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FIXINGS THAT ENSURE THE FREE MOVEMENT OF THE STRUCTURE FOR RESISTANCE IN RELATION TO NON-STRUCTURAL WALLS

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ABSTRACT

Recent earthquakes have confirmed that non-structural walls interacting mainly with frame structures are severely damaged during seismic actions endangering human lives. The ongoing life after earthquakes and major costs for rebuilding are deeply affected. In order to avoid this kind of drawbacks, the present paper suggests the introduction of a set of joints between the structure and the non-structural closing and division walls. The joints should observe the following: joints will be designed to provide free development of displacements in the plane of the walls with no major interactions in the structure; joints will be designed to provide transmission of the seismic forces acting perpendicularly to the non-structural walls towards the main structure. This paper will include several conclusions concerning the admission, constraint or removal of interactions between the structure and the closing and division walls.

KEYWORDS: fixing, free movement, masonry, non-structural walls

1. Introduction

Seismic performance requirements concern safety and diminishing of damage, in tight correlation with the ultimate service states (SLS) and ultimate limit states (ULS) [1, 2].

In general, no control is possible regarding the interaction between the frame and a masonry wall. Considering this lack of certitude, it is believed that the best solution consists in removing the masonry walls from the frame core and allowing it to move freely.

2. Calculation on non-structural walls subjected to perpendicular seismic loads on the wall plane

2.1. General aspects

To calculate the bending moments M_{EXd1} and M_{EXd2} under the action of uniform seismic loads, the non-structural walls (CNS) are modelled as elastic slabs placed down on the floor, then on the top, and laterally on the joints designed.

In the case of void panels, it will be applied 6.4.1 from CR-6-2013 [4, 5].

The bending moments M_{Rxd1} and M_{Rxd2} are calculated for a wall strip of width equal to 1.00 m and of thickness t.

$$M_{Rxd1}= w_w f_{xd1} \quad M_{Rxd2}= w_w f_{xd2}$$

where: f_{xd1} and f_{xd2} - represent the design bending tensile strengths perpendicular to the masonry plane.

$$w_w= 1000\ t^2 / 6$$

The requirement for stability is satisfied if:

$$M_{Rxd1} \geq M_{EXd1}$$
$$M_{Rxd2} \geq M_{EXd2}$$

If the strength requirement is not met, we can apply one of the solutions below.

In walls made with nut and feeder vertical joining, the wall is reinforced in the horizontal joints.

In the other cases, the dimensions of the walls are reduced by belts and middle piles so that the formed masonry panels respect the strength requirement.

The piles and the belts will be dimensioned to take over the stresses coming from the loads

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perpendicular to the unstructural masonry and to be transmitted to the main structure through the loads.

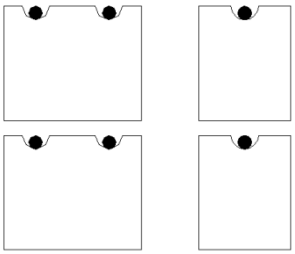

Fig. 1. *Reinforcement of masonry in horizontal joint*

In the case of larger size masonry members, such as firewalls, gables, lunettes, etc. acting in cantilevers, CR-6-2013 provisions will be followed. [4, 5].

