REINFORCEMENT PRACTICES OF BUILDINGS FROM WEAK LOCAL MATERIALS IN UZBEKISTAN

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ABSTRACT:

In the paper are discussed results of antiseismic reinforcement of residential buildings, schools, hospitals in earthquake prone regions of Uzbekistan, constructed using weak local materials. For the each type of buildings were developed methods of reinforcement, taking into account material properties, expected service time, acceptable seismic risk and repetition period of earthquakes of different intensity.

KEYWORDS: adobe, reinforcement, earthquake resistance

From ancient times and up to present in cities and settlements of republics of the Central Asia part of population are living in buildings, constructed using traditional adobe and stone materials without antiseismic measures. In addition to its low cost and simple construction technology, adobe construction has other advantages, such as excellent thermal and acoustic properties.
Traditional adobe construction responds very poorly to earthquake ground motions, suffering serious structural damage or collapse, and causing a significant loss of life and property. Seismic deficiencies of adobe construction are caused by the heavy weight of the structures, their low strength, and brittle behavior. During strong earthquakes, due to their heavy weight, these structures develop high levels of seismic forces they are unable to resist, and therefore they fail abruptly. Due to its low cost, adobe construction will continue to be used in high-risk seismic areas of the world. Development of cost-effective building technologies leading to improved seismic performance of adobe construction is of utmost importance to the substantial percentage of the global population that lives in adobe buildings.
As material for construction of buildings from local materials were used: adobe bricks, rammed earth called “pahsa”, air dried clay rolled out of spherical shape “gualyak”, clay blocks, reinforced by saman (straw), natural sledged stones, limestone, silicate bricks etc. As the mortar are used usually clay, sometimes clay with lime. For foundation used sledged stone or sometimes no foundation at all. The buildings were constructed one-storey without special design. For construction the population was guided mainly by services of the national masters, using their expertise and traditions. Durability on compression of products from adobe materials is varied in limits from 2 up to 30 kg / cm^2; durability of a natural stone - 50-200 kg / cm^2, silicate brick of 50-100 kg / cm^2, blocks - up to 35 kg / cm^2. Though durability of stone is high enough, but because of low coupling a mortar with a stone, durability of laying turns out rather low.
Such situation may be explained by the following reasons:

- buildings were constructed without any antiseismic measures;
- lack of information for the population about ways of reinforcement of individual building with walls from local materials;
- absence of set of regulations for standards of practice on both national and local levels;
- absence of the mechanism of influence to the population from engineering institutes, etc.

Characteristic types of damages of houses from adobe materials at earthquakes are:

- separation of adjacent walls,
- large diagonal and X-shaped cracks on walls,
- partial or total collapse of walls
- roof collapse,
- basement failure.

These damages sometimes may bring to full collapse and significant economic losses.
Methods of antiseismic strengthening of buildings from adobe materials should be focused on prevention of the specified kinds of damages.
To the basic antiseismic actions of houses from adobe materials it is necessary to relate:

- simplicity and consistency of building plan;
- observance of restrictions at a ratio of thickness, heights of walls, partitions etc.;
- presence of the stone, concrete or reinforced-concrete basements and socles;
- antiseismic belts (wooden or reinforced-concrete);
- strengthening by horizontal reinforcing or timber elements;
- windows and doorways framed by reinforced-concrete or timber elements;
- light, well-connected roof.

Radical method of strengthening of houses from weak materials might be the provision of holders from steel rods in layer of cement-sandy mortar. Depending on volumes of strengthening buildings may be erected in areas with seismicity 7,8 and 9 intensity units.
Below the recommendations for three types of constructive systems of buildings with walls from weak materials for application in seismic areas are presented.

