Features of Buildings Made of Soil Materials in Seismic Areas

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ABSTRACT

The article discusses the technology of producing thermoelectric materials under inert gas pressure, which makes it possible to provide reproducible results from melting to melting and to synthesize sufficiently large amounts of a working substance.

KEYWORDS: *Thermoelectric materials, solid solutions, thermo-EMF, semiconductor materials Bi2Te3, Bi2Se3, charge, tellurium, selenium, lead, crucible.*

Earthquakes occur all the time on our planet, most of which are not felt by humans at all. The strongest earthquakes cause significant material and social damage. The higher the population density and level of infrastructure development in cities and towns, the more dangerous the area and the higher the risk of earthquake damage. The objective of earthquake-resistant building design is to reduce the risk, or at least the severity, of earthquakes.

The most readily available building material, which is ubiquitous, is the soil beneath the vegetation layer.

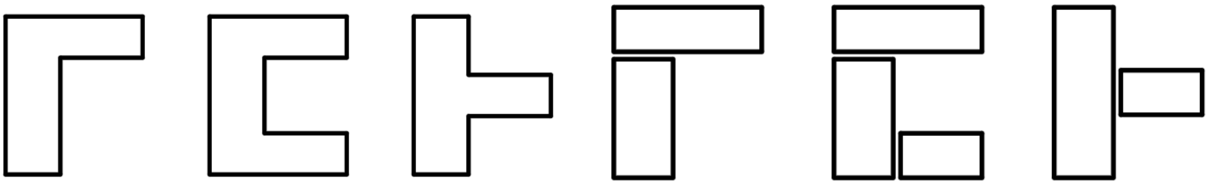
One of the current problems is the earthquake resistance of individual residential buildings constructed from earth materials. With earthquake protection measures in place, residential buildings made of them could well be earthquake-proof and withstand an earthquake of magnitude eight inclusive without any major damage.

The centuries-old experience of building with low-strength materials inherited from our ancestors, including the anti-seismic measures used, must be studied, and the techniques and technologies used to build them revived.

Since ancient times, especially in treeless areas, dwellings and other buildings have been built from earth by ramming it into a formwork or from earth blocks prefabricated in mould by tamping or plastic moulding. In warmer climates, walls made of plastic clay, known as "pakhsy" wall technology, have been widespread since the dawn of time. The advantage of this construction is the cheapness and accessibility of the material. Walls built with soil materials are 5 times cheaper than walls built with bricks and concrete. The labour required to produce the material and to lay it is 5 times less than for walls made of fired brick. [5]

Important structural measures that ensure dynamically favourable behaviour of buildings in earthquake zones and minimise earthquake risks are as follows.

One of the most important and necessary measures is to choose a simple, as rectangular as possible, building configuration and to break down complex structures into individual, simple shapes (see fig. 1). [3]



Unfavourable Seismic

Fig. 1. Building configuration diagrams.

To ensure the seismic resistance of the building, wall protrusions (kinks) in the building plan are not allowed. In case the buildings have complex shapes (L-shaped, U-shaped, T-shaped, etc.) and the length of the buildings exceeds the admissible values (24 m on sites with seismicity of 7 and 18 m on sites with seismicity of 8), the buildings should be divided into rectangular sections by means of anti-seismic joints. In accordance with CMC [1], antiseismic joints are constructed by constructing double walls between bays, providing a gap (distance) of at least 30 millimetres between them.

When designing a building, the stiffening elements (diaphragms, frames, etc.) must be symmetrically positioned in both directions (see Fig. 2) so that the centres of stiffness and masses are as close together as possible. [3]

Choose stiffeners that have ductile properties and do not fail suddenly; ensure structural reliability of the most deformable areas.

