UCLA- RCWALLS DATABASE FOR REINFORCED CONCRETE STRUCTURAL WALLS

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\textbf{ABSTRACT}

Reinforced concrete structural walls are commonly used as lateral force-resisting elements for buildings subjected to strong earthquake shaking. Assessing the deformation capacity of structural walls prior to significant strength loss has received considerable attention in recent years due to observations of poor wall performance in recent earthquakes and laboratory test programs. Although relatively few wall tests were reported in the literature prior to 1990, a substantial number of tests have been reported since. Therefore, to assess the role of various parameters on wall deformation capacity, as well as wall strength and stiffness, a robust database was assembled to serve as a resource for both researchers and practitioners. The database includes detailed, organized, and parameterized information on more than 1000 RC wall specimens subjected to uniaxial lateral loading carried out around the globe. The database was developed using software that enabled use of a database structure with a user-friendly interface (foreground) and a powerful and secure storage (background). Furthermore, the features of the database makes it easy to manipulate data, i.e., group, filter, combine, modify, import, export, review, and visualize, which is a critical component of any useful engineering database. The database currently includes parameterized test specimen details, experimental backbone relations, failure mode details, and analytical information such as computed moment-curvature relations and ACI 318 nominal shear strength calculations for all the tests.

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Reinforced concrete structural walls are commonly used as lateral force-resisting elements for buildings subjected to strong earthquake shaking. Assessing the deformation capacity of structural walls prior to significant strength loss has received considerable attention in recent years due to observations of poor wall performance in recent earthquakes and laboratory test programs. Although relatively few wall tests were reported in the literature prior to 1990, a substantial number of tests have been reported since. Therefore, to assess the role of various parameters on wall deformation capacity, as well as wall strength and stiffness, a robust database was assembled to serve as a resource for both researchers and practitioners. The database includes detailed, organized, and parameterized information on more than 1000 RC wall specimens subjected to uniaxial lateral loading carried out around the globe. The database was developed using software that enabled use of a database structure with a user-friendly interface (foreground) and a powerful and secure storage (background). Furthermore, the features of the database make it easy to manipulate data, i.e., group, filter, combine, modify, import, export, review, and visualize, which is a critical component of any useful engineering database. The database currently includes parameterized test specimen details, experimental backbone relations, failure mode details, and analytical information such as computed moment-curvature relations and ACI 318 nominal shear strength calculations for all the tests.

Background

In the US, test programs on squat walls were first initiated in the 1950s at Stanford University and MIT. These tests were conducted on barbell-shaped walls under monotonic loading to evaluate peak shear strength. Tests on squat walls under quasi-static, cyclic lateral loading began in early 1970s in the US and mid-1970s in Japan. Significant changes to wall shear strength provisions were introduced in the ACI 318-83[1] and the two subsequent versions. Experimental studies on flexure-dominated walls also started in mid-1970s in the US with Portland Cement Association’s (PCA) extensive, three-phase experimental program, which consisted of testing 19 walls (excluding repaired walls) between 1974 to 1983. These tests, along with tests in New Zealand [2], were primarily responsible for introducing provisions for wall boundary elements in ACI 318-83 [1]. Another prominent wall testing program was conducted at UC Berkeley between 1975 to 1980 to study the impact of various design parameters. Following these initial

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studies, relatively few additional experimental studies on slender walls were conducted in the US in the 1980s, with studies generally focused on assessing the behavior of coupled walls and walls with openings, although a few additional tests were conducted in New Zealand in mid-1980s. A large number of wall tests also were conducted in Japan throughout 1980s, as well as 1990s. Introduction of displacement-based design approach [3], observations from major earthquakes in the US and Japan in the mid-1990s, and the expansion of experimental testing facilities around the world led to significant increase in available test results reported in the literature since roughly 1990. This paper present a recently developed robust and well-detailed database (UCLA-RCWalls), which currently contains information on more than 1000 isolated solid RC wall tests collected from more than 200 test programs reported in the literature around the world.