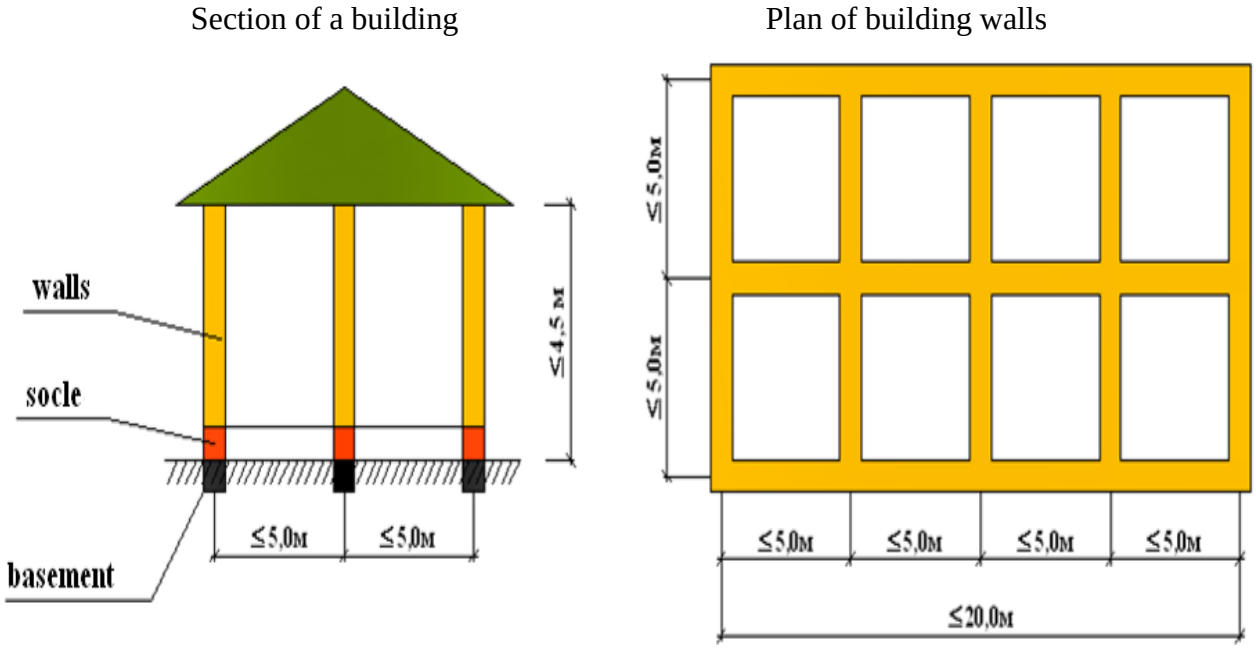


Fig. 1 Sizes of buildings for 7-intensity unit zones

Type A. Walls from adobe brick, adobe materials, at presence of the concrete or stone basement

