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Portable R.C.C. Block Wall with Bracing System

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Abstract – *An Idea of Portable walls is generated by keeping in mind the move on conditions of people from one place to other and this will help to reduce the construction cost as well as the construction time. The concept is inspired from two major benefits. First is cost saving and quick construction by using standard size prefabricated RCC blocks. Second is to resist the building frame to go under shear failure during earthquake, such a system will help in structural stability by reducing the time period of the building in seismic and high speed wind conditions. This is the time of rapid construction and even the new techniques are widely adopted everywhere so to implement the ideas inspired by prefabrication will be helpful.*

Key Words: Portable walls, Prefabricated, RCC blocks, Shear failure, Time-period.

1. INTRODUCTION

In this paper we discussed the concept of portable walls. This is something which is originated from prefabrication of members. The portable walls here is the need for the buildings which are not in use and the owner want to reuse the members of one building to the other building, in this way owner can reduce the cost of construction. Also these portable walls are efficient in reducing the risk of major structural member failures during seismic conditions, which the simple brick work or hollow concrete blocks fail to do. The technique adopted is very simple but much effective. The lateral forces in RCC frame are responsible for the storey shear and the deflections in frame. The outcome of these deflections is the cracks in infill or sometimes the failure of RCC beam column joints. If beam column joint fails it results to the collapse of superstructure above which the failure takes place. So by keeping this in mind to reduce the building time period so simple mechanism like damping is used to maintain the stability of structure.

1.1 Portable walls and its construction techniques

The portable walls are those which can be constructed by assembling the small standard size RCC blocks (say 1mX1m). These blocks are the prefabricated blocks with a suitable interlocking. Blocks can be easily transported due to their limited size according to the carrier. During its construction a semi pre-tensioned wire mesh(Approx. diameter=2mm) is used. The wire mesh is placed in block (as shown in figure.1) in such a manner that it will resist shear cracks, these cracks mainly occur in walls due to the lateral forces acting on the frame structure. The duct is kept in the diagonal blocks in the form of cross bracing. These ducts are kept for the high strength steel tendons, which will act as cross bracing system.

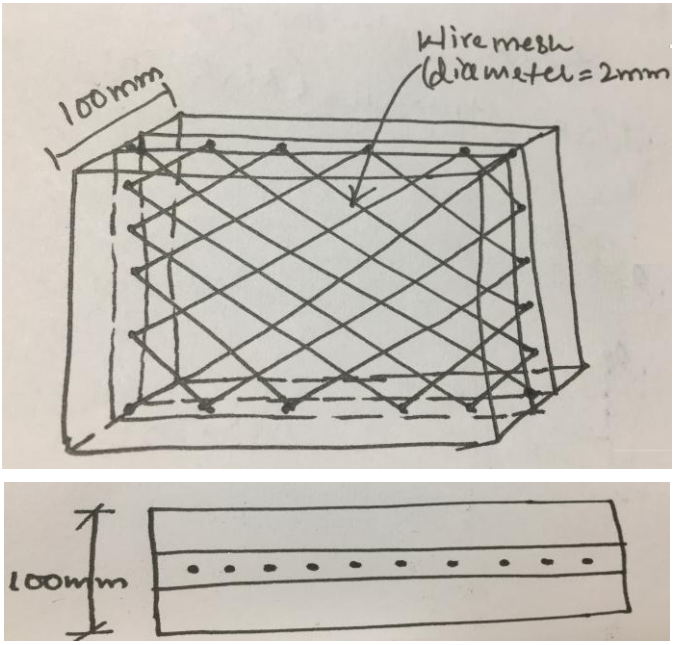

Fig -1: wire mesh placement in block

1.2 The crack patterns in Brick wall

The brick walls are stiff and very brittle in nature in resistance to seismic action[1]. The mechanism of Shear failure of wall (Approx. 45°) with frame is shown below in figure.2. It is found that brick walls are brittle in nature so to avoid this type of failure in portable wall blocks casting is done using wire mesh inside the concrete. In the above figure it can be easily found that the brick work will act differently from the frame while application of lateral loads. Earlier the brick wall and frame are acting as monolithic body but only in case when load is acting from top to bottom direction. Due to lateral load the frame which is stiff but ductile can go under deflections, while on other side the wall which is brittle and stiff acts differently.

