Stabilised Rammed Earth - Physical Properties and Compliance with UK Building Regulations

Stabilised rammed earth (SRE) can successfully be used to conform to the Building Regulations (2000) for England & Wales as an acceptable alternative form of low-rise masonry construction in public and residential buildings. Recommendations for how this can be achieved are given through the case study by the Planning Department of Chesterfield Borough Council (refer: Hall, Damms & Djerbib, 2004)

**Regulation 7 – Materials and Workmanship**

At present there are no officially recognised codes of practice for rammed earth construction in the United Kingdom. The fitness of SRE materials is currently established under:

f) Tests and calculations, and

g) Past experience

Suitability & classification of soil materials is established in accordance with:


A series of 100mm SRE cube samples are produced in a laboratory using the prescribed mix design in accordance with the guidelines prescribed in:

  
  *N.B. Based upon BS 1881 for concrete materials*

The curing shrinkage and estimated construction tolerances are calculated based upon:

- BS EN 772-16: 2000 Methods of Test for Masonry Units - Part 16: Determination of Dimensions, British Standards Institute, London

Cube samples are tested for compressive strength in accordance with the guidelines prescribed in:


Cube samples can also be tested for other physical properties depending upon the application, e.g. moisture absorption, acoustic, thermal etc
Approved Document A - Structural Stability
For the purposes of assessment under Part A (structural stability) of the Building Regulations, SRE walls can simply be treated as a high density mass walling element.

Test Specimens
All SRE test specimens are characterised and produced as 100mm cube samples using the methodologies proposed by Hall M & Djerbib Y, 2004, “Rammed Earth Sample Production: Context, Recommendations and Consistency”, Construction and Building Materials, 18 [4] pp.281-286

Compressive strength
Minimum characteristic unconfined compressive strength ($f'_{cu}$) = ≥ 3.5 N/mm²
Typical range of $f'_{cu}$ ≈ 3.5 N/mm² to 12 N/mm²
N.B The $f'_{cu}$ can be increased by altering the soil grading, the cement content, the ramming and the curing procedures.

Density
Typical dry density ($\rho_d$) ≈ 2000 to 2100 kg/m³ (at 98% of Proctor compaction)
Tested in accordance with BS 1377-4: 1990 - Soils for Civil Engineering Purposes - Part 4: Compaction Related Tests

Fixing capacity
300mm Hilti C10 epoxy holds 2,000kg pull, Amdel Report No. M1034/87

For further details of compliance please refer to:

Approved Document B - Fire Safety
SRE is classified as a ‘non-combustible material’
Fire-resistance rating= 4 hours
- Tests performed by CSIRO Report No. 1839

Approved Document C4 - Resistance to Weather and Ground Moisture
*SRE walls are constructed using standard practices for DPC & DPM installation*

Experimental testing has revealed that SRE easily conforms to the Building Regulations in this country;

Water Absorption Properties
*Pressure-driven moisture absorption:
Initial surface absorption after 10 min (6% cement content) ≈ 1.90 to 9.95 ml/m² sec
Capillary absorption:
Typical Sorptivity (S) value ≈ 0.251 to 1.631 mm min^{-0.5}
Initial rate of suction (6% cement content) ≈ 0.29 to 1.47 kg/m² min
(Compare with conventional materials using diagram below)


Durability Properties
Durability of SRE materials is determined using the ‘accelerated erosion test’ (AET) in accordance with
- AET value for SRE = 0.0 mm/min

Please note: Unstabilised rammed earth walls may not be compliant under Building Regulations. Both Regulation 7 and Approved Document C categorically state that external masonry walls on a building must:
× Not be damaged by rain or snow
× Resist the passage of rain (or snow) to the inside of the building
× Not transmit moisture due to rain (or snow) to another part of the building that might be damaged

Approved Document E - Resistance to the Passage of Sound
In order to demonstrate compliance “laboratory values for new internal walls and floors within: dwelling-houses, flats and rooms for residential purposes, whether purpose built or formed by material change of use” must have a minimum $R_w$ of 40 dB ($R_w =$ weighted sound reduction index)

Example: an SRE wall;
Assuming a wall thickness of 300mm the typical $R_w$ of the wall = 58.3 dB
Approved Document L1 - Conservation of Fuel and Power in Dwellings

SRE buildings can be assessed either using the target U-value method, the Carbon Index method or the elemental method. The walls can be constructed in 3 different Part L-compliant configurations:

1. Solid SRE wall with external insulated cladding + render
2. Solid SRE wall with internal dry lining
3. Cavity SRE wall with solid-foam cavity insulation

Example:
For a cavity SRE wall with 175mm SRE inner & outer leaves incorporating polyisocyanurate solid cavity insulation and stainless steel wall ties;
Calculated U-value

\[ = 0.335 \text{ W/m}^2 \text{ K} \] (for 50mm thick insulation)
\[ = 0.245 \text{ W/m}^2 \text{ K} \] (for 75mm thick insulation)

SRE walls also have very high thermal capacitance (i.e. “thermal mass”)
Typical value for a 300mm wall = 1673 KL/m³K
Approximate thermal time lag = 6 - 8 hours