SEISMIC BEHAVIOUR OF SPRC CUTTING WALLS WITH DIFFERENT STEEL CONTENT AND AXIAL STRESS RATIOS

Lokesh[1]

[1]Research Scholar, Department of Civil, Sri Satya Sai University of Technology &
Medical Sciences (SSSUTMS), Sehore(MP), India

Dr. AJAY SWAROOP

Research Guide, Dept. of Civil Engineering,

Sri Satya Sai University of Technology & Medical Sciences,

Sehore, Bhopal Indore Road,Madhya Pradesh, India

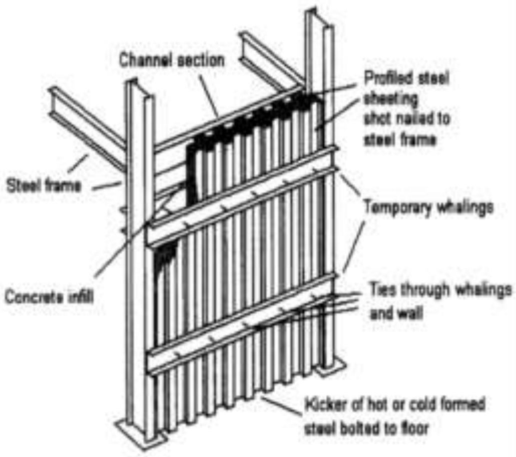
Abstract -- Steel plate reinforced concrete (SPRC) composite shear walls, which are made out of steel sections embedded in limit elements and an embedded steel plate in the wall web, have been utilized in super-elevated structures. When exposed to uncommon quake loads, combined tension-bending-shear activities are frequently created in the shear walls of super-elevated structures in light of the increasing demand for a more noteworthy tallness width ratio. In light of semi static tests on seven SPRC shear walls under tension-bending loads, the seismic behavior of SPRC shear walls with different steel-content ratios and axial tension ratios was investigated. The failure mode, strength and relocation capacity, stiffness degradation, shear deformation, damping coefficient, strain, and cracking of each test example are presented in detail. This paper showed that the FE model predicted the heap uprooting relationship, stiffness degradation, and extreme capacity with a healthy degree of precision. In light of the test outcomes, a design strategy is proposed for predicting a definitive strength of the SPRC shear walls under tension-bending combined burdens, and proposals for improved anchorage design are proposed.

Keywords: Steel plate shear walls (SPSW), Stiffened or unstiffened, Material non-linearity, shear strength capacity, experimental work, connectivity, codal provision, Design methodologies.

I. INTRODUCTION

The shear walls are perhaps the most basic elements in the skyscraper or very skyscraper primary system, which have for some time been utilized as an effective parallel force-resisting system for building. With the increase of building tallness and the development work prerequisite of architecture, the better demand of underlying walls were proposed. Steel plate - concrete composite walls are one of the new-style underlying walls and have effectively been utilized in the genuine practice lately.

The intrinsic issue of normal concrete is its brittle nature which may cause collapse in non seismicallynitty gritty primary individuals after the main break during an enormous quake. The utilization of steel fibers may change the brittle qualities over to malleable ones. The principal job of fibers is to bridge breaks and oppose their formation. Therefore an impressive improvement in elasticity and higher extreme strain can be obtained.



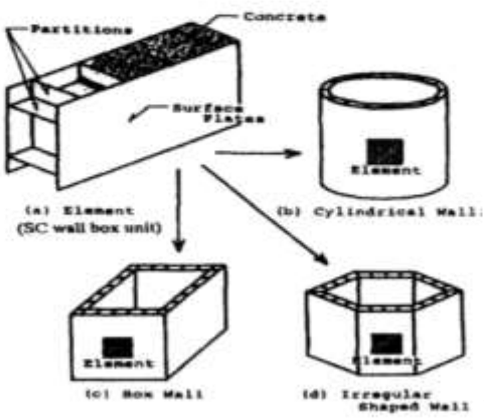


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Fig. 1.Proposed by Wright Fig 2.Proposed by Emory

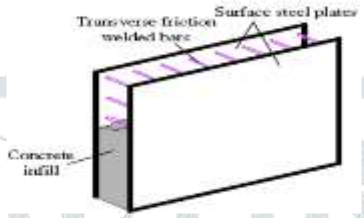


Fig 3. Bi-Steel

It can be classified as steel plate reinforced concrete composite walls (SPRC) and concrete filled double steel plate (CFDSP) composite walls according to the different relative places of the steel plates and concrete. Base on the interaction and cooperation of the two materials, the mechanical behavior of shear walls prominently changes. Numerous researchers have completed experimental and logical investigations on CFDSP walls in the previous years, and a few different configurations have been proposed.