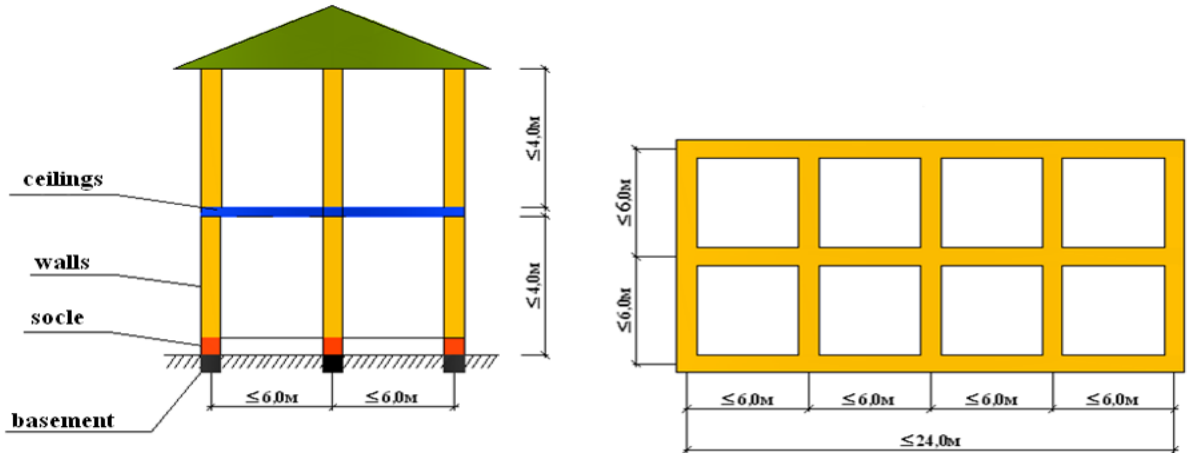


Fig. 2 Sizes of buildings for 7-intensity unit zones

Type B Walls from brick or adobe materials, strengthened with a wooden frame, at presence of the concrete or stone basement

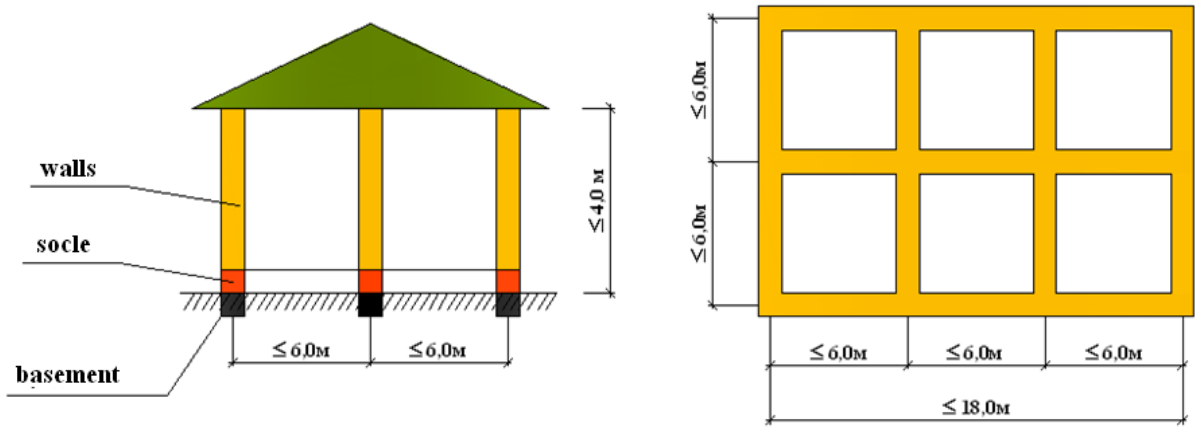


Fig. 3 Sizes of buildings for 8-intensity unit zones

Type B Walls from a brick or adobe materials, strengthened with a wooden frame, at presence of the concrete or stone basement

