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# Hybrid Masonry: A Review

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## Abstract

Hybrid masonry is a relatively new concept where the structural properties of masonry wall is taken into consideration, thus incorporating it for load transfer along with the frame. Together the frame and the masonry panel give rise to a system with high redundancy, ductility and stiffness. Hybrid masonry can be used instead of lateral bracing in a steel frame thereby reducing the cost and also it reduces the possibility of progressive collapse by providing an alternative load transfer path.
**Keywords: Hybrid masonry, Connector plates**

## I. INTRODUCTION

Hybrid masonry is a new structural system that combines the strength characteristics of reinforced concrete masonry walls with conventional steel framing to produce an innovative system which is capable of resisting both gravity and lateral loads i.e, if a steel column is damaged in a hybrid structure, gravity loads will transfer to the reinforced masonry, if the masonry is damaged, the gravity load transfers to the frame. Hence hybrid masonry represents a return to using masonry for lateral stiffness and strength within frames in addition to supporting out-of-plane (flexural) loads. The concept was introduced first in 2006 by David T Biggs.

The basic scheme is to attach a reinforced concrete masonry panel to a structural steel frame such that gravity and lateral forces can be shared between steel and masonry. The connections are done using steel connector plates.

## II. LITERATURE REVIEW

Hybrid masonry, as a new structural concept,offers new opportunities for seismic bracing of steel frames by incorporating the in-plane strength and stiffness of reinforced concrete masonry wall panels with the ease of erecting conventional steel framing. The hybrid masonry system relies on the structural strength of reinforced masonry panels that are well connected to the surrounding steel frame.

The masonry serves the dual purpose of supporting both out-ofplane and in-plane loadings. This results in a highly competitive system to steel braced frames, shear walls, or moment-resisting frames since masonry structural panels can also serve as architectural elements.[1]

### *A. Classification of Hybrid Walls*

Based on thedegree of confinement of the masonry within the frame there are three hybrid wall types, Type I, Type II and Type III.

Type I walls is practically a non-loadbearing masonry shear wall built within the frame which also supports out-of-plane loads. [2] The walls are connected to the beam using connector plates while they may not have to be anchored to the columns. The gap at the top and the top anchors should not transmit axial loads. Also the gaps at the columns must be adequate so the columns do not bear against the masonry when the frame undergoes drift. [3]

In Type II walls, the masonry wall is essentially a loadbearing shear wall built within the frame. The wall supports both gravity and out-of-plane loads [2]. The wall is constructed tight to the beam framing above such that axial loads are transmitted to the masonry wall [3]. Type II walls are further classified as type II a and Type II b hybrid walls.

For Type IIa walls, the vertical reinforcement (dowels) must be welded to the perimeter framing to transfer tension tie-down forces into the frame. The vertical dowels also transfer shear.

For Type IIb walls, the vertical reinforcement only needs to be doweled to the concrete slab to transfer shear forces because tie-down is not required. [2]

Type II walls are generally limited to buildings 10 to 14 stories high since masonry stresses will usually govern. [3]

Type III Hybrid Wall is fully confined within the framing -at beams and columns. Currently, there are no standards in the United States that govern the design of this type of wall. Standards are under development and research is also underway to help determine structural and construction requirements. [2]