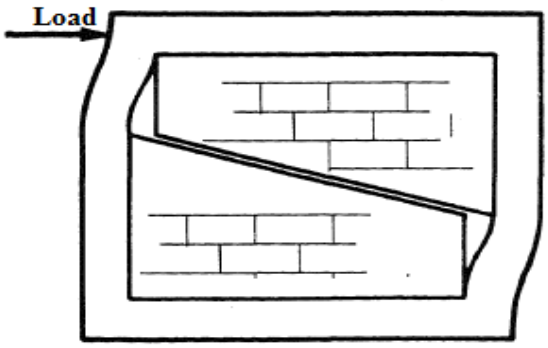

Fig -2: Mechanism of shear failure of brick wall with frame[1]

The wall comes under shear failure and form a diagonal crack due to this the wall portion below the crack will try to avoid the deflection and wall portion above the crack will help in frame deflections. In this sometimes there are chances of even beam column joint failure, so brick work proves dangerous as infill in such failures.

1.3 Strengthening of frame and description joints of RCC blocks

The frame under seismic loading conditions will produce base shear and storey due to which each floor of building will feel certain shear and as long we go on top floors the deflections will be more. These deflections are responsible for the damages during earthquake and cracking of walls is one of its parts. These damages are high if the building has high time period, whereas deflection in any building also depends on building time period. Time-period is directly proportional the deflection and the height of building i.e. Deflection increases with building time period. The time period of any building will depend on how stiff and ductile it is. More the building is stiff lesser will be the time period. In this particular case of brick masonry wall the major failure is due to shear, which occurs diagonally. Say the frame move toward negative XX axis, due to this diagonal part of frame will reduce in one direction and increasing in other direction diagonally. To avoid shear failure in RCC beams shear reinforcement is provided perpendicular to the direction of the crack, during cranking of beam reinforcement. This helps to avoid the expansion of crack. Similarly the shear failure in frame can also be controlled by providing the tendons diagonally as shown in figure.3. These tendons will pass through the ducts provided in the RCC blocks of portable wall. The tendon functioning will be similar in the post tensioning. Using the tendons in the form of cross bracings the dampening of the building can be done easily. This bracing system is provided within these RCC blocks of portable wall.

The joints are designed in such a way that if in case the earthquake will came these joints will help to avoid the reaction of walls on the columns in the frame. The joints can make a free space in case of earthquake, because as the frame will deform it will reduce diagonally in one direction and increase in another direction. The crack appears in wall due to the lack of space in brick joints during compression and tension in brick wall diagonally. Due to this less space in joints to expend and squeeze cause failure which makes the brick masonry a brittle failure. The portable wall RCC blocks joint concept comes from the expansion gap concept. The joints are filled internally with the thermo cool or any other joint filler material with more brittle in nature compare to the concrete. These joint will help to keep the frame free from any of the sudden pushing force from the infill to the frame work. Also the joints can compress in both directions i.e. that is horizontally and vertically. Due to compression in both sides the diagonal compression can also occur.

For Example:

3m X 3m size wall before earthquake with diagonal dimension 4.2426m, during the earthquake the size compressed by 0.2426m diagonally. The joints will allow the blocks to get locked closely and compressed vertically and horizontally. The size of wall will remain 4m diagonally this means from the size 3m X 3m after the earthquake the wall gets compressed to 2m X 2m. The joints used in prefabricated RCC portable (PRP) wall blocks are shown in figure 4.

