CHAPTER 1. INTRODUCTION

1.1 Background

Research related to reinforced concrete is still being carried out. One of them is a study related to variations in the cross-sectional shape of reinforced concrete. Krisnamurti (2013) with his research on the effect of variations in the shape of the column cross-section on structural elements due to earthquake loads resulting in the circle column's capacity to receive axial loads being greater than square and rectangular columns.

Reinforced concrete with circular cross-sections is widely used in various constructions and is preferred over rectangular sections for instance as building columns, piles on foundations, and bridge pillars. Because of its cross-sectional shape, the circular cross-section was chosen. In terms of strength, circular reinforced concrete has strong characteristics in all directions under wind and earthquake loads (Ali, A. H., Mohamed, H. M., & Benmokrane, B., 2016). Besides, the effect of geometry on circular reinforced concrete columns indicates circular columns had more uniform internal stress distribution than square or rectangular columns due to stress concentrations at the corners of square and rectangular columns, causing stresses to occur unevenly across the entire surface of the concrete. Some attempt to round the corners to reduce stress concentration. (Hadi, M.N., Jameel, M.T. and Sheikh. M.N., 2017).

Hollow reinforced concrete is reinforced concrete with a channel of holes. The opening or hollow in the structure elements is becoming popular in modern building design and has been increasingly applied in construction (Nasr Z, etc.2018). As a result, the section is not solid, and the presence of a hole reduces the area and strength. This hole is typically made by joining pipes used to install electricity channels, rainwater or dirty water, pipelines, and so on. Creating a hollow section reduces the amount of material used in columns and reduces self-weight, resulting in a more efficient construction system (O.S. AlAjarmeh., etc. 2020). Another advantage is that the moment of inertia is greater than that of a solid cross-section of the same size, reducing the mass of inertia, saving materials during construction, and reducing problems associated with hydration from large-mass concrete, making it more cost-effective (Cassena, P., Ricci, P., & Verderame, G. M., 2017). **Figure 1.1.** shows the applied of hollow column in building.

Figure 1.1 Pipelines on Hollow Reinforced Concrete Column

The shear force in the building structure is caused by earthquake, wind, gravitational, and vehicle loads. Structural behavior that experiences shear collapse is very different from those that experience flexural collapse (Nawy, 1998). Shear collapse occurs suddenly and without warning, and it is brittle. So, the planning of a structure must ensure that there is no shear failure with design the shear capacity must be higher than the flexural capacity.

According to SNI -2847 - 2002 "the pipeline, along with its hooks, which are planted in the column must not occupy more than 4 percent of the cross-sectional area needed for strength or protection against fire". Hollow in circular reinforced concrete structure was once examined by previous researchers. Research on the shear strength of hollow circular reinforced sections (Cassese, Bonati, Risi, Verderrame & Cosenza, 2019) decreased shear capacity. This hole makes elements more critical and needs to be reviewed further to determine how much influence it has on shear capacity.

The shear strength of a circular cross-section is calculated using the Rectangular Cross Section Model (Equivalent Rectangular Section) based on ACI 318-19. This study produces the value of the shear strength of the hollow circular cross-section element in experimental compared to the existing standard. The shear capacity of hollow circular reinforced concrete is still a lot of focus of research because research related to holes in reinforced concrete has not been done much even though hollow reinforced concrete has been used widely.

Hollow columns behave significantly different than solid columns because of the lack of a concrete core. The use of holes reduces its cross-sectional area, making the elements more critical and influencing the structure's strength. However, when the proper design parameters ((i/o) ratio, fc', and ρ) are used, the capacity of a hollow column can be compared to or even greater than a solid column. To predict the physical and mechanical behavior of hollow circular reinforced concrete structures, research into the effect of the hole on shear capacity is required. Furthermore, providing holes in reinforced concrete structures is frequently neglected by planners who do not consider the effect of the hole.

1.2 Objective of the Research

In general, this research aims to find out the effect of the hole percentage on the shear capacity of the circular reinforced concrete structure. More detailed objectives of the research are as follows:

1. Comparing the shear capacity experimental results to the theoretical shear capacity formulation based on ACI-318 19
2. Determine the effect of the hole area on the shear capacity of the test object
3. Getting the effect of longitudinal reinforcement ratio on the shear capacity of the test object
4. Identify the crack pattern and failure mode that occur in the test object

The advantage of this research is to be taken into consideration the use of holes in reinforced concrete with circular cross-sections. The results of the research can also be used as a guide in making circular hollow reinforced concrete structures.

1.3 Scope and Limitation

The problems that are discussed in this study need to be limited. The limitation of this problem is needed so that the discussion is more focused and follows what is expected. The limitations of the problem in the study are as follows:

1. The research specimen is circular reinforced concrete structure without stirrups with 250 mm diameter and 2300 mm length. There are 12 test objects with group specifications as follows:
   - 3 specimens solid or without holes as specimens' control
   - 3 specimens with 1.5-inch diameter holes (2.32%)
   - 3 specimens with 2.5-inch diameter holes (6.45%)
   - 3 specimens with 3-inch diameter holes (9.3%)
2. Each specimen group contains eight pieces of longitudinal reinforcement with diameters of 13, 16, and 19 mm.
3. The use of holes in the specimen is only in the area under consideration, along the maximum shear span of 1000 mm.
4. The specimen is placed on a simple beam arrangement that is excessive on one side or overhang beam when testing
5. The loading of the test object is in the form of a lateral load which is concentrated load at two points distance of 1500 mm
6. The concrete quality is 40 MPa and 30 MPa
7. The behavior under review is the shear behavior of circular reinforced concrete structural elements
8. Theoretical shear capacity analysis of the specimen based on ACI 318-19 (Building Code Requirements for Structural Concrete)
9. The Reinforced Cross Section Analysis (RCCSA) computer program is used to analyze the reinforced concrete cross-sections.