2.2. Types of joints

2.1.1. Joint in a structure

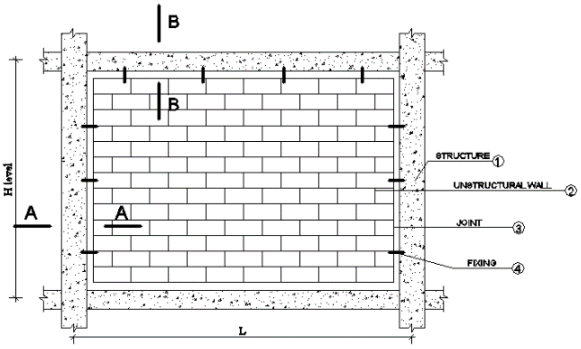

Fig. 2. *Masonry joints of vertical and horizontal elements*

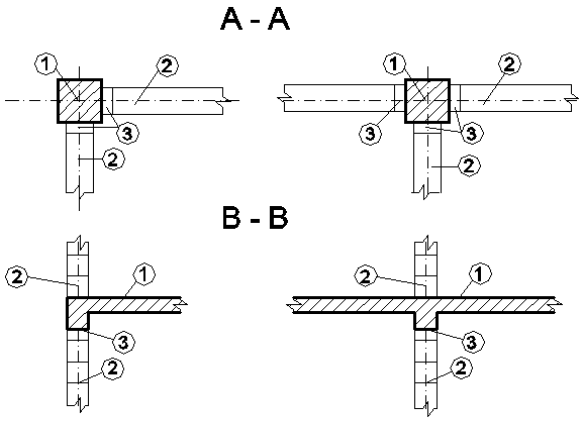

Fig. 3. *Detail A-A. Detail B-B*

Joints of vertical elements made from reinforced concrete (piles, membranes).

2.1.2. Fixing with steel bars

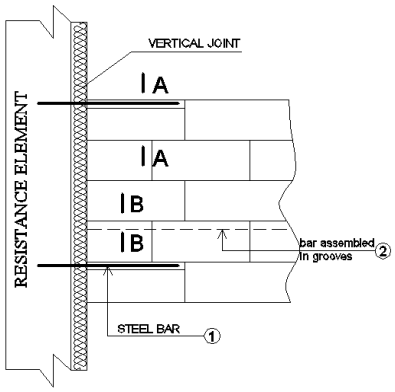

Fig. 4. *Section A-A*

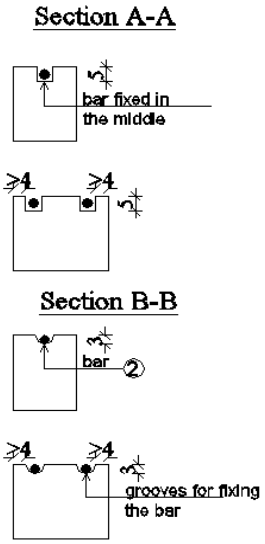

Fig. 5. *Detail A-A, Detail B-B*

The diameter of the bars 1, their number and the distance between the bars will be established by calculation.

Bars are fixed in the structural member by making a hole in the formwork before the member is cast or by making a hole in the concrete block and joining it with resins or cement mortars [3].

The slot made in the concrete block can be filled with elastic materials.

Bars 2 (if necessary) are mounted in grooves and fixed with minimum M5 mortar, (section B-B) [1, 2, 6].

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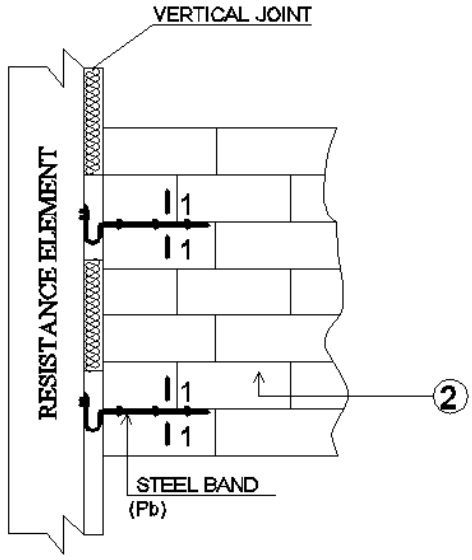
2.3. Metal strip joints with vertical strength members