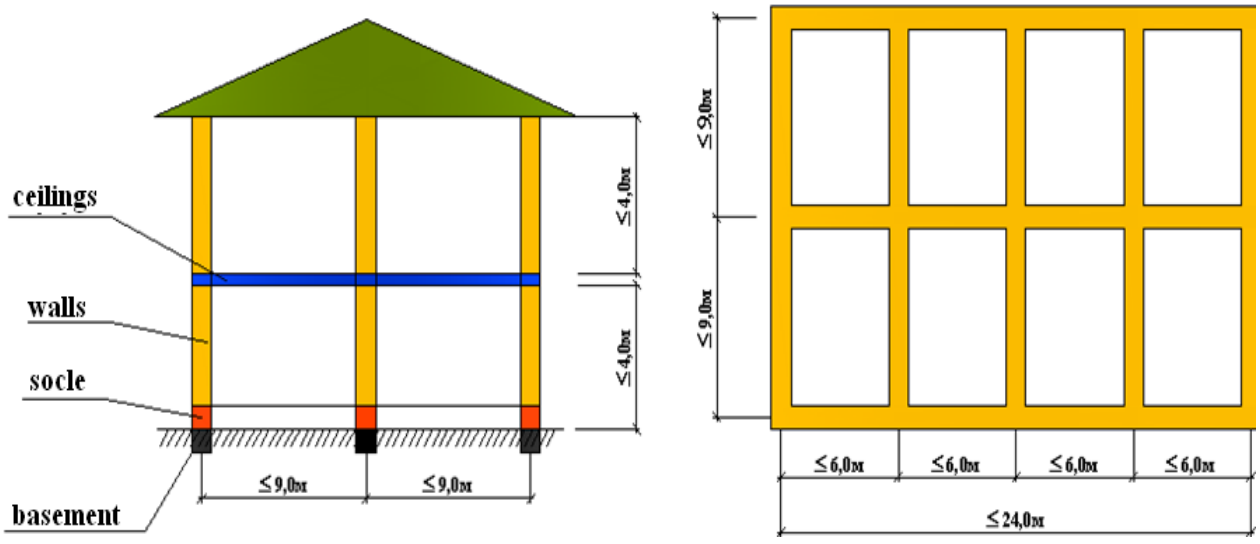


Fig. 4 Sizes of buildings for 7-intensity unit zones

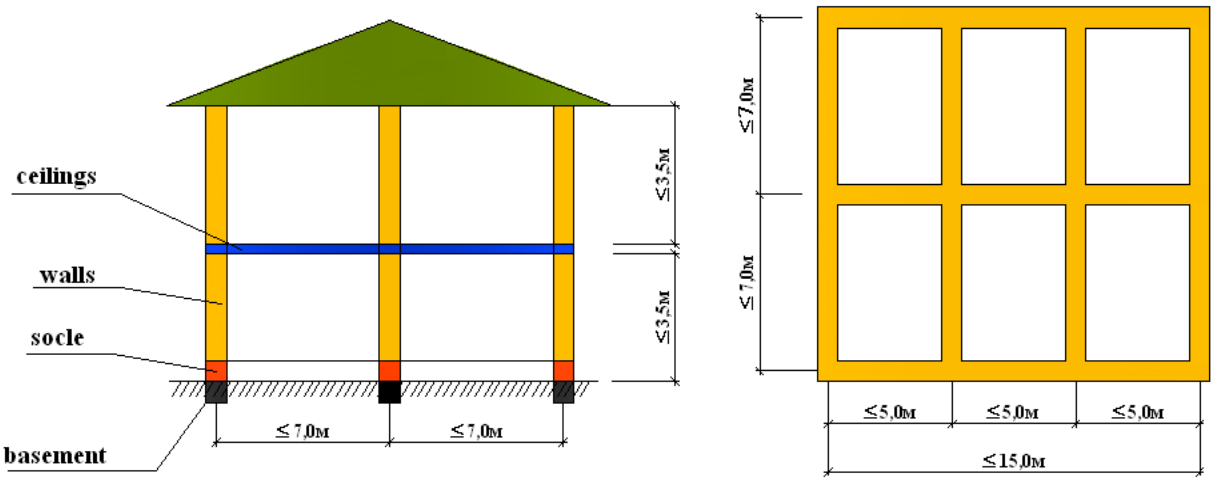


Fig. 5 Sizes of buildings for 8 intensity unit zones

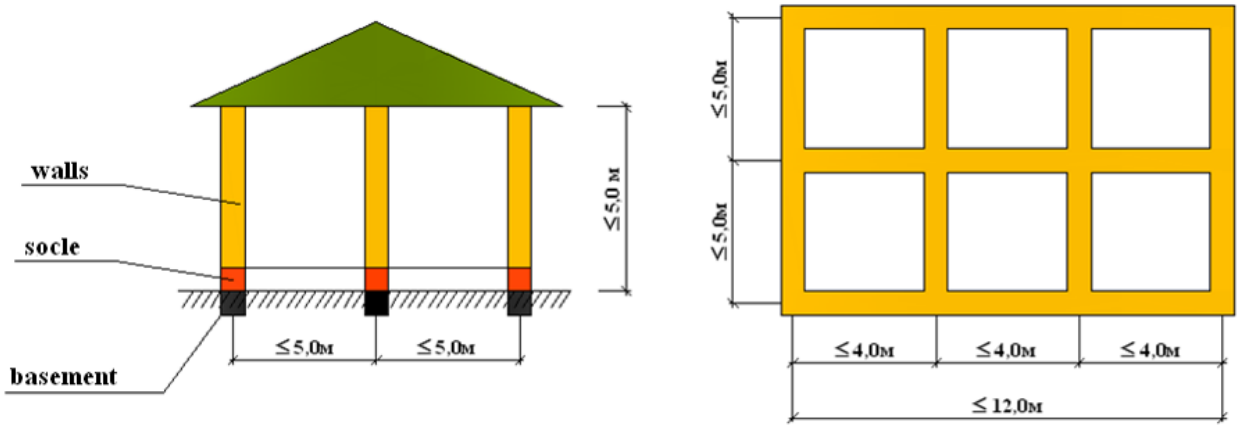
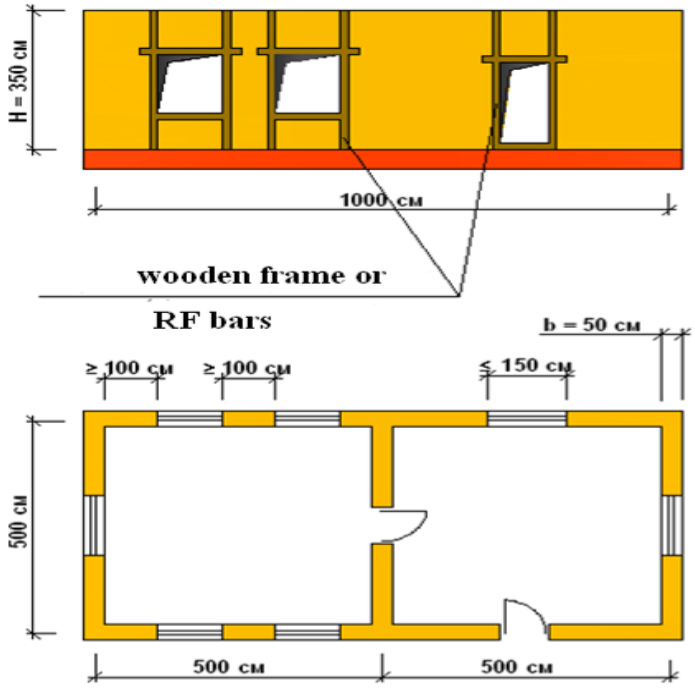


Fig. 6 Sizes of buildings for 9-intensity unit zones



1) H/b ≤ 9
2) Total section of partitions in every directions not less than 4 % of the area on external perimeter of walls at level of middle of height of window
3) Ledges of walls in plane of buildings not allowed
4) Temporal resistance to axial stretching on the not tied up section not less than 0,3 kg /cm ²