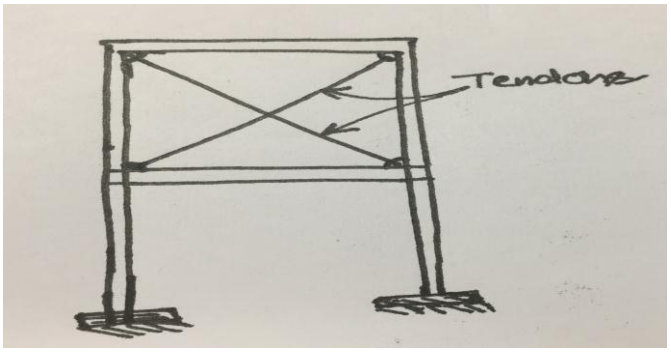

Fig -3: Frame provided tendons diagonally to control shear cracks

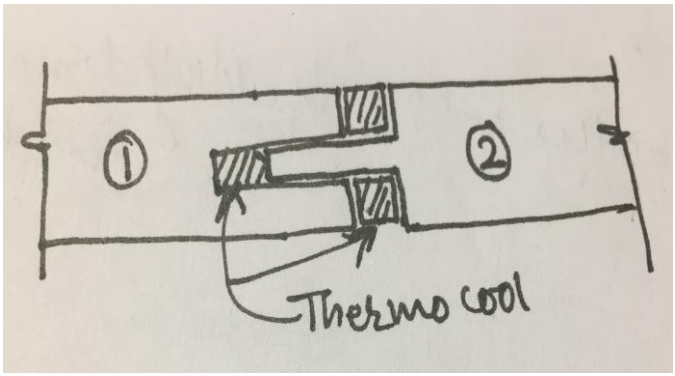

Fig -4: Joint of PRP wall blocks with thermo cool as a filler

The tendons passing through the blocks will be fixed at the corner of the frame with the plates and hook attached at the beam column joint.

2. WORKING OF PORTABLE WALLS WITH BRACING SYSTEM

The PRP wall blocks with the joints to expand in vertical and horizontal direction, can be used for services like electric conduit and water supply etc. The tendons are first fixed at bottom corners, the blocks with duct for tendons inside it are used first at bottom corners. Using thermo- cool in each joint blocks are locked properly. The blocks are placed one over the other and joints are locked. Block coming at the center of the wall will have two ducts and both ducts are separated by the wire mesh inside it. All the blocks are similar except the block at top corners. Shape of top corner blocks is different so that pull in tendons is allowed. After pull the tendon is fixed similar to the post tensioning system as shown in figure 5.

The functioning of frame and wall without tendons and with tendons during earthquake is shown below in figure 6. Figure reflects both the system is proving stiffness to the building without any serious damage to the building like the brick masonry.

Fig -5: Fixing tendon at corners of frame

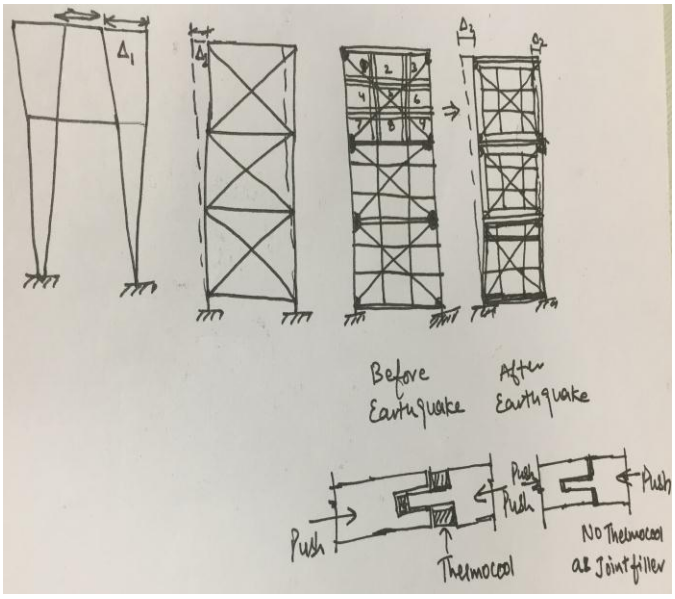

Fig -6: Functioning of frame and wall without tendons and with tendons during earthquake

3. BENEFITS

- Move on building place to place.
- Only building frame is necessary.
- Easily portable and fitted.
- Less theft chances.
- Reduces construction cost for new building.
- Saves time for construction.
- More strength against shear (figure 6).
- Less thickness of wall will provide more free space.
- The limitation of brick wall will be reduced.
- This will resist lateral forces in both the directions i.e. lateral shear in x-direction and bending in z-direction.

4. CONCLUSION

PRP walls are stronger as compared to brick wall by reducing all its limitations with simple construction techniques. The tendon bracing will minimize the deflections and cracks in wall also the PRP wall blocks can work more efficiently with the tendon system. PRP wall blocks are portable in nature and even can be reused for other construction. Due to its limited size the blocks are easy to transport. It is common that a structure may interact once with earthquake during its lifespan so such a system can help reducing the wall reconstruction cost, providing antitheft solution and majorly the structural stability in seismic and high wind conditions. These walls and bracing will provide damping and stiffness to the frame structure, also the time period of building is reduced.

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