The average weight of a two-stone wall construction is 1600 kg/m^3. A plastered or insulated wall section with a thickness of 50cm (20") of 0.6m high (2 ft.) and 3m long (10 ft.) has a weight of 3m x 0.5m x 0.6m x 1600 kg/m^3 = 1500 kg over 3m, or 500 kg/m.
The theoretical horizontal earthquake load is then 15% of 500 kg/m = 75 kg/m.
Each strip of a wall section is supported in the direction of the plane at the extremes, the shortest length being the distance between the floor and roof (3m).
When that wall section is considered as a horizontally loaded strip (beam) with a load of 75 kg/m, the maximum momentum in the middle will be 1/8 x (75 x 3 x 3) = 85 kgm.

The distance between the two 2.3mm wires in the 18" wall is 17" or about 40cm = 0.4m (internal moment arm).
The momentum the stone wall can resist with a 2.3mm wire that is adequately embedded is 200 kgf x 0.4m = 80 kgm.
The above calculation shows that a single 2.3mm "ladder" can easily take the horizontal forces in a 3m long wall section over a height of 2 ft.
With more detailed earthquake calculations, as has been realised by NESPAK[10] (see Annexe I), the same values have been found.

Length Forces in a Wall

The same wall of 3m x 3m will have a total mass of 0.5m x 3m x 3m x 1600 kg/m^3 = 7200 kg. About a quarter of that mass (= 1800 kg) can cause the 15% shear force in the wall (15% of 1800 = 270 kg).
A similar amount of force can be expected from each cross-wall, extending to either side of the shear wall, bringing the horizontal shear force to 3 x 270 kg = 810 kg.
One 2.3mm wire can take a load of 200 kg, thus only four wires or two "ladders" are required to hold the shear wall and the cross-wall together[11]. These two "ladders" are to be placed in the upper half of the construction at lintel and tie-beam levels.
When the reinforcement "ladders" are placed in every other course at 12"-14" vertical intervals, they provide more than sufficient reinforcement to withstand the lengthwise shear forces.

Lifting Forces in Wall Piers

When piers in the wall are small, such as along the sides of doors and windows, they may tend to be pushed over by forces in the length direction of the wall.
The smaller the piers, the more they need to be reinforced as columns with sufficient vertical reinforcement on either side of the pier. The use of C-blocks will assist in positioning the vertical reinforcement alongside doors and windows and wall ends.
The minimum recommendation is to have at least three "ladders" in each side of the pier. The three "ladders" will have a resistance of minimum 3 x 2 x 200 kgf = 1200 kgf. The breaking strength is then over 2000 kgf.
The "ladders" do not have to be in one piece. The triple reinforcement "ladders" can be created by folding the wire reinforcement from the horizontal layers upwards. An overlap of 2 ft. is recommended to provide the necessary strength.
The NESPAK calculation determines that only one wire is necessary and recommends two vertical wires (one "ladder") at the sides (see Annexe I). This calculation, however, does not yet include the effect of the openings in the walls.

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[10] *Application of Galvanized Wire-Mesh for Stone Wall Construction*, National Engineering Services Pakistan (Pvt) Ltd. (NESPAK), Islamabad, Pakistan (June 2000).
[11] This is about the same as calculated by NESPAK, Pakistan (see Annexe I).