Fig. 7 Dimensions of walls and partitions

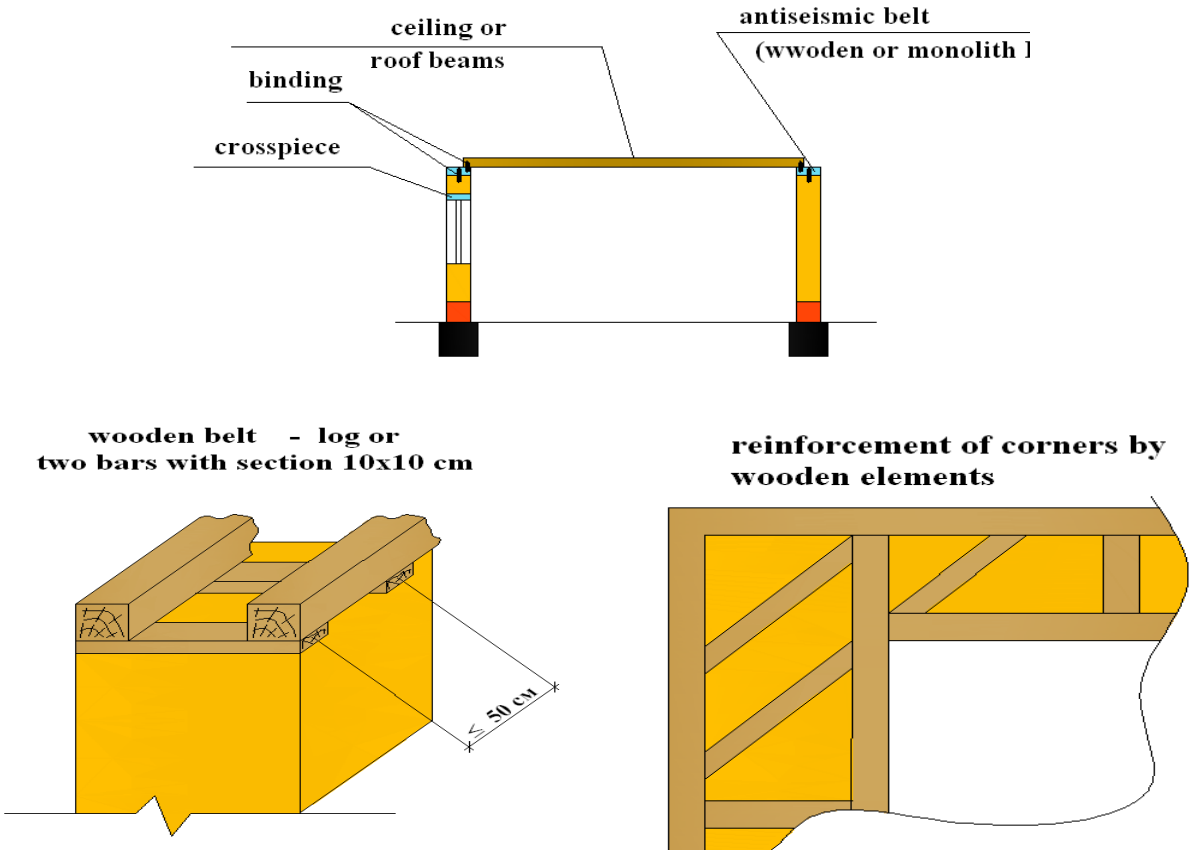


Fig. 8 Reinforcement of walls.

