Retraction

Retraction: Schematic of monotonic shear test for hollow circle elements no stirrups (*IOP Conf. Ser.: Earth Environ. Sci. 737* 012044)

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All authors agree to this retraction.

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Schematic of monotonic shear test for hollow circle elements no stirrups

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Abstract. The shear behavior of reinforced concrete beams with circular cross-sections is different from beams with rectangular cross-sections. Most shear formulations designed for circular parts are based on rectangular sections. This study aims to obtain a scheme for testing the hollow circle elements without stirrups by simple structural analysis. There were two layouts analyzed before an experiment: Layout A is an element with one hole in the middle, and B is an element with two holes at the end of the element. This study was by trial and error structural analyzed. The elements had set up with two vertical loading points and two placement points with different positions. The result is the distance between loading and placement with an equal moment. The shear force in layout B is greater than the shear force in layout A.

1. Introduction
Structural elements such as columns, bridge pillars, and pile foundations are structural elements that play a major role in holding axial loads. However, as a result of lateral loads i.e. wind pressure, earthquakes or vehicle impacts that cause a large enough shear load. It is necessary to plan enough shear strength of a circular section structural element to prevent sudden shear failure.

According to Jensen et al [1], reinforced concrete elements with circular cross-section are very often used in civil engineering construction, for example as pile foundations, reinforced concrete structures, and bridge pillars. The circular cross-section allows structural elements to provide the same response to all directions of internal forces. The circle element is very popular for bridge pier designs, because of its simplicity of construction and its characteristics under wind and similar seismic loads in all directions. Hollow concrete is much less structurally used than solid cross-sections. However, this can be found in concrete chimneys, concrete pipes, and elevated water tanks, as well as in large bridge columns and offshore platforms [2].

Most of the research conducted to obtain shear and bending behavior of reinforced concrete beams is generally focused on rectangular cross-sections [3]. The shear behavior of reinforced concrete beams with circular cross-sections is different from beams with rectangular cross-sections. The shear capacity of elements with circular reinforced concrete structures has been studied by several previous researchers [4,5]. Shear behavior in perforated elements has also been examined [2,6–10].
Experimental studies of relatively few hollow columns, especially when compared to columns with solid cross sections. The accuracy of the existing regulations must also be tested for safety by validation using experimental studies. Most of the design formulations for circular cross sections especially those which are hollow in practice based on the shear design formulations for rectangular cross sections. Before making and testing elements on an experimental basis, it is necessary to plan the setup of the experimental layout. This is because there are few different references to the setup of a shear tested hollow circle element.

2. Research related to shear experimental
An experimental study of the flexural and shear with solid circular cross-sections [3,11]. The tested samples were two-point monotonic loads. It showed Figure 1.

![Figure 1. Schematic of test arrangement [3].](image)

Horowitz et al [10] evaluate the shear capacity of a hollow circle based on an experimental basis with a hollow rectangular element. In this study collected 79 test resulted in the setting up had shown in Figure 2. The test was two symmetrical shear forces and axial compressive forces by a hydraulic jack. The loading set up shown in Figure 2.

![Figure 2. Test set up [10].](image)

Lignola et al [12] conducted research to evaluate the performance of the seismic hollow pier that was constructed in accordance with a solid pier and measure the strength of the FRP layer. It was shown in Figure 3. The testing set up shown in Figure 3.

![Figure 3. Rectangular hollow cross section [12].](image)
Turmo et al [2] have proposed analytic models to calculate the capacity of solid and hollow cross-sections. This study used an experimental method on a circular element reinforce by shear reinforcement. It is shown in Figure 4.

Figure 4. Shear Crack pattern in (a) solid circular cross section and (b) hollow (c) circular cross section and test set up [2].

Myoungsu Shin et al [8] conducted an assessment model for concrete contribution to the shear strength of reinforced concrete (RC) rectangular hollow columns subjected to lateral loading. It shown in Figure 5.

Figure 5. Set up hollow column [8].

A hollow pier with semi-static cyclic loads [13]. Two variable parameters were the volumetric stirrup ratio and axial load level. It shown in Figure 6.

Figure 6. Details of the test specimen [13].
The seismic performance of circular hollow reinforced concrete columns [14]. Test results show that the transverse reinforcement effectively limits the concrete, increasing ductility, reducing damage to the surface area. The testing set up shown in Figure 7.

![Figure 7. Details of the test specimen [14].](image)

Priestley et al [15] experimented with hollow circular columns. Its variables were the ratio of longitudinal reinforcement. They were tested axial load and lateral cyclic load. Detail of the test specimen shown in Figure 8.

![Figure 8. Details of the test specimen [15].](image)

Ahmed et al [16] has conducted bending and shear experiments and compared the performance of circular beams with square beams. Schematic and experimental are shown in Figure 9.

![Figure 9. Schematic diagram and experimental [16].](image)

### 3. Methodology

Two layout were planned, before making an experiment and calculating the shear test on a hollow circle element without stirrups. A plan was made to determine the load and two support positions. The element was equipped with two loads and support points. Layout A used one hole located in the center of the element between two load points and B two holes located on the edge of the element between the load and the support point. These elements had the same cross-section, dimensions of length (L), diameter element (D), diameter hole (d), reinforcement ratio longitudinal, and load (P). In this study, a simple structure analysis is done by trial and error to get the same maximum moment value. The results obtained
are the position of the load point and the position of the support point. It also gets the value of the shear force. The layout planned element is shown in Figures 10 and 11.

![Figure 10. Layout A.](image10)

![Figure 11. Layout B.](image11)

### 4. Results and discussion

This study focuses on real contribution to the shear strength of a hollow beam by transversal load. For layout A, the length of the pipe is half of the span length beam, which is located in the middle of the span with the load points on the solid element. The maximum shear force value is equal to the minimum shear force of 1/3P. The shear force is evenly distributed along the element, both solid and hollow elements. The load position P remains in the center of the span, the load 2/3P at x=¼L and the load 1/3P at the cantilever end. In simple structural analysis, the maximum deflection that will occur is at the boundary of a hollow element with a solid that is under the load point 2/3P. It is shown in Figure 12.

![Figure 12. Scheme of layout A.](image12)

For layout B, the pipe length is more than half of the span length of 2/3L which is located on two sides of the span with the load points on a solid element. The maximum shear force value is equal to the minimum shear force that is 1/2P which occurs in the hollow element only. The load position P remains in the center of the span, the load 1/2P symmetrically located on a solid element. In simple structural analysis, the maximum deflection that will occur in the middle of the span, right in the position of a solid element. It is shown Figure 13.

From this analysis above, a larger shear value and a large deflection is in layout B. The length of the hollow element in layout B is longer than layout A. Layout B should be careful to install two separate pipes in one element.
5. Conclusion
There were two layouts in the shear element hollow testing up. Layout A has one hole with 1/2L in the middle element and layout B has two hole in the middle element with 1/3L each hole. From the simple analysis, a larger shear value and a large deflection are in layout B. The length of the hollow element in layout B is longer than layout A. Layout B should be careful to install two separate pipes in one element. It needs further research on experiments for validation.

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