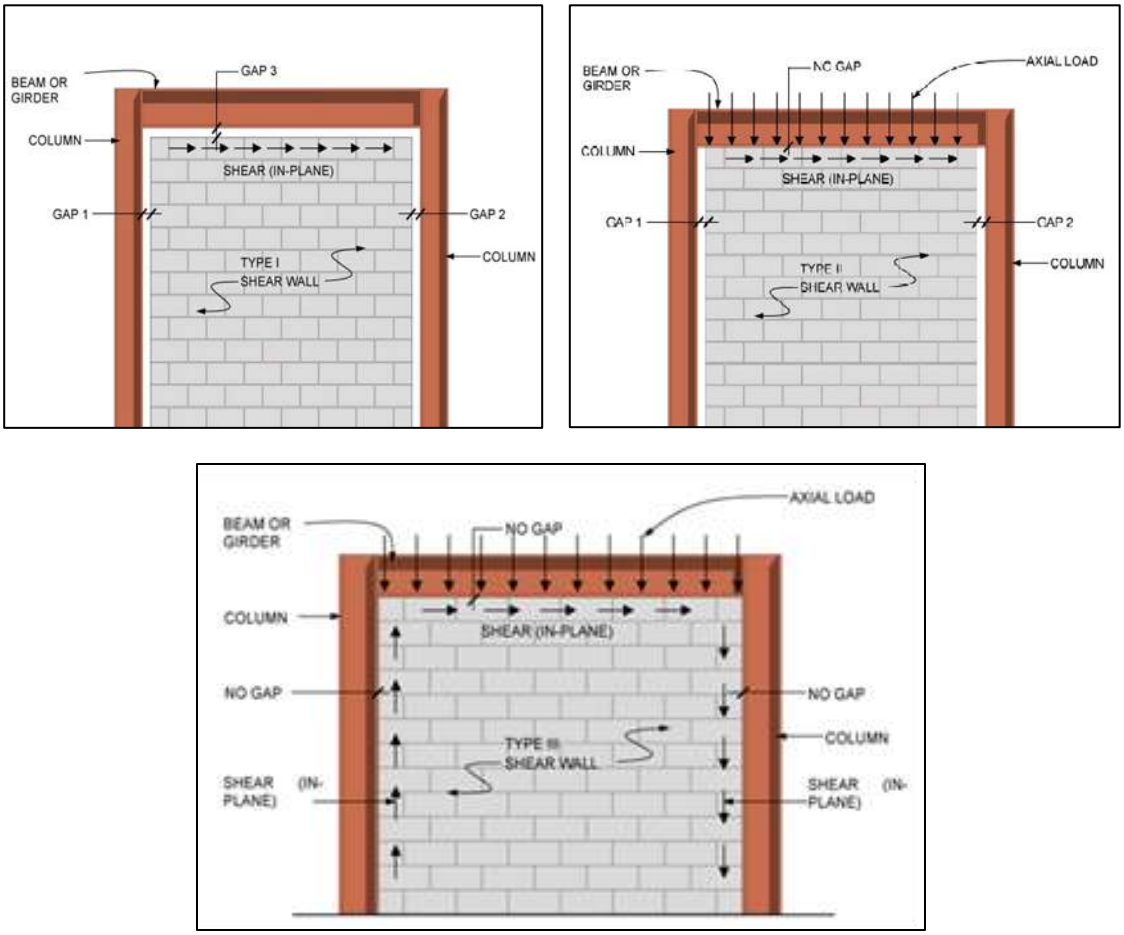


Fig. 1: type I Type II and Type III hybrid walls in clockwise direction respectively [2]

### *B. Components of Hybrid Masonry*

*Connector plates* Connector plates are the most important component of hybrid masonry system. connector plate dissipate energy within the structural system caused by seismic loads and minimize damage to the masonry wall. There are mainly two types of connector plates namely link type connector plate and tapered fuse connector plate. The link plate have a straight profile or a bent profile. The plates are placed on opposite sides of a masonry at each fuse location. Each plate is either welded to the bottom of the beam flange ( in case of link type connectors) or bolted to a side plate which was welded to the flanges of the steel beam (in case of fuse type connectors). Slip critical bolts are used to ensure elastic response during yielding of the fuse. The bottom of the plate is bolted through the bond beam. A vertical slotted hole was used in the plate at the through-bolt location to prevent vertical load transfer from the steel beam to the masonry panel.

*1) Masonry Wall Panels*

The masonry wall is reinforced with steel bars and the wall units used are either solid block or hollow block. The masonry wall panels are typically designed as either intermediate reinforced masonry shear walls or special reinforced masonry shear walls for seismic zones.

Partial grouting is given to intermediate reinforced masonry shear walls and horizontal reinforcement should not exceed 600mm.

Special reinforced masonry shear walls are solidly grouted with reinforcement not to exceed 600mm. The ductility of the system is provided by the vertical reinforcement, which must yield as is typical for any masonry shear wall. [1]

*2) Steel Frame*

The frame is usually taken as steel and need to be designed as per the requirement.

### *C. Advantages of Hybrid Masonry*

The advantages of hybrid masonry over conventional braced-frame steel construction, which enhance performance are as below.

1) Masonry panels can be constructed with current skills and training.
2) Steel bracing members are not necessary since the masonry resists story shears thus a reduction in economy can be achieved.
3) Stiffness, strength and deformation capacity can be proactively adjusted by varying the width and/or thickness of a panel, the compressive strength of the masonry and amounts of panel reinforcement. [4]

4) Seismic energy can be effectively dissipated by designing the system such that that damage is confined to selected masonry panels and/or connectors, thus the repair costs are minimized.
5) As the system is highly redundant Loss of a masonry panel will not result in progressive collapse.

Even though hybrid masonry has advantages over lateral bracings it is still not popular because of the following reasons.
1) Uncertainty in modeling mechanics of hybrid masonry.
2) Lack of guidelines and building code requirements.
3) Lack of knowledge and experience with the concept.

## III. CONCLUSIONS

Hybrid masonry is an innovative approach in structural engineering. It can reduce the cost of construction by reducing the amount of steel by replacing it with masonry and also the chance of progressive collapse is reduced by providing an alternate load path. Different types of hybrid masonry behave in different ways as their load transfer mechanism is different. It has a lot of advantages over traditional laterally braced frame but however its implementation is still not much popular due to lack of structural code provision.

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