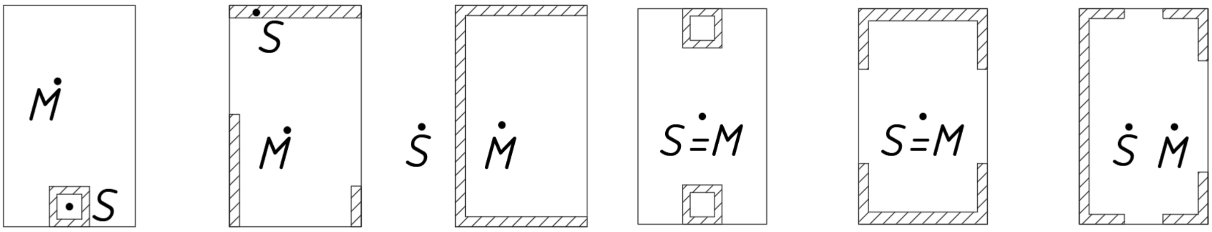


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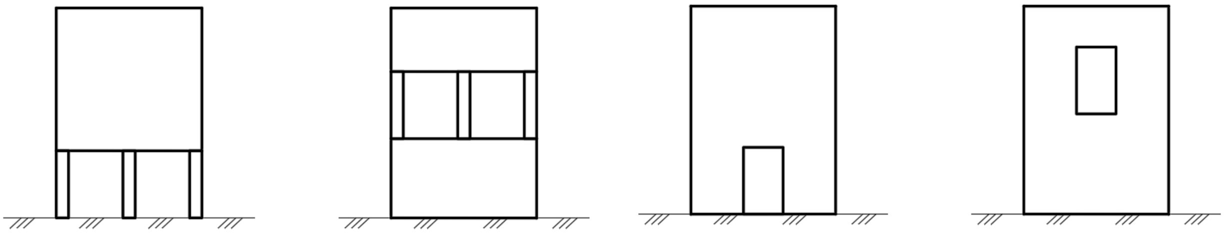
Fig.2. Locations of the centres of stiffness and masses in the building plan.

When designing, the stiffening walls must be connected floor by floor (if two storeys) with slabs acting as rigid discs; height differences must be avoided, ring anchors should be placed across the storeys on which the floor beams are firmly fixed.

The design requires a constant or continuously decreasing distribution of masses over the height of the building; there must be no heavy roof; and the "whiplash" effect must be avoided (i.e. there must be no heavy mass at the top on the flexible lower part of the base; (see. fig. 3, b); [3]

a)



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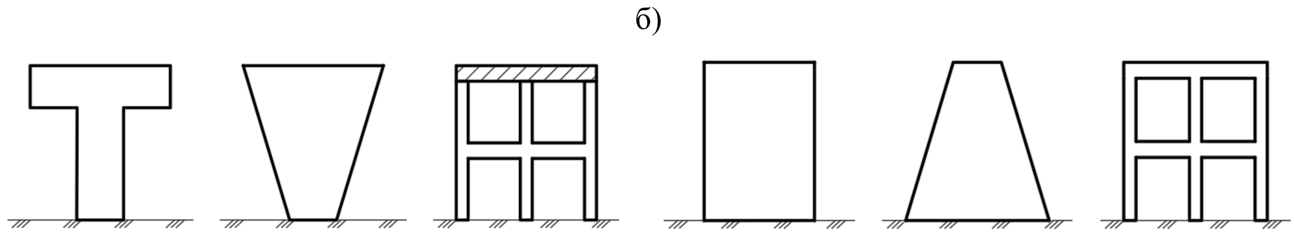

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Fig.3. Scheme for providing stiffness in height (a) and mass in height (b).

When designing the underground part of the building, the foundations must be laid at a uniform height and in a homogeneous soil layer; if deep foundations have to be laid, avoid using soils with a liquefaction risk. (see. fig.4,b) . [3]

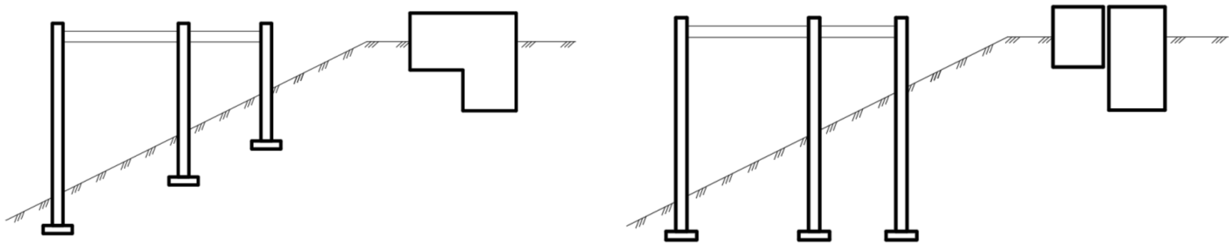

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Fig.4. Foundation laying diagrams.

