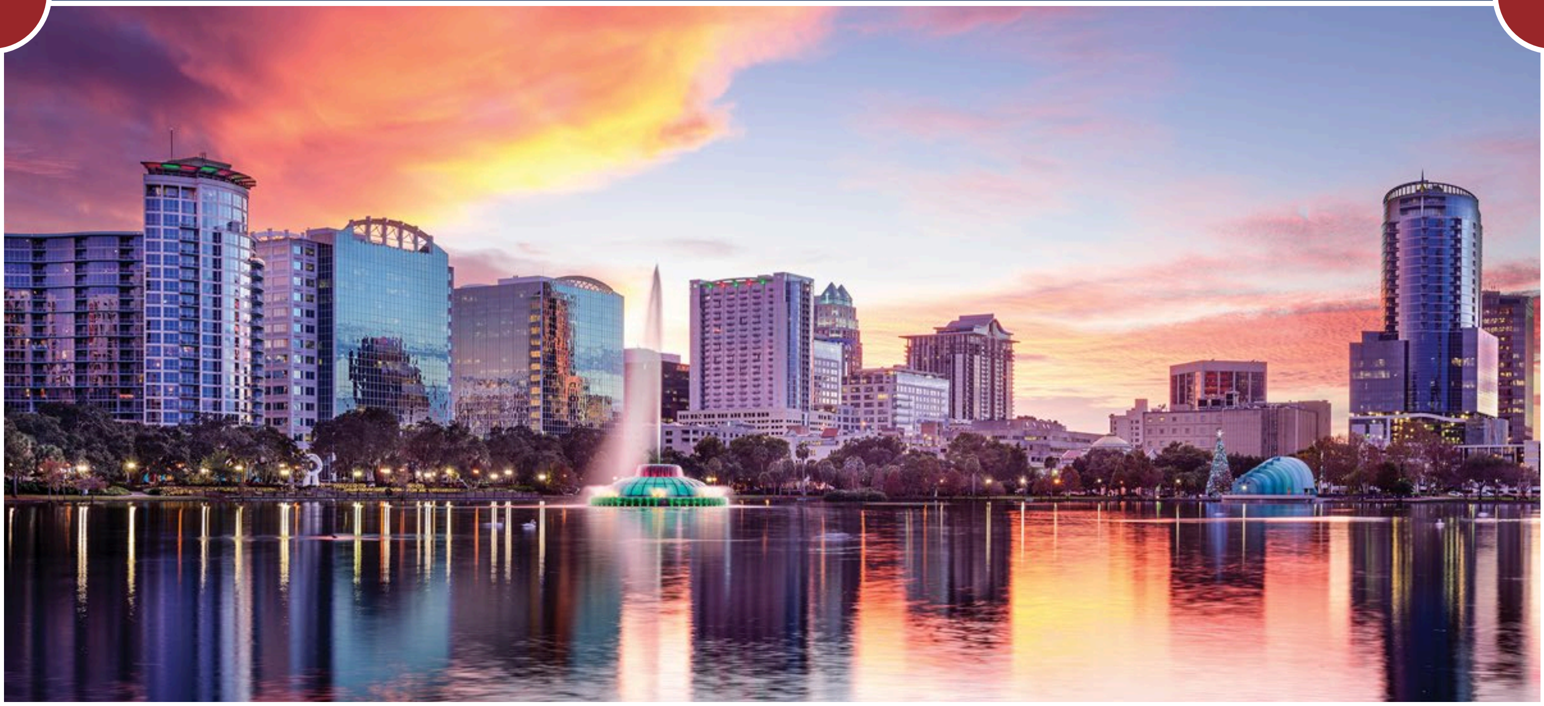

Structures Congress 2019

Buildings and Natural Disasters

Proceedings of the
Structures Congress 2019

Orlando, Florida

April 24–27, 2019

ASCE

Edited by
James Gregory Soules, P.E., S.E., P.Eng.

SEI STRUCTURAL ENGINEERING INSTITUTE
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SELECTED PAPERS FROM THE STRUCTURES CONGRESS 2019

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SPONSORED BY
The Structural Engineering Institute of the
American Society of Civil Engineers

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Published by the American Society of Civil Engineers

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia, 20191-4382
www.asce.org/publications | ascelibrary.org

***Errata:* Errata, if any, can be found at https://doi.org/10.1061/9780784482223**

ISBN 978-0-7844-8222-3 (PDF)
Manufactured in the United States of America.