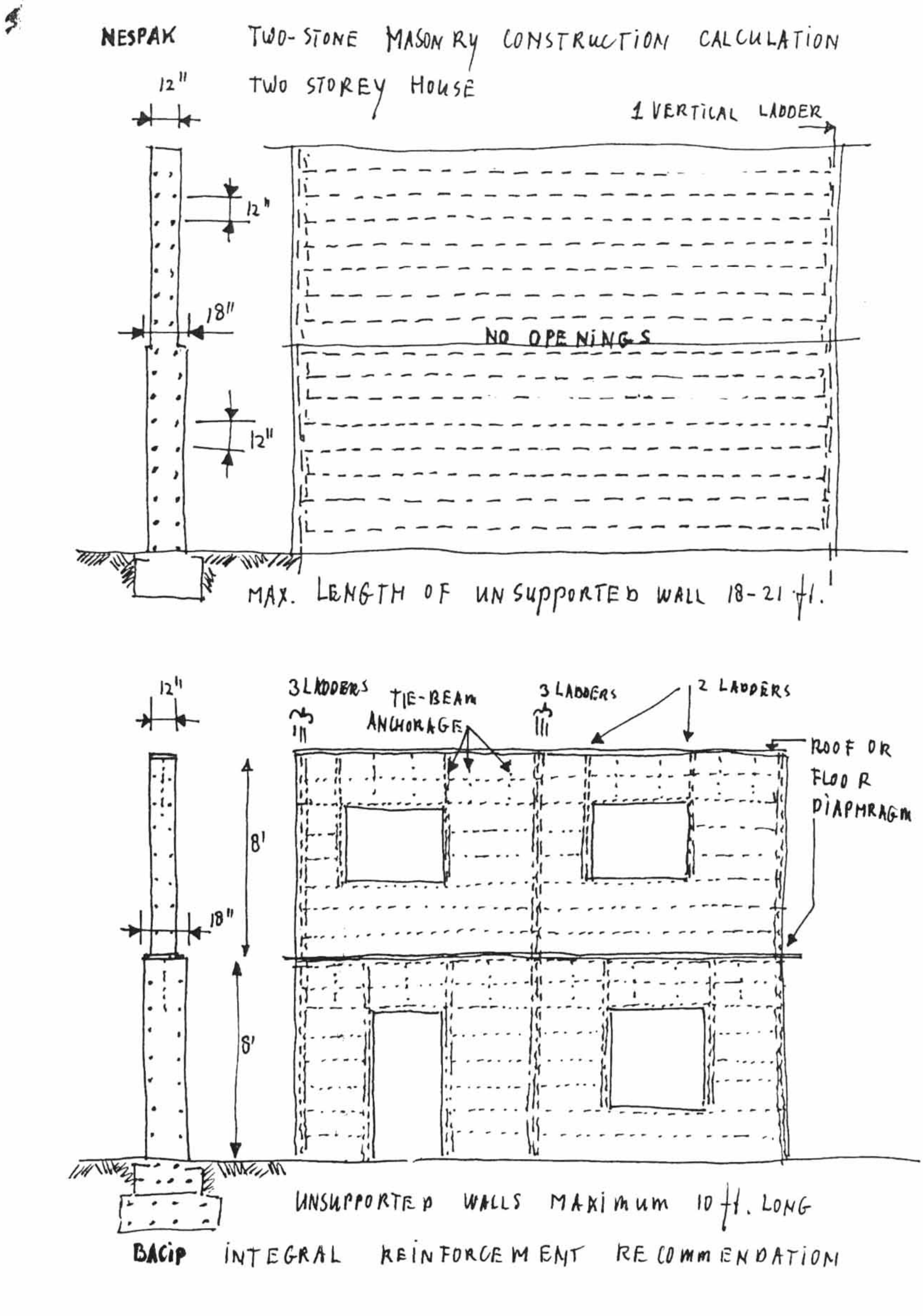

FIGURE 16. RECOMMENDED PLACEMENT OF BACIP WIRE-MESH REINFORCEMENT IN WALLS

The lintels over the windows and doors have a multiple function:
- To bear the masonry above the window or door.
- To provide for the framing around the door and window.
- To provide for the anchorage of the above floor or roof beams.
- To serve as a lower tie-beam in the wall construction that ties the wall ends together.

As the vertical load from the stone masonry is the largest force factor, the calculation of the reinforcement of the lintel will only take those forces into consideration.

The stone masonry has a mass of 1600 kg/m³, whereas the wall thickness of an 18"-19" wall is about 0.5m. In the case of the stone masonry, calculations need to be made of the load of the full width of the opening and the weight will be based on a wall section that is at least as high as the width of the opening[12]. In most cases the wall above the window or door of high rooms is not more than 5 ft.