For prefabricated strip footings, a layer of 100 grade cement mortar not less than 40 mm thick and longitudinal reinforcement of 3, 4, and 6 with a diameter of 10 at earthquake resistant sites of 7, 8, and 9 points, respectively, should be provided on top. Every 300-400 mm the longitudinal rods must be connected by 6 mm diameter rods.

Any earthquake resistant clay-material house needs a strong foundation, firmly connected to the walls. It is best to have monolithic concrete foundations. If bricks or cobbles are to be placed inside the foundation, the top layer of the foundation must be reinforced with steel reinforcement.

Tape foundations must be laid beneath the walls of buildings made of soil materials. The following requirements apply to the foundations of buildings made from soil materials and their connection to walls:

- the base under the foundations must be flat, reliable and low-moisture;
- a foundation made in monolithic concrete is considered ideal;
- the use of not split cobblestone (rounded stones) for the construction of foundations is prohibited (clause 3.7.16. KMK [1];
- when constructing foundations made of rubble concrete, the upper layer is reinforced, or a monolithic reinforced belt is arranged on the top;
- foundations should be buried at least 40 cm from the surface of the earth and rise above it by 30-50 cm (to prevent the walls from wetting with atmospheric precipitation);
- water proofing should be arranged from a layer of cement-sand mortar (composition - cement: sand 1: 1 or 1: 2) with a thickness of 30 mm. The device of waterproofing from a layer of roofing material is not allowed (due to its rapid aging and destruction in time, as well as the exclusion of

the possibility of sliding of the walls relative to the foundation in the event of horizontal force action.

In accordance with the requirements of clause 3.7.14 KMK [1], the materials and structures of the walls within the same floor and one compartment should be taken to be the same. In the case of two-story buildings, the weight (and thickness) of the walls on the higher floor must not exceed the weight of the walls on the lower floor.

Walls built from soil materials gain strength over time. In terms of strength, walls made of soil materials are practically not inferior to concrete ones. If the initial value of the compressive strength lies in the range of 1.5 ... 2.0 MPa (15 ... 20 kg / cm 2), then after about 20 ... 30 years it increases to 12 ... 15 MPa (120 ... 150 kg / cm^2), which is comparable to the strength of lightweight concrete and exceeds the strength of fired bricks. [5]

From soil materials (blocks, mud bricks, "pakhsy", etc.), mainly one- and two-storey residential buildings with a thickness of external walls on the first floor of 30 ... 40 cm, and on the second - 25 ... 30 cm are being erected. Walls from soil materials 50 cm thick in terms of thermal conductivity are equal to walls 2.5 bricks thick.

In accordance with the requirements of the KMK [1], buildings with a width of more than 5 meters must have at least one internal longitudinal wall. Moreover, all internal walls must be continuous (continuous) in the building plan. The distance between the axes of the transverse and longitudinal walls should not exceed 6 meters.

The ratio of the height of the floor to the thickness of the walls should not exceed 9. The total cross-section of the walls in each direction of the walls at the level of the middle of the height of the floor should be at least 4% of the area of the building along the outer perimeter of the walls. The width of the walls should be at least 1.0 m, and the width of the openings should not be more than 1.5 m. [1]

To resist an earthquake, buildings made of clay materials should have a simple shape in plan, one floor and be no longer than 20 m. Earthquake-resistant walls should be short and thick (the thicker the better) and firmly connected by internal walls or external pilasters.

It is good if the number and sizes of openings on opposite sides of the building are the same.

Work on the construction of walls from soil materials must be carried out in the summer period of the year for good drying of the walls.

Door and window openings on each side of the building should be no more than 1/3 of the wall length. The width of door and window openings should be no more than 1.5 meters, and the extreme openings should be located at a distance of at least 1.2 meters from the corners of the building. The width of the walls must be at least 1.0 meters. It is good if the number and sizes of openings on opposite sides of the building are the same. [1]

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Seismic belts is the most important element for preventing earthquake destruction in the construction of clay materials.