Preface

The Structures Congress has a robust technical program focusing on topics important to Structural Engineers.

The papers in the proceeding are on the following topics

- Blast & Impact Loading & Response of Structures
- Bridges, Tunnels and other Transportation Structures
- Disproportionate Collapse
- Advances in Structural Engineering Research
- Analysis, Design & Performance
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- Materials- Design & Construction
- Natural Disasters - Moving Toward Improved Resilience
- Nonbuilding Structures and Nonstructural Components
- Special Topics in Structures
- Transformation in SE Education

Acknowledgments

Preparation for the Structures Congress required significant time and effort from the members of the National Technical Program Committee, the Local Planning Committee and staff. Much of the success of the conference reflects the dedication and hard work by these volunteers.

The National Technical Program Committee, the Local Planning Committee and staff would like to acknowledge the critical support of the sponsors, exhibitors, presenters, and moderators who contributed to the success of the conference through their participation.

Thank you for spending your valuable time attending the Structures Congress. It is our hope that you and your colleagues will benefit greatly from the information provided, learn things you can implement and make professional connections that last for years.

Sincerely,

J. G. (Greg) Soules, P.E., S.E., P.Eng, SECB, F.SEI, F.ASCE
McDermott International
Chair, National Technical Program Committee

Contents

Buildings

Innovative Frame/Wall System for Seismic Protection of Residential Buildings

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ABSTRACT

This paper presents an "innovative" structural system, aiming to provide a cheap yet reliable, and very effective seismic protection to residential houses/buildings, characterized with abundance of masonry infill wall panels. This is achieved through use of innovative IDRIZI seismic devices (based on a combination of two-layered friction/sliding mechanism), which are placed at characteristic locations between the masonry infill walls and the structural frame system of the building. An analytical study, supported by experimental research, indicates that buildings utilized with this innovative frame/wall system, dissipate up to 80% of earthquake energy input through the friction mechanism of IDRIZI seismic devices.

INTRODUCTION

It is historically proven that masonry structures respond poorly under strong seismic events. This poor seismic performance of masonry walls is owed to their stiff, brittle and low-strength characteristics. Once seismic energy input exceeds the limited lateral strength capacity of masonry walls, masonry buildings get severely damaged or collapse completely. The social and economic consequences of such failures are catastrophic. This is the reason why masonry structures lost popularity particularly in regions estimated with moderate to high seismicity. Subsequently, many seismic building codes prohibited the use of masonry walls as "primary seismic resistant elements" at regions with high seismicity, particularly with the advent of reinforced concrete structures. Nowadays, masonry walls are merely used as separation partitions to meet the architectural intentions.

From the structural designer's perspective, it is a common practice to completely neglect the load bearing capacity and lateral resistance of masonry walls, when estimating the seismic performance of building analytical models. Their weights, however, are considered in building modeling and analysis stages. This approach seems to be pragmatic for simplifying the modeling and analysis process of buildings, particularly when recognizing the weak-lateral-strength, heterogeneity, brittleness of masonry walls, and masonry's high standard deviations from their mean characteristic strength.

One would "NOT" expect that this modeling approach, over conventional buildings with masonry infill walls, would alter the building seismic performance to notable extents. However, past on-site observations on conventional buildings, affected by medium-to-strong earthquakes, suggest reconsidering this approach, particularly on cases where masonry wall panels are abundantly present on buildings, on which cases they affect the seismic building performance notably and in complex and unexpected ways.

The consideration of masonry infill walls as structural elements affecting the seismic performance of conventional buildings has been a subject of study to many engineering researchers for decades. And there are many still ongoing.

