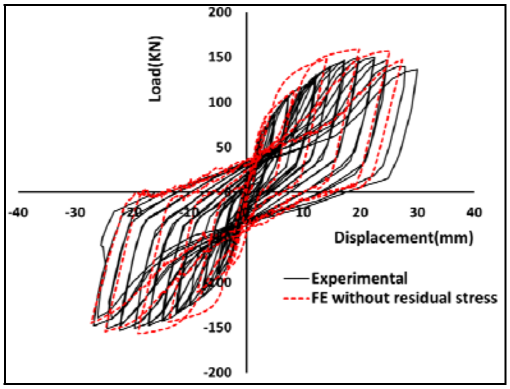

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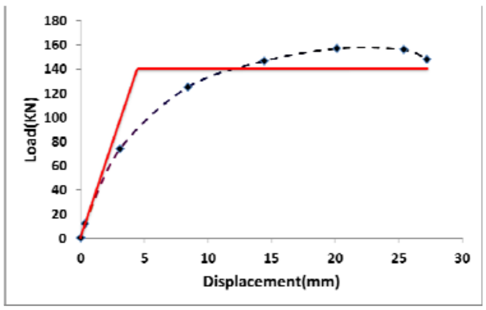

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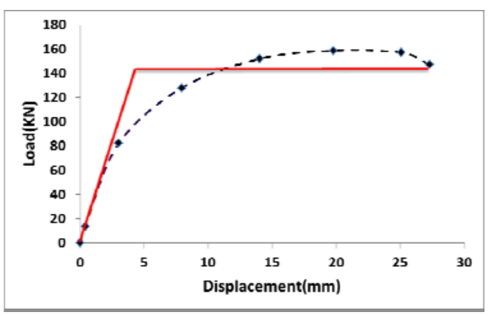

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Figure 2. (a) Comparison of hysteresis curves of experimental SPSW and FE model with residual stress, (b) Comparison of hysteresis curves of experimental SPSW and FE model without residual stress, (c) Bilinear envelop curve of the model excluding residual stresses, (d) Bilinear envelop curve of the model including residual stresses

4. Conclusions

Construction of steel shear wall is always accompanied with large amounts of welding for attaching the infill plate to the surrounding frame and this issue would cause creation of residual stresses in plates. If the welding process is not performed regularly and periodically, it would have a great influence on the behavioral parameters of the system. In this paper, thermal loads resulting from heat transfer analysis were applied on the infill plates of a three-story SPSW and residual stresses were obtained. The model containing residual stresses was subsequently analyzed under cyclic lateral loads. The finite element analysis results revealed that inclusion of residual stresses resulting from plates' periodic welding has led to about 7.5% reduction in stiffness and ductility of the SPSW specimen compared to those obtained in the absence of residual stress. The impact of these stresses on the yielding and ultimate strengths and the energy absorption capacity was, however, found to be negligible. Based on these observations, further studies that assess the effect of residual stresses on stiffness and ductility of SPSW specimens will be required. These results, if reflected in design codes, can improve the safety of the designed SPSWs.

Effect of Welding Residual Stresses on Performance of Steel Plate Shear Wall

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1. Introduction

Application of steel plate shear wall (SPSW) system as a lateral load resisting system has been considered by designers and researchers in recent decades, due to its several advantages [1]. The infill plates are attached to the surrounding beam and columns by a large amount of welding and in the case that welding is not controlled, the welding residual stresses can be effective on steel shear wall`s behavior. Residual stresses in a welded structure are the result of non-uniform expansion and contraction and plastic deformation of the weld and surrounding base metal, caused by the heating and cooling cycles during the welding process. Welding-caused residual stresses may increase up to the yielding point and can potentially reduce structural performance. Therefore, their magnitude and distribution need to be thoroughly studied.

2. Methodology

2.1. Experimental Model. Three story, 1/3 scale steel plate shear wall with rigid beam to column connection has been tested under cycling loading according to ATC24 [7], by Golhaki Fig (1) [2].

2.2. FE modeling

The ABAQUS finite element software is utilized for modeling the steel shear wall. The infill plates and the boundary elements were meshed using four-node reduced integrated shell element, S4R. FE modeling was done in two steps. At the first step, the steel shear wall was analyzed without the effect of residual stresses and in the second step the steel shear wall with residual stresses as initial condition was analyzed and the results of FE analysis were compared with experimental results.

3. Results and discussion

3.1. Results of the model without residual stresses. Lateral loading was applied according to the experimental condition on top of the FE model. At the first model, the three story SPSW was analyzed under cyclic loading without residual stresses and the obtained load-displacement hysteresis curve was compared with experimental results. In the second step, the SPSW specimen was modeled in ABAQUS assuming the existence of residual stresses resulting from welding of the plate to the surrounding frame. The welding process was simulated without consideration of metal deposition. A sequentially coupled thermo-mechanical analysis was performed where heat transfer analysis was followed by mechanical analysis.

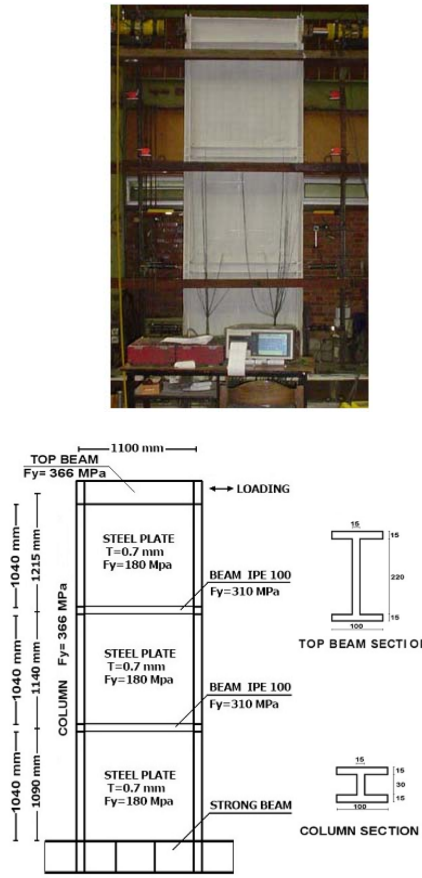
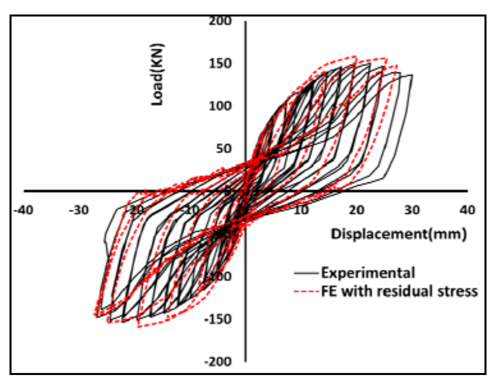


Figure 1. Schematic and photograph of experimental specimen



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