In buildings made of soil materials, antiseismic belts can be made of wood or monolithic reinforced concrete. The belts should be provided at the level of the floor beams and connected to the latter. Antiseismic belts should be installed around the entire perimeter of longitudinal and transverse walls. The concrete foundation works like a second belt. Ideally, you can add a seismic belt at the level of window sills and door or window lintels.

A monolithic reinforced concrete belt made of concrete of class B 5 at least is arranged over the entire width of the wall in accordance with the requirement for stone walls. Outlets of vertical reinforcement should be provided from the walls, anchored by 300 mm in increments of no more than 0.5 m. It is allowed to arrange nests in the masonry walls with a section of 140*140 mm with a depth of at least 0.3 m with a step of up to 1 m, filled with concrete when laying the seismic belt with the installation of four rods with a diameter of 5 mm. [1]

A wooden seismic belt should be made of sturdy wooden planks or poplar logs, connected by crossbeams. The belt should be 20-50 cm wide and about 5 cm high. To ensure the rigidity of the seismic belt, braces are installed at the corners. Round logs should be hewn for wider wall support. Spacers measuring 2*5 cm are installed every 50 cm to create a rigid triangular grid. The seismic belts are completely flooded with clay solution.

The seismic belt works effectively if it is firmly connected to the walls. This can be achieved:

- the use of diagonal spacers between the seismic belt and window or door lintels;
- installation through the seismic belts into the walls of galvanized anchor bolts or wooden pins (40-50 cm long).

Strengthening of corners and intersections of walls made of soil materials should be carried out, as a rule, with metal meshes covered with an anti-corrosion compound, with a total cross-sectional area of longitudinal reinforcement of 1 cm^2, 1 m long on each side of the intersection axis through 500 mm along the height of the walls.

With a design seismicity of 7 points, it is allowed to strengthen the intersections of the walls of one-story buildings with gaskets made of reeds impregnated with hot bitumen. The reed prevented cracks and gaps between the walls.

Reinforcement between rows of masonry or inside adobe walls should be carried out approximately every 0.5 meters in height. If there are no seismic belts at the level of the window sills and window lintels, then the plastic reinforcement is installed at this level as well.

Buildings with timber frame walls “frame” refers to buildings whose walls are made using a single or double timber frame “frame”. A frame of this type is a system of horizontally and vertically located beams, equipped with wooden braces to ensure rigidity (wooden beams located at an angle with their ends recessed into beams and posts). The space between the wooden elements of the frame is filled with adobe bricks or clay cakes in the form of an ellipse of the "guvalyak" type. In the case of a double frame "frame", the wall is a two-layer structure, the cavity between the layers of which is usually not filled. Buildings of this type are usually single-storey (very rarely 2 stories). Wooden beams are used as load-bearing structures of the roof.

The centuries-old history of the operation of buildings with a frame of the “frame” type indicates that, provided that the lattice of a wooden frame is correctly constructed, such buildings can withstand earthquakes with an intensity of up to 6-7 points.

In buildings with walls made of soil materials, wooden beam floors should be used with a beam spacing of no more than 1500 mm with a cross section of at least 150 * 200 mm and a double diagonal flooring (at an angle of 450) made of boards. Floor beams should be rigidly connected to the anti-seismic belt or the upper chord of the wall trim. [1] From below, the ceiling is sheathed with sheets of dry plaster, chipboard, fiberboard, plywood or other materials attached to the roof beams. The use of suspended ceilings promotes the perception of seismic vibrations, thereby reducing the degree of destruction of the ceiling, which is an important factor in construction in a seismic area.

It is allowed to use monolithic lightweight concrete slabs with a keyway connection to the walls and support along the contour.

Thermal insulation should be arranged from a layer of reeds (or other light materials) and covered with a layer of clay-adobe screed.

