additives: ash, lime, cement, fibres, cow dung
Increase strength of the mortar
Not necessarily increase seismic resistance
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Literature Review and Expert Advice

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No data was found on the seismic resistance behaviour of fibre stabilised earth mortar, therefore a series of laboratory tests was proposed to investigate this quality
Testing

Fibres commonly used: straw, hay, hemp, sisal, elephant grass

Test samples in cement mortar and earth mortar
Fibre reinforcement added:
  None: control
  Straw: traditional
  Rope: low or zero cost local material
  Shredded tarpaulin: low or zero cost local material
Testing the samples Two shear tests: initial failure (cracking) and total failure (breaks in two)
Cement samples after testing
Earth samples after testing
Results

Fibres did little to improve shear resistance

Better post cracking behaviour with fibre reinforcement

Dependent on fibre density

Demonstrates fibre reinforcement does have an effect
Next tests

Determine optimum fibre length and density

Load test on optimised samples

Build sample wall panels test for static and dynamic shear
Next Steps

- Field test of using mortar in construction
- Dissemination
  - Universities
  - Building Codes
  - NGO
- Behaviour Change Research
Earth Mortar in Masonry Construction

Questions