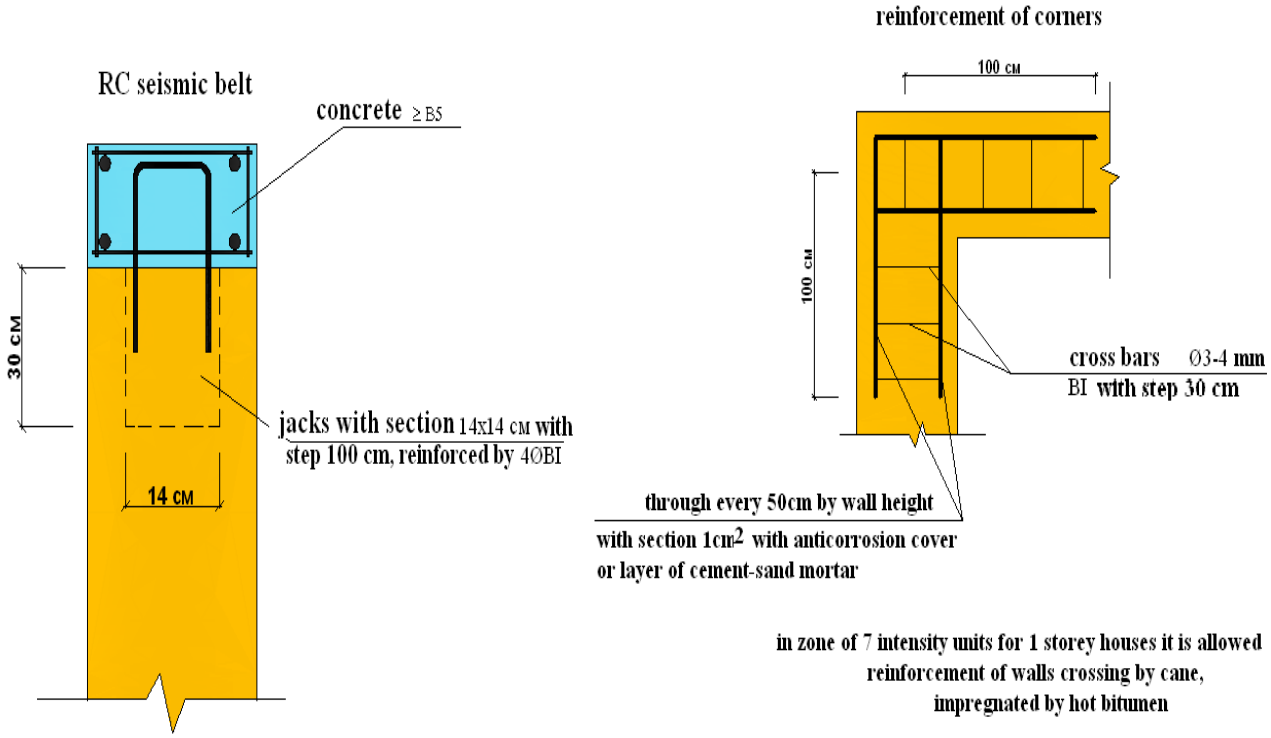


Fig.9 RC seismic belt

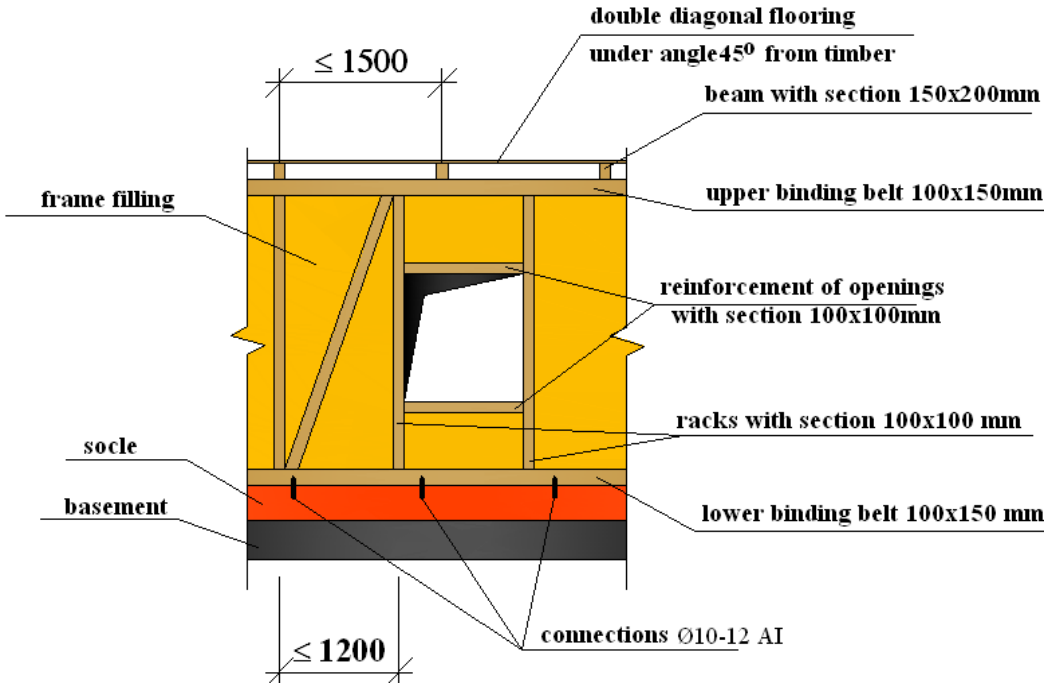


Fig. 10 Double or unary wooden frame for strengthening of walls

1) Racks section 100x100 mm or diameter 100 mm with step < 1200 mm
2) Diagonal ties - 100x100 mm or diameter100 mm
3) Horizontal and vertical reinforcement should be tied together and to the other structural elements (foundations, ring beam, roof)

