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Evaluation the Structural Capacity of Hotel Mutiara I for into a Shopping Center

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ABSTRACT : Mutiara 1 Hotel in Yogyakarta was iconic heritage old buildings, which are planned to be change function as shopping centers, require comprehensive structural assessments to meet technical feasibility standards in support of building permit applications in Indonesia. The objective of this study is to evaluate the existing quality of concrete in structural elements—specifically beams, columns, and slabs—as a basis for structural calculations. The investigation employed both non-destructive testing (NDT) and destructive testing (DT), including Ultrasonic Pulse Velocity (UPV), rebound hammer tests, core drilling, and hardness testing. According to SNI 1727:2020, the design live load for hotel buildings is 4.79 kN/m², which increases to 6.00 kN/m² for shopping centers—a 125% increase. The average concrete strength obtained from all testing methods exceeded 25 MPa. In reference to SNI 2847:2019, public building structures must use concrete with a minimum compressive strength of 21 MPa and reinforcement steel with a yield strength of 360 MPa. Structural analysis results indicated that while most elements remain reliable, several require strengthening. Carbon Fiber Reinforced Polymer (CFRP)is recommended can increase axial capacity in columns by 139%, shear capacity in beams by 543%, and flexural capacity by 109% with one strip.

KEYWORDS: *Schmid Hammer; Ultrasonic Pulse Velocity; Core Drill Test, Compressive Strength*

I. INTRODUCTION

According to Government Regulation in Lieu of Law No. 2 of 2022 pertaining to Job Creation in Indonesia, all instances of constructing a new building or modifying the use of an existing structure must include the submission of a Building Approval (PBG) application. The Building Approval (PBG) is mandated as an essential legal requirement for both new projects and changes to existing building functions. [1] [2] . In detail, the application for PBG (formerly Building Construction Permit or IMB) and Certificate of Functional Suitability (SLF) has been regulated in Law 28 of 2002 concerning Buildings, PP 16 of 2021, Regulation of the Minister of Public Works and Public Works 19 of 2018 concerning IMB and SLF of Buildings through electronically integrated Business Licensing Services, and the Minister of Public Works and Public Works Number 27 of 2018 concerning Building SLF. The former Mutiara I Hotel building located on Jl. Malioboro, Yogyakarta, which has been an asset of the Yogyakarta Provincial Government since the Covid 19 period, is no longer operating and will be converted into an MSME Shopping Center as well as in the context of restructuring the relocation of traders in the Malioboro Area [3] [4] [5] [6] . The 4-story hotel, which was built in the 1970s, is one of the architectural icons whose façade is preserved [7] [8]. With the transfer of functions from hotels to shopping centers, the burden becomes greater so that to ensure the certainty of structural strength, a study and evaluation of structural laboratory tests must be carried out as the basis for input for the restructure calculation [9]. The building is old, but the DIY earthquake in 2006 with a magnitude of 7.1 when Richter is still visually good [10]. To ensure the technical condition is carried out by the method of non-destructive test and structural damage test to obtain valid parameters of a number of structural elements of columns, beams and reinforced concrete slabs [11] .

The problem of data supporting existing technical planning is only found working drawings, there is no information on concrete quality, steel quality and reinforced concrete specifications which are usually described in the contract support [12, 13]. Meanwhile, in the recalculation of structural planning due to changes in function that have an impact on the increase in loading, data on the compressive strength of concrete and the tensile strength of steel, steel arrangement patterns, and building vibrations are needed [14] [15] [16].

The purpose of the research is to analyze the quality of concrete and steel in concrete structures such as elements of blocks, columns and building plates that are more than 50 years old by the destructive test method and the non-destructive test method of the structure. The novelty of this study is an assessment of the structure of the old building 4 floors older than 50 years to be used from hotel functions to shopping centers with NDT and DT methods testing all structural elements of columns, beams and slabs so as to provide recommendations for the sustainability of the building.

In maintaining the strength of the existing building structure so that it continues to function for a longer period of time, a structural assessment is needed to assess and know the condition of the existing building structure to ensure whether the building is safe and not at risk [17] [18] [19]. If the existing technical data is not enough, then to find out the strength of the structure, a test must be carried out with a test method without damaging and or a test method with damaging the structure. Non-destructive test methods include Pulse Velocity Test, Covermeter and Scanning Rebar Test, Hammer Test, Vibration Test. Meanwhile, destructive testing (DT) includes the Coredrill Test and Brinell Hardness Test. The quality of the f'c concrete press and the tensile strength of the fy reinforcing steel are important data inputs in the calculation of restructure. Based on SNI 2847:2013, ACI 318-11, ACI 214.4R-10 and ACI 228.1R-03 on buildings to find out the quality of concrete is not always the same as the quality of cylindrical test strips, due to the influence of workmanship and other factors. The number of concrete test pieces has a great effect on the quality of the equivalent concrete, especially if the deviation of the data is large enough. The use of the Ultrasonic Concrete Tomography (UCT) Test can be used and gives better results than the Ultrasonic Pulse Velocity (UPV) Test, especially if the structure can only be accessed on one side [20]

II. LITERATURE REVIEW

2.1. Building Service Lifetime Estimation

The life of the building is reviewed from the functional, technological and economic aspects of the [21]. In building planning, this function is an important factor in the serviceability of the structure. Generally, the design *life* or *service life* of a building for residential buildings, offices, schools, hospitals, hotels according to ISO 15686-1 and SNI 03-1734-2000 is 50 years. The age of the building will affect the durability of the reinforced concrete structure which will reduce the quality of the room environment [22]. Factors that can change the age of a building include quality of design and material. environmental conditions (extreme weather, pollution). intensity of use. maintenance level [23].