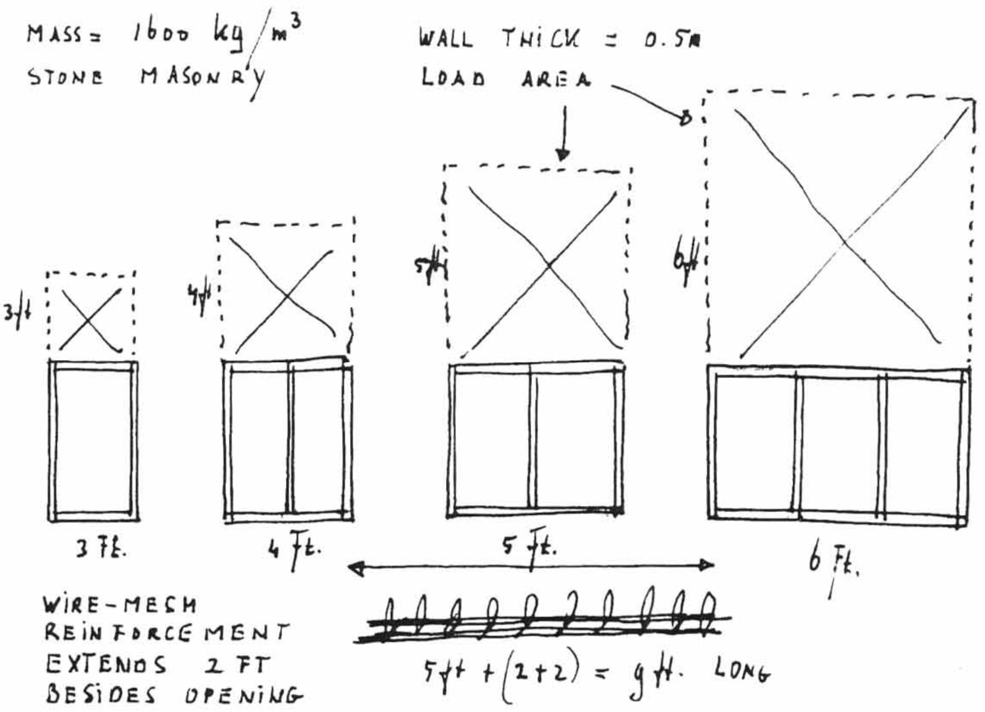

FIGURE 17. BASIS OF THE LINTEL BEAM CALCULATION FOR A STONE WALL

For the calculation of the lintel beam created above the door or window opening by using the galvanised wire-mesh, it is considered that the wire takes the stress forces in the bottom of the beam and the stones above the compression. The linkage between stone and wire is created by the wire-mesh loops that are masoned in between the stones. The height of the theoretical wall beam is maximum 2 ft. (0.60m), whereas the height of the internal moment arm is taken at 0.4m (less than wall thickness). The wire loops that are standing up must therefore be 0.3m (12") and 0.4m (16") high.
The elastic strength of the steel of the wire-mesh is 60,000 PSI or 50 kg/mm². The cross-section of one 2.3mm galvanised wire is 4mm² and provides a resistance of 200 kgf.

[12] In stiff masonry constructions, often only a triangular load section is considered. With poorly masoned stone constructions, the whole width of the opening should be taken.

For estimated designs in 18" -19" walls, the following table can be used.

Opening in Feet and Meters and Length of Wire-Mesh	**Calculated Moment 1/8 QL²**	**Required Wire Section in mm²**	**Minimum Required Number of Length Wires**	**BACIP Recommendation for Lintel Beam**
2-3 ft. = 0.90m length of "ladders" 3 + 4 = 7 ft.	1/8 x 720 x 0.81 = 72.6 kgm	73 kgm : 0.4m = 183 kgf	1 x 2.3mm = 200 kgf 4 = 800 kgf	4 x 2.3mm **(2 ladders)** One normal "ladder" One with 12" high loops
4 ft. = 1.20m length of "ladders" 4 + 4 = 8 ft.	1/8 x 960 x 1.44 = 172.8 kgm	173 kgm : 0.4m = 433 kgf	3 x 2.3mm = 600 kgf 4 = 800 kgf	4 x 2.3mm **(2 ladders)** One normal "ladders" One with 12" high loops
5 ft. = 1.50m length of "ladders" 5 + 4 = 9 ft.	1/8 x 1200 x 2.25 = 337.5 kgm	338 kgm : 0.4m = 845 kgf	5 x 2.3mm = 1000 kgf 6 = 1200 kgf	6 x 2.3mm **(3 ladders)** One normal "ladders" One with 12" high loops One with 16" high loops
6 ft. = 1.80m length of "ladders" 6 + 4 = 10 ft.	1/8 x 1440 x 3.24 = 583.2 kgm Without point loads of beams above the window.	583 kgm : 0.4m = 1458 kgf	8 x 2.3mm = 1600 kgf 10 = 2000 kgf	10 x 2.3mm **(5 ladders)** Two normal "ladders" Two with 12" high loops One with 16" high loops
7 ft. = 2.10m length of "ladders" 7 + 4 = 11 ft.	1/8 x 1680 x 4.41 = 926.1 kgm Without point loads of beams above the window.	926 kgm : 0.4m = 2315 kgf	12 x 2.3mm = 2400 kgf 14 = 2800 kgf	14 x 2.3mm **(7 ladders)** Three normal "ladders" Two with 12" high loops Two with 16" high loops
8 ft. = 2.40m **Not recommended**	Large openings have possible other force influences.	Points with loads to be calculated separately.		Possible reinforcement with additional iron bars is necessary.
All beams to be masoned in mortar of minimum quality sand : cement (5:1).	Bottom of opening to be supported with form-work during masonry work.	Stones are to be masoned fully over the full height of the 2-ft. "beam".	No masonry of 5-6 ft. beams during the possibility of night frost.	Curing for minimum one week is necessary. Removal of form-work not before two weeks after the masonry work.
All beams.	When detailed load calculation is possible.	When site supervision is well executed.		With known loads, a smaller number of wires may be possible.

For thinner and/or lighter walls the calculations will be different.
See publication on *Lintel Construction with BACIP Galvanised Wire-Mesh Reinforcement.*