The experimental tests were completed on joints reinforced with steel fibers just and the combination of stirrups and steel fibers to determine the effect of steel fiber and the combination of stirrups and steel fibers on the shear behavior of joints. Furthermore, the possible use for steel fibers to be utilized to supplant the stirrups is likewise obtained. In light of the experimental test outcomes and prior distributed examinations, a formula for predicting a definitive shear strength for joints reinforced with steel fibers and the two stirrups and steel fibers is proposed. Moreover, an effective technique for designing steel fiber reinforced joints is additionally introduced.

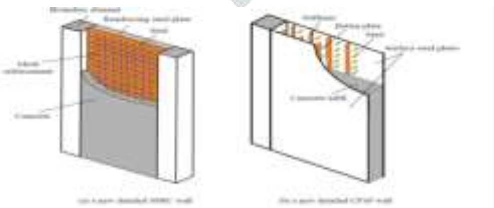


Fig 4. Two new developed composite walls

It was applied in the atomic offices, marine climate structures on account of its superior behavior, huge parallel stiffness, minimal effort and fast construction. Wright et al. led some pilot concentrates on the composite wall formed from two skins of profiled steel sheeting filled with concrete under different loading conditions and tracked down that the steel sheeting gives comparable attributes to conventional framework for concrete casting and finally to build up design formulas for real practice. Three 1/4 scale examples of CFDSP walls with both horizontal and vertical stomachs were worked to take cyclic shear loading test by Emori K. The shear test exhibited high strength and huge ductility of these kinds of walls. Welded association was utilized between the insert plates and the long-side steel plate, which would bring about the inadequacy of the steel plates and be hard to be applied to the engineering.

II. LITERATURE REVIEW

The Corus Company built up a CFDSP construction called Bi-Steel with two surface steel plates associated by a variety of cross over grinding welded shear connectors, and a progression of researches have been directed on Bi-Steel. Likewise, Eomet al. tested 5 separated and 2 coupled CFDSP walls with rectangular and T-molded cross segments under in-plane cyclic loading. The two surface steel plates of their test examples were associated by tie bars, which was like Bi-Steel. Considering the way that the elements are difficult to manufacture and may bring the remaining pressure in the steel plate when an enormous number of weld stud or board is embrace, the composite concrete and steel plate shear walls with binding bars were proposed. Disregarding broad investigations of CFDSP walls in the writing, the CFDSP walls with binding bars have not been completely tended to. In order to intensively investigate the seismic behavior of this new point by point concrete filled double-steel-plate composite wall, ten wall examples were tried under axial compressive forces and turned around cyclic sidelong loads. Failure component, hysteric behavior, strength and deformation limits, and so on are examined in detail. The feasibility of the configuration was tried, and the influences of different factors on the behavior of shear walls were investigated.

Steel plate-concrete composite walls are of late evolved forms of underlying walls. Contrasted with the customary reinforced concrete (RC) wall, the composite wall has higher bearing and deformation limits. So the wall thickness can be decreased and more usable floor territories can be obtained when using the composite walls in the very tall structures. The steel plate-concrete composite walls have been utilized in a few too tall structures and constructions. The created steel plate-concrete composite walls can be separated into two sorts depending on the general situation of the steel plates and concrete: steel-plate reinforced concrete (SPRC) composite walls and concrete filled double-steel-plate (CFSP) composite walls.

A few experimental tests have been directed on the seismic behavior of SPRC walls . And the hysteretic behavior, stiffness, strength and ductility were investigated. Studies on CFSP walls started very before. Wright et al. first proposed a composite wall formed from two skins of profiled steel sheeting filled with concrete, and tried it under different loading conditions. During the 1990s, concrete filled double-steel-plate composite walls for thermal energy stations were proposed in Japan in order to lessen the continuously increased labor costs. A few experimental and theoretical examinations were completed by the Japanese researchers during that time Takeda et al. (1995), Usami et al. (1995), Ozaki et al. (2001). In the 21st century, the static and cyclic behaviors of double skin composite bars and walls with steel plates associated by tie bars were concentrated by Clubley et al. (2003) and Eom et al. (2009).