2.2. Rechange Building Service Lifetime Estimation

Economic and environmental considerations are as light as making the historic iconic old building into a shopping or tourist center. [24] [25]. Based on SNI 1727:2020 concerning the Minimum Design Load for the live load of hotel fungi is 4.79 kN/m2, while the function of shopping centers or shops is 6.00 kN/m2. In addition, considering the location of the earthquake area, earthquake resilience planning for building structures is partly regulated in SNI 1726:2019. The increase in living load will affect the building safety factor which can be analyzed from the calculation of the structure.

2.3. Desturctive and Non-Destructive Testing

Structural property testing is carried out if there is no supporting planning archive data through destructive (DT) or non-destructive NDT testing), such as UPV testing, hammer testing, covermeter, coredrill, Brinell testing [26]. Some NDT methods research such as the Schmidt rebound hammer test are quite representative and effective for estimating the compressive strength of reinforced concrete such as studies conducted by [27] and [28]. DT with core drill will take concrete core samples can produce actual concrete pressure strength [29]. The results of the study estimate the strength of the concrete pressure of the NDT Scmidth hammer test method are generally greater than the DT core drill method which has an actual value [30] [31].

2.4. Structure Analysis

The restructure analysis was carried out to ensure the reliability of the building that meets technical and safety requirements [32]. Several National Indonesia (SNI) standards related to building structure analysis SNI 1726:2019: Earthquake Resilience Planning Procedures for Building and Non-Building Structures (adopting ASCE 7 and IBC). SNI 2847:2019 Structural Concrete Requirements for Buildings, SNI 1727:2020 Minimum Load for Building and Structure Design, SNI 7833:2012 Procedures for Evaluating the Performance of Existing Building Structures, SNI 7972:2013 Procedures for Strengthening Concrete Structures of Buildings. If there are structural elements that are at risk of being unsafe, then the option of reinforcing steel plate jacketing with shear connector and Carbon Fiber Reinforced Polymer (CRFP) reinforcement is carried out to qualify, where the cross-sectional capacity is greater than the accepted load [33].

III. METODE PENELITIAN

This research on the 4-storey Ex Hotel Mutiara is an old building built in 1970 on Malioboro Street, Yogyakarta. Because there is no archive of planning documents, the quality of concrete and the quality of reinforcement are unknown. The laboratory test targets the reinforced concrete structure elements of columns, beams and slabs of the 1st, 2nd, 3rd and 4th floors. The testing method is non-destructive testing through UPV Testing and Hammer Testing and the destructive testing method through coredrill testing.

Table 1. Types of Testing

Method	Type of Testing	Quantity (units)
Non-Destructive Test	UPV Pundit Test (Homogenity & Compression Strength Estimation)	20
	Hammer Test Live Digital (Homogenity & Compression Strength Estimation)	24
	Covermeter Test (Rebar Scan)	20
Destructive Test	Brinell/Hardeness Test (Steel Tensile Strength Estimation)	10
	Coredrill Test dan Actual Compressive Strength on Laboratoroium	14

The equipment and technical collection and laboratory testing were carried out in partnership with PT. Qies Nusantara Consultant, and actual testing of compressive strength at the Concrete Construction Laboratory of Tarumanegara University.

IV. RESULTS AND DISCUSSION

Performing a feasibility study on the functional adaptation of an old hotel—now functioning as a shopping centre—requires reassessment of the load-bearing capacity and structural integrity due to the change in use. Under Indonesian law, any building intended for conversion, renovation, or new construction must apply for a Building Approval (PBG) along with a Certificate of Functional Suitability (SLF), as delineated in Government Regulation Number 16 of 2021. The findings derived from both destructive and non-destructive tests have played an instrumental role in guiding the redesign process.