2.1.3. Simple fixing



NOTE: Loop should insure the freedom of mouvement

Fig. 6. *Simple fixing*

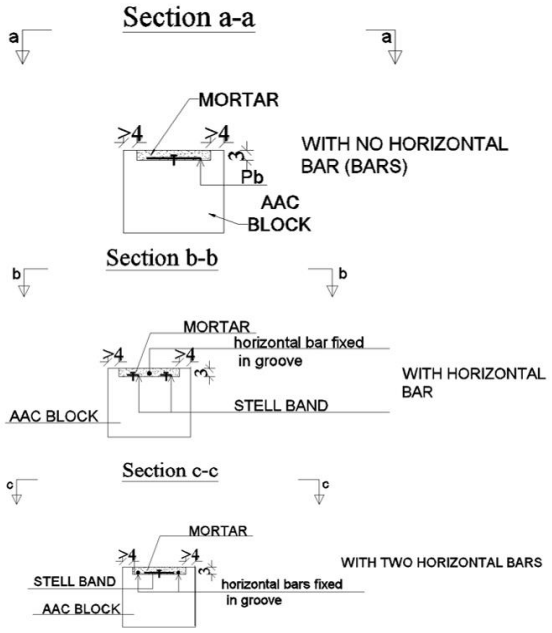


Fig. 7. *Sections a-a; b-b and c-c*

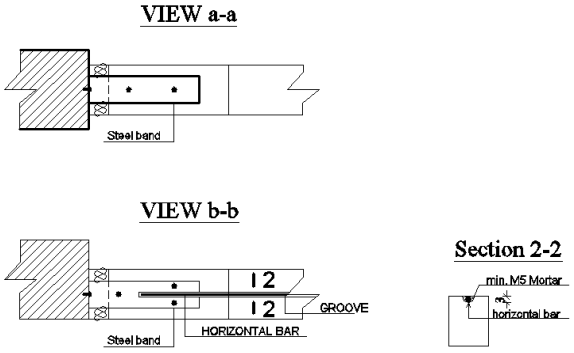


Fig. 8. *Section 1-1*

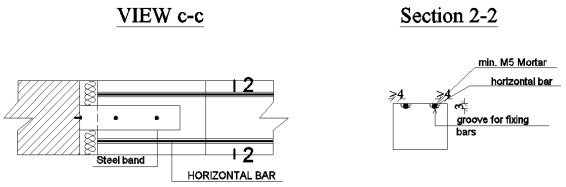


Fig. 9. *Double joint*

2.1.4. Double joint

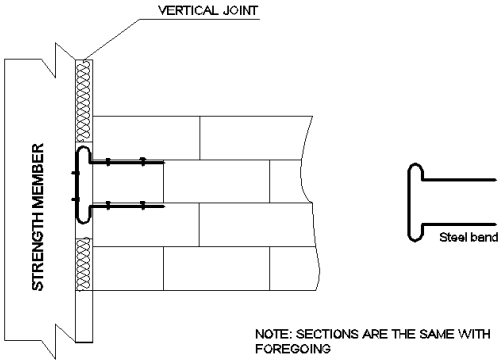


Fig. 10. *Fixing with steel band*

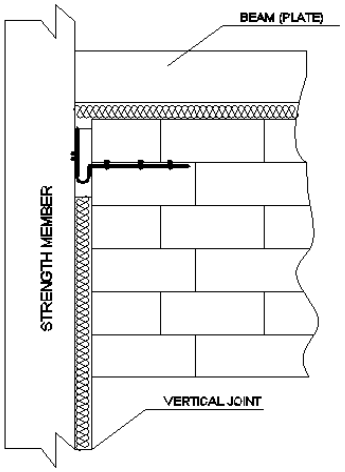


Fig. 11. *Simple joint*

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In vertical metal strength members, the same type of joints can be used, on condition that the joint is connected to the vertical metal member by welding, threaded screws or similar means.