Motivation

Several factors motivated the development of UCLA-RCWalls database. First, despite attempts by researchers to gather available experimental data of RC walls, there was a lack of a robust and comprehensive database. Existing databases do not contain sufficiently detailed and parameterized information about test setups and specimens, experimental results, and analytical results. In addition, the significant number of wall tests, mostly code-compliant, conducted since the 2010 Chile and 2011 New Zealand earthquakes, are typically not included in the available databases. Second, following observations of poor performance and severe wall damage following the aforementioned recent earthquakes, as well as recent laboratory wall tests, researchers have raised concerns about the potential building code deficiencies and have suggested more studies be conducted to investigate wall seismic performance and revisit design provisions. Third, there are uncertainties around the effectiveness of some boundary element details and configurations that are not specifically addressed in the current ACI 318 [4] provisions, e.g., the type of hooks used on crossties, the effectiveness of overlapping hoops relative to a perimeter hoop with intermediate legs of crossties, and the need to support all boundary longitudinal bar versus every other bar. Studying the impact of these parameters over wide large range of parameters requires a database that contains well-parameterized boundary element information. As part of the effort to address some of these issues, Abdullah and Wallace [5] have utilized this database to assess the impact of various design parameters on lateral drift capacity at strength loss of walls with special boundary elements. Additionally, documents such as ASCE 41 [6], which provide wall modeling parameters for deformation capacity and section stiffness, have been developed based on a review of limited experimental results, and research has demonstrated that existing provisions are, in many cases, generally conservative (7). Therefore, there is interest in using a robust database to assess current provisions related to the performance of RC walls and to identify gaps in the available wall test results and provide guidance to direct future test programs. In short, to understand and address the aforementioned issues and challenges, the availability of a robust and well-detailed database such as UCLA-RCWalls is essential.

UCLA-RCWalls Structure and Content

Being able to efficiently manipulate data is critically important to effectively assess data trends and develop models that capture these trends. Furthermore, other important features include ensuring that the data is secure so that unauthorized changes cannot be performed, exporting or
publishing data to enable access for researchers/practitioners, and recording a large amount of data and detail without causing slowdown. To address these needs, a sophisticated database management software [8] and a web application framework [9] were utilized to develop the background (powerful data repository) and foreground (user-friendly interface) of the database, respectively. Fig. 1 shows a screenshot of the database interface, in which all data manipulations can be performed (i.e., filter, modify, import, export, and review).

Currently, UCLA-RCWalls contains over 1000 isolated solid RC wall tests collected from more than 200 test programs reported in the literature, making it by far the largest database of RC walls. The database contains three major clusters of data: 1) information about the test specimen and test setup/loading, i.e., details of wall geometry, material properties, loading protocol, and web and boundary reinforcements (see Fig. 2a, b, &c for examples of boundary details), 2) test results, e.g., backbone relations for total top displacement, shear displacement, and/or base rotation (see Fig. 2d for an example of backbone curve), key damage details, and failure modes and details, 3) analytical data such as data obtained from analytical moment-curvature relationships (e.g., depth of neutral axis and nominal flexural strength and curvature) and wall shear strength according to ACI 318-14 [4]. More detailed information about UCLA-RCWalls is given elsewhere [10]. Fig. 3 presents histograms of some of the characteristics of the data assembled in UCLA-RCWalls.

![Figure 1. Interface of UCLA-RCWalls.](image1.png)

![Figure 2. Some examples of the contents of UCLA-RCWalls.](image2.png)
Summary

This paper presents a comprehensive database of RC walls known as UCLA-RCWalls, which is designed and developed to enable efficient filtering and data manipulation. The database currently contains parameterized details and test results of over 1000 walls reported in the literature from more than 200 experimental programs. The database can serve as a valuable tool for researchers/practitioners to address issues associated with performance of walls, to develop empirical models that capture data trends, and to validate analytical studies.

References