Coverings and roofs should be lightweight and made of sheet roofing steel or corrugated asbestos-cement sheets (slate). Houses made of clay materials with a heavy earthen roof are easily destroyed by earth quakes, this often leads to the death of residents. Ideally, the roof should be made of lightweight materials. So that the thermal insulation is not disturbed, a layer of clay or soil can be laid on top.

Flooded roofing devices made of soil materials are not allowed.

Gable roofs are preferable over gable roofs (as they are more stable) and flat. In the case of gable roofs, cross wires or wooden struts (braces) should be arranged between the posts of the supporting system. The rafters should be bolted to the belts.

Around the building (along the perimeter), a sweep is arranged with a width of at least 1.2-1.5 meters, with a slope from the walls of the building to provide a drain, i.e. to ensure the removal of moisture from atmospheric precipitation from the foundation and soils of the base of the building.

The overhangs of the roof should be at least 50-60 cm to ensure the walls are protected from moisture during slanting rains.

Stacks of firewood, bushes and other items that can trap moisture should not be located near the building.

To ensure the reliability of the operated building, it is necessary to fix all heavy structural elements (facades, chimneys, gables, etc.) and heavy equipment (containers, mechanisms, shelves, devices, etc.) to the supporting structures.

If there are many closely spaced buildings, you should plan a sufficient distance between buildings as the sum of the amplitudes of seismic deformations of both buildings, in order to avoid collisions with each other during an earthquake.

In accordance with this requirement, the issue of reducing the weight of structural elements of residential buildings from soil materials is of the most important importance.

The forces caused by an earthquake are inertial forces that are proportional to the weight of the buildings and need to be dissipated. Therefore, for this purpose, it is the "light" building structures erected by the "dry" construction method that have a fundamental advantage over heavy capital structures and their importance is steadily growing today. [2]

From the theoretical and experimental analysis of the operation of dry construction structures in already implemented projects, we can say with confidence that they have at least two very important advantages in seismically active zones:

- in terms of danger to human lives - at a very low rate of casualties and injuries;
- from the point of view of design tasks - by a significant reduction in the periods of natural oscillations and, therefore, by detuning the vibration spectrum of buildings from the zone of the most dangerous sectors of real earthquakes.

The danger of seismic impact on structures depends on many factors: the bearing capacity of the structure for large horizontal loads, the ability of the structure to dissipate energy due to damping and, above all, due to the nonlinear (elastic - plastic) behavior of structural elements (compliance, plasticity). These factors are the most decisive because, according to [2], it is believed that:

Structural behavior in case of an earthquake = (bearing capacity) * pliability.

In this case, the structure, which must withstand seismic loads without collapse, must have a high bearing capacity and if it is weakly plastic. With a high ductility of the structure, for example, the load-bearing capacity can be low. Buildings with medium load-bearing capacity also have a chance of survival.

Thus, buildings can be designed in different ways for a given design seismic load. The simplest solution is to make the main structure with such a high load-bearing capacity that it can dissipate seismic energy in the elastic stage. Then there is no need to take plasticity into account. This approach is applicable in areas of low seismicity or where only minor earthquake damage is tolerated.

For areas with high seismicity, this approach is usually too uneconomical. In such cases, structures with a lower load-bearing capacity, but with a higher energy dissipation capacity, are used. More damage is tolerated here, but does not completely collapse. Of course, the corresponding design solutions must ensure high ductility of the structure. In areas with moderate seismicity, an intermediate solution can be applied.

The value of the "dry" method of erection of internal structural elements in earthquake-resistant construction, mainly, can be expressed in the following advantages:

- net weight loss. Since during seismic vibrations the inertial loads are proportional to the mass, the replacement of heavy non-load-bearing walls with light walls by the "dry" construction method itself gives a significant reduction in load;
- internal wall structures with plasticity, light frame and infill form a common load-bearing system for the perception of horizontal loads.
- "lag" of natural frequencies from the spectra of real earthquakes. According to the building codes of most countries, buildings and structures in seismic areas are calculated using the spectral method. In this case, more or less similar graphs of the dynamic coefficient (DC) are used depending on the period (frequency). Lightweight structures have significantly longer periods of vibration, and therefore the dynamic coefficient, and hence the design strength of the earthquake, is significantly reduced. This issue also requires additional numerical and field studies.

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