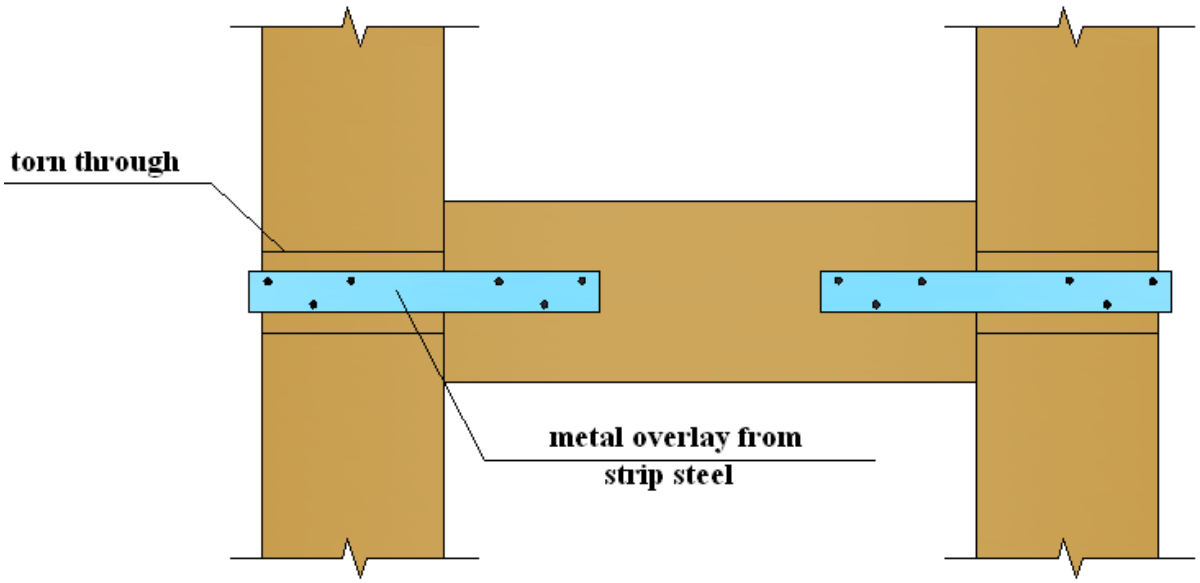


Fig. 11 Node of connection of elements of wooden frame

For intensity 9 unit zones the wall from both sides of frame are grouted by welded mesh 3/4/300/300 and are plastered by cement-sandy mortar of grade B3,5 - 5.

Other requirements:

1) The ring beam must be strong, continuous and well tied to the walls and it must receive and support the roof. The ring beam can either be made of concrete or timber.
2) Use of an insulated lightweight roof instead of a heavy compacted earth roof.

3) Adobe homes should always rest on a firm foundation, preferably a monolithic concrete foundation.
4) Reinforcement bars and metal products used for walls from weak materials should have an anticorrosive covering or be in a layer of a cement-sandy mortar with cover not less than 10 mm.
All different ways of application of local weak materials, not tested in the country have recommendatory character and are not obligatory for application.
In manuals and recommendations it is necessary to specify a source of the information and authors of development. Manuals and recommendations should have the sufficient information allowing to builder to construct the house without reference to additional sources.
The most complex still is question about methods how to bring attention of population to these approaches of strengthening and its training.
It is complex enough problem and to start, as it seems to us, it is necessary from the edition of colourful attractive booklets, brochures, books. The following step should be presentation of these printed materials in neighborhood centers with a high level of material presentation.
Ideas and effective methods of the report of knowledge of aseismic construction of dwelling to the population may be various and more perfect. For this purpose the engineers, sociologists, philosophers, psychologists and other experts of the countries should be united and make common efforts.

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