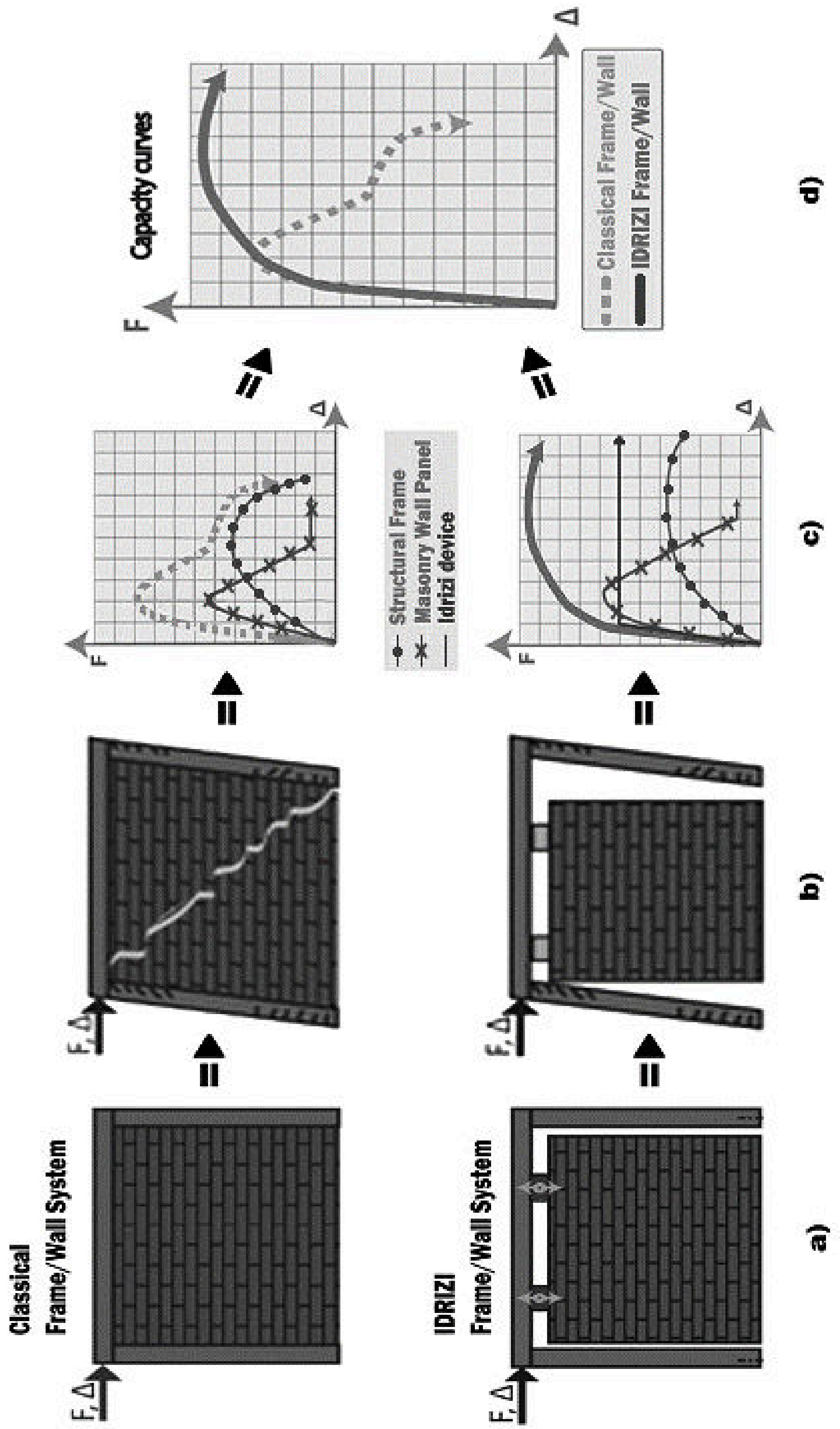

Figure 1. Classical vs. Innovative (IDRIZI) frame/wall system

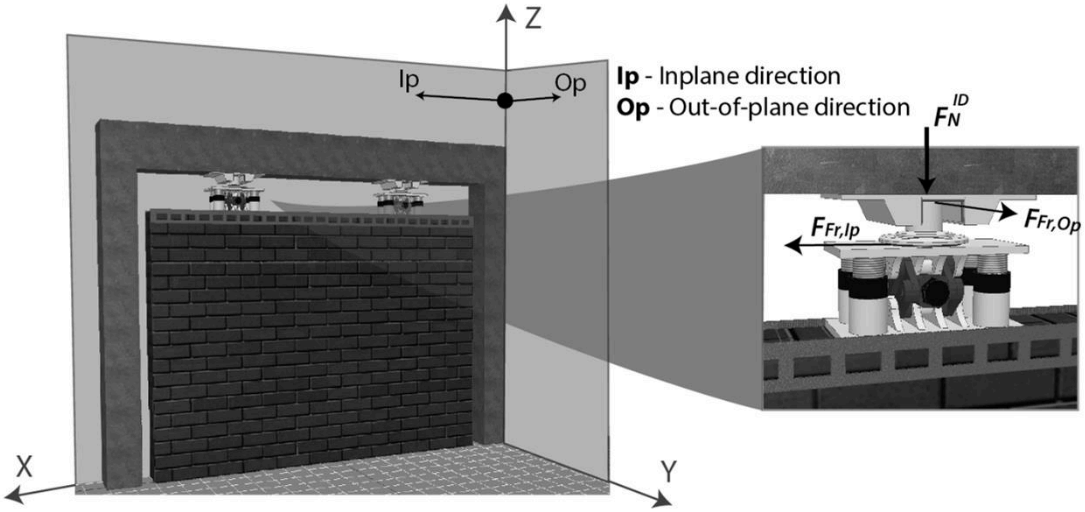

Figure 2. Perspective view of an IDRIZI wall system frame and friction forces

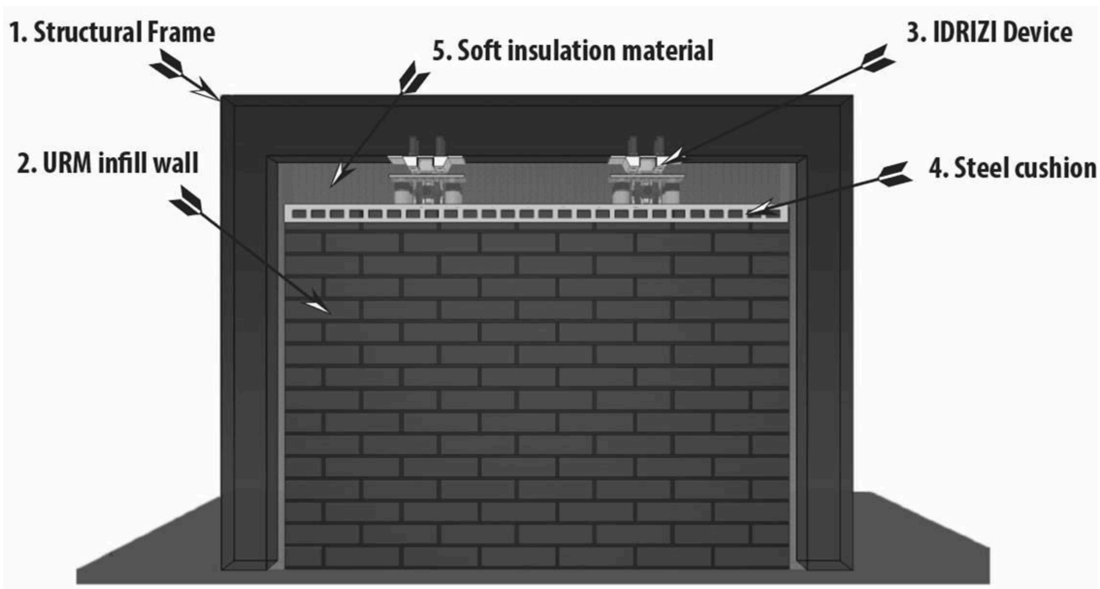

Figure 3. Constitutive structural units of the IDRIZI frame/wall system

CONCEPTION OF THE INNOVATIVE FRAME/WALL SYSTEM

This paper is product of over a five-year-long studies and research related to seismic response improvement of conventional buildings, by the optimal and reliable utilization masonry infill walls (which are abundantly present on conventional buildings).

Before considering masonry infill walls as structural members, their physical and mechanical drawbacks (mentioned above in the introduction section) must be carefully addressed at material, component and structural level.

Perhaps, the most important features, that led to the development of this paper's technical solution right from the beginning, were the *lateral stiffness/strength/deformation* characteristics of masonry walls (Figure 1a/top, 1b/top, 1c/top). Specifically, masonry infill walls demonstrate excessively higher lateral stiffness as compared to other structural frame members, i.e. columns and beams, which is inherited by their geometrical characteristics (second moments of inertia of