2.1.5. Special joints

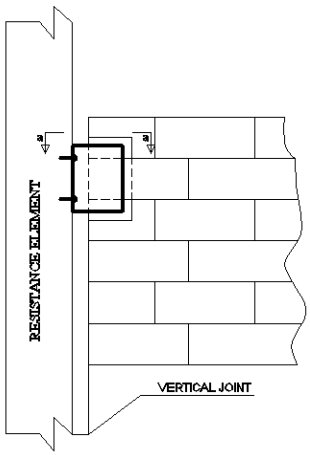

Fig. 12. *Fixing with special pieces*

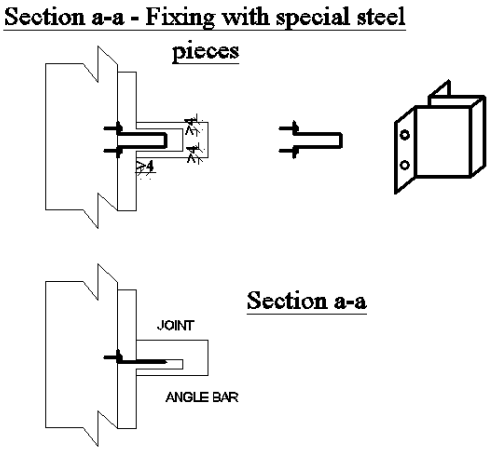

Fig. 13. *Section a-a for fixing with special pieces*

3. Wall top joining to beams or reinforced concrete slabs

3.1. Fixing with lateral angle bars

If it is necessary to have more blocks for taking over the normal to-the-wall horizontal loads, bars can be mounted in the grooves and fixed with mortars [3].

The angle bars will be inserted after the masonry is erected.

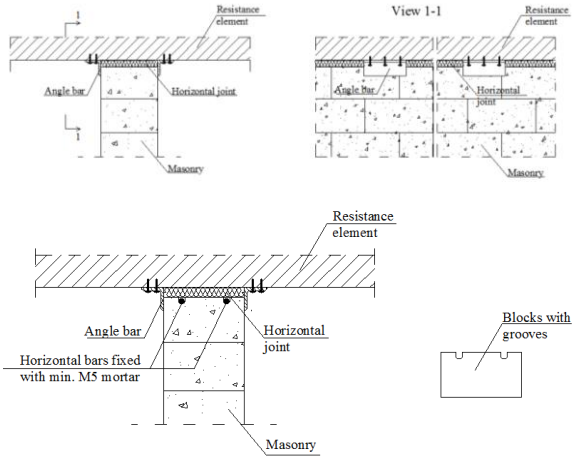

Fig. 14. *Fixing with lateral angle bars*

3.2. Fixing with angle bar incorporated in masonry

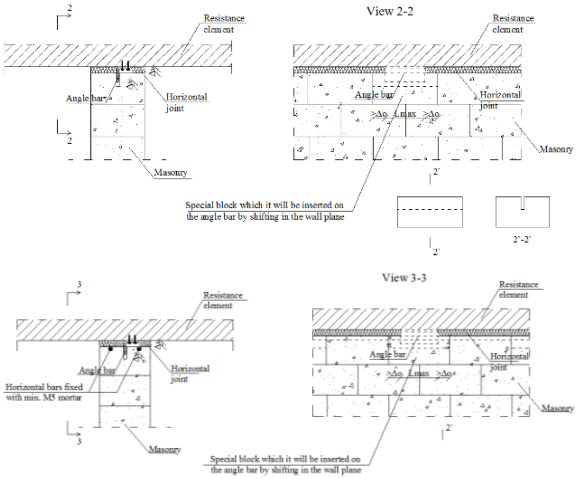

Fig. 15. *Fixing with angle bar incorporated in masonry*

To take over the horizontal loads of more BCA blocks, horizontal steel bars will be incorporated in the mortar.

4. Conclusions

It is appreciated that the interaction between the frame and the masonry panel (framed masonry) is an extremely complex issue, with many aspects still to be studied. In most cases, in the current design practice, this interaction is neglected (and this is recommended in the design codes), but the detriments of interaction cannot be eliminated and with severe earthquakes, they are always visible. We think that the solutions presented here are applicable and their use will lead to the desired consequence that is the

joints will separate the masonry walls from the structure. In this way, the system will become a controllable system.

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