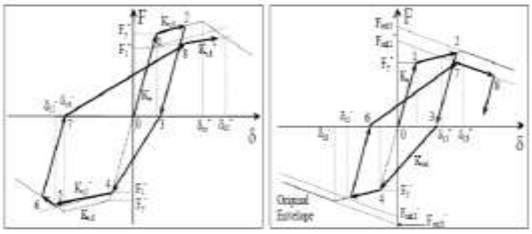
For the utilization of high-strength concrete in the very elevated structures, two new created composite walls were proposed .The new definite SPRC wall contains concrete filled steel tube (CFST) segments or flanged CFSP walls at the limits of the wall. A reinforcing steel plate is inserted in the concrete of the wall body. Shear studs are welded on the reinforcing steel plate to make the steel plate and surface concrete to work together. Lattice reinforcement are likewise positioned in the concrete of the wall body. The new itemized CFSP wall additionally contains concrete filled steel tube (CFST) sections or flanged CFSP walls at the limits of the wall. The wall body is separated into a few rooms by vertical stiffeners dynamically associated by secure plates, and the concrete in each room is confined by surrounding steel plates. This configuration is steel saving than the use of vertical stomachs.

Examples of the new created HSC filled double-steel-plate composite walls and three examples of the new evolved steel-plate reinforced HSC composite walls were tried under high axial compressive forces and turned around cyclic horizontal loading. Failure system, hysteric behavior, bearing and deformation limits, and so forth are examined.

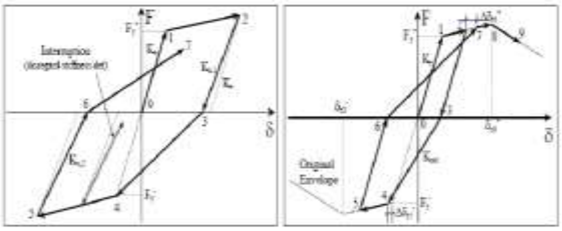
III. **MODELING ANALYSIS AND RESULTS**

3.1 Selecting Degradation Models for SPSW Components

Although several SPSW specimens have been tested in some of this research beyond the final point and strength degradations have been registered and published, and while fragility curves have been established to link SPSW damage states to drift values (Baldvins et al. 2012), no attempt has been found in the current literature to simulate the strength deterioration through numerical research. Using numerical models, multiple contributing elements can be investigated.



(a) Basic Strength Deterioration (b) Post-Capping Strength Deterioration



(c) Unloading Stiffness Deterioration (d) Accelerated Reloading Stiffness Det.

Figure 5 Hysteretic Rules for Cyclic Deterioration in Ibarra and Krawinkler (2005) Model

3.1.2 Parameters that influence SPSW efficiency when there was strength depletion, which could be economically impractical to investigate only through experiments. The creation of degradation models for SPSW components (i.e. boundary elements and infill plates) and the calibration of them to the available experimental data are one of the aims of the research presented in this paper. However, since experimental data for SPSWs is only available at the global structural level, models of moment-rotation and axial force-deformation degradation for boundary elements and infill plates, respectively, will be described in terms of observations made at that global structural level. Here, the pattern of deterioration at the global structural level is considered to be an expression of behavior at the component level.

Several examples of force-displacement hysteretic curves for SPSW specimens are presented in Figure 6, describing one- to four-story specimens. Several observations can be made with regard to the hysteretic rules for cyclic deterioration shown in Figure 5, as follows:

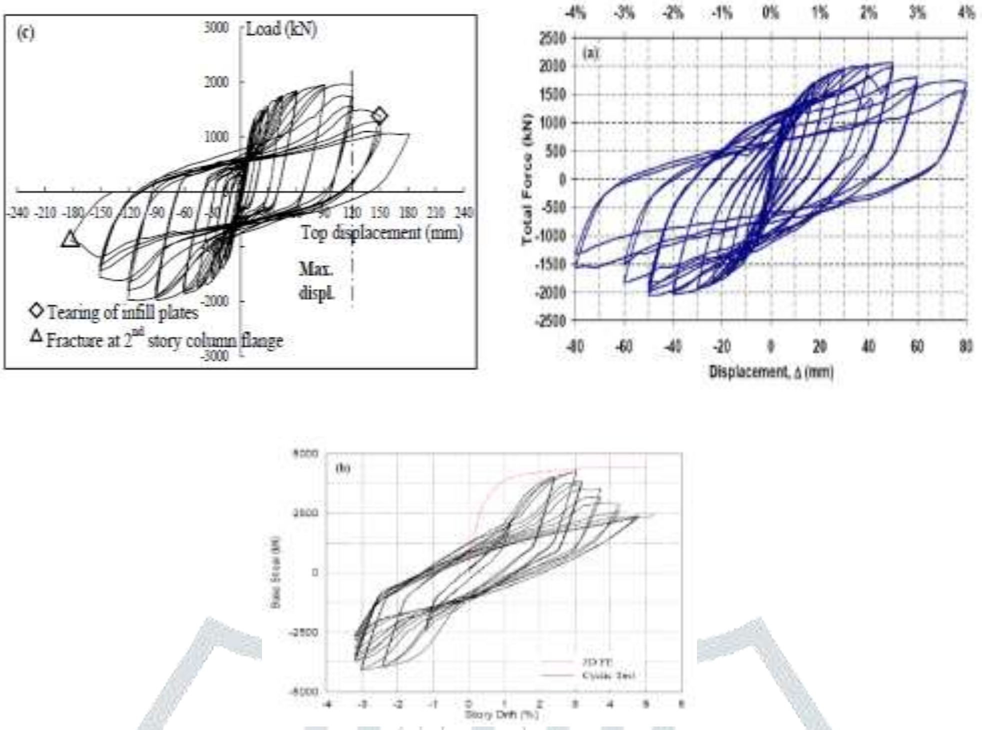


Figure 6 Force -Displacement Hysteretic Curves for SPSW Specimens: (a) One-story Specimen (Vian and Bruneau 2005); (b) Two Storey specimen

Hysteretic slopes both during loading and unloading are somewhat the same between one and another hysteretic loop until the capping point. Moderate shift of the hysteretic slope is observed only after degradation of intensity has occurred. This behaviour indicates that it does not seem crucial to integrate stiffness degradation into the deterioration models for components of SPSW, especially for the collapse analysis of SPSWs intended in this study.

Strength degradation due to repetitive cycles at the same displacement is relatively small; as such, in the deterioration models of SPSW components, fundamental strength degradation (Figure 5c) can be ignored.

3.1.3 Strength degradation occurs primarily as the growing inelastic displacements cross the final point in the curve of the backbone. Here, the cyclic envelope is supposed to be close to the backbone boundary of force-displacement.

As for the noticeable pinching action shown in the hysteretic curve of those SPSWs, it is a consequence of the fact that slender tension-only bracing functions analogously to the infill plates. Roberts and Sabouri-Ghomi (1991) tested SPSWs with boundary elements connected to the pin and reported a significant pinching action of the unstiffened plates (Figure 7). In addition, Berman and Bruneau (2005) subtracted from the total hysteretic response of their single-story SPSW specimen the semi-rigid boundary frame contribution and obtained the same results for infill-only hysteresis, as shown in Figure8.

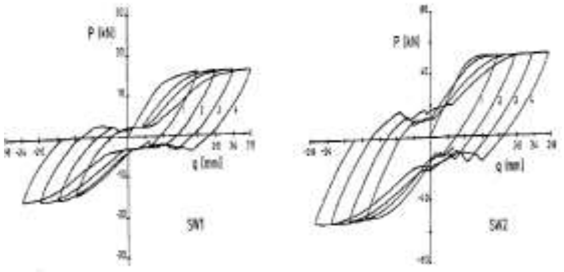


Figure 7 Typical Hysteretic Curves for Unstiffened Steel Plates (Roberts and Sabouri-Ghomi 1991)

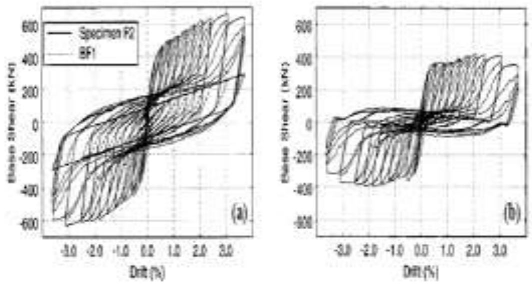


Figure 8 Hysteretic Curves for Berman and Bruneau (2005) Single Story Specimen:

(a) Specimen and Modeled Boundary Frame Hysteresis; (b) Infill-only Hysteresis

IV. CONCLUSIONS

The hysteresis curves were also very stable throughout the response and they did not show any sudden drops in capacity. The post-ultimate degradation was gradual and controlled and significant degradation occurred only after a large number of displacement cycles and at very large deflections. Furthermore, the amount of energy dissipated during the loading cycles was significantly greater than that shown by similar shear walls but with shear-type beam-to-column connections The amount of energy dissipated also increased steadily with each cycle of increased deflection. Based on the results of this large-scale four storey test, it is concluded that the steel plate shear wall configuration tested represents an excellent lateral load-resisting system for seismic loading.

It was found that the hysteresis model presented generally led to reasonable predictions of the amount of energy dissipated by the test structure. However, a new hysteresis model has been proposed that results in improved estimates of energy dissipation and offers the ability to isolate the respective contributions of the shear panels and the moment-resisting frame at all stages of the cycle. It is recommended that the proposed new hysteresis model be used to predict the hysteretic response of steel plate shear walls**.**

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