4.1. UPV Pundit Test Results.

Non-Destructive Testing with UPV Pundit in accordance with Code BS 1881: Part 203:1986 and ASTM C597-16 [34]. The Pulse Velocity measurement method is carried out in 3 ways, namely direct transmission, semi-direct transmission, and indirect/surface transmission depending on the surface condition of the construction element [35] [36]. The results of the test of 20 elements (column 9 units, beam 8 units and slab 3 units) obtained a concrete pulse velocity criterion of 3249.2 m/s which is in the category of medium concrete conditions (3000 - 3500 m/s). This condition if associated with the quality of compressive strength of concrete is included in the normal category. For concrete quality according to the formula based on ASTM C597 – 16, the average quality of column concrete is 28.15 MPa, beam concrete is 25.11 MPa, slab concrete is 25.60 MPa. In SNI-2847-2019, in the planning of public building structures, the quality of concrete compressive strength is required to be at least 21 MPa. Based on the Guidebook on Non-destructive testing of concrete structures, Ch.11.1.4.4 based on ASTM C215 Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens converts Indirect factor to direct factor by increasing the velocity result by 5% - 30%. In this case, an indirect factor value of 10% was taken.

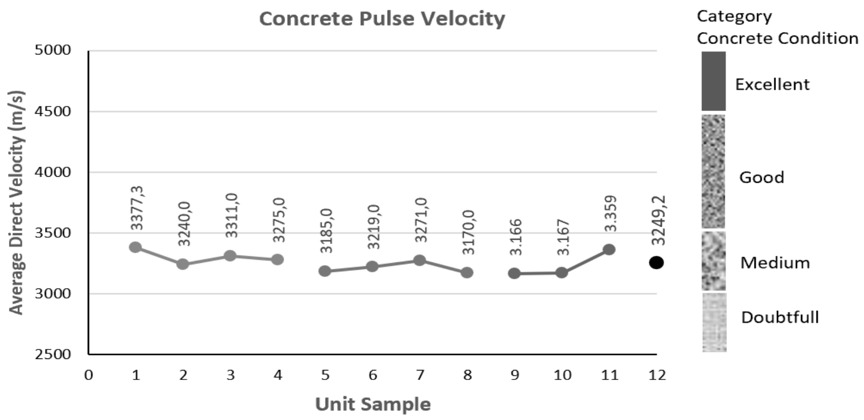

Figure 1 . Pulse Velocity Values and Concrete Criteria

4.2. Schmidt Hammer Test Results.

Non destructive testing with Schmidt hammer test to determine the homogeneity of concrete surface quality based on BS 1881 Part 202:1986 and ASTM G80S-89. Test method by applying impact loads (impacts) on concrete surfaces. The bounce distance arising from the mass at the time of collision with the concrete surface of the test specimen can give an indication of hardness also after calibration. Schmidt Hammer tests were carried out on 24 elements (column 11 units, beam 10 units, and slab 3 units) with an average result of 30.38 MPa. For the average quality of column concrete is 28.00 MPa, beam concrete is 31.93 MPa, slab concrete is 31.20 MPa. As per SNI-2847-2019, the minimum requirement of compressive strength of concrete is 21 MPa for Structural Concrete Requirements for Buildings.

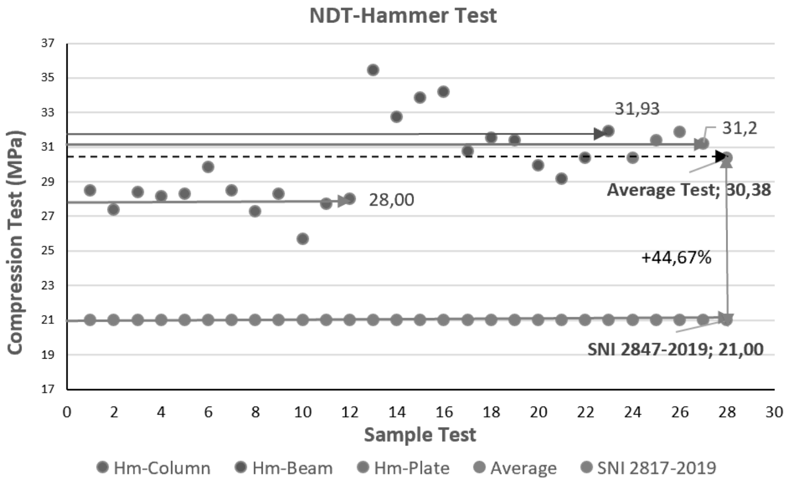

Fig. 2. Hammer Test Result.

4.3. Covermeter and Scanning Rebar Test Results.

To determine the position and arrangement of reinforcement in existing concrete structures, covermeter and scanning rebar testing is used. The result was for main column structure with cross section 400x600 mm had 10D19 mm main reinforcement (plain) and tie D8 plain 150-200 mm spacing, 15-48 mm concrete cover. Beams 300x570 mm, plain main reinforcement, 14D22 mm plain main reinforcement, tie D8 spacing 130-200 mm, concrete cover 25 mm. Slab with thickness 1500 mm had plain reinforcement as-X steel D8 spacing 100-160 mm, as-Y D8 spacing 100-160 mm concrete cover 40 mm. The results of the covermeter test above show that the reinforcement used for both the main reinforcement and the stinging reinforcement is using plain reinforcement, then if it is associated with the regulation when it does not in accordance with SNI 2847-2019 article 20.2.1.1 it is not allowed to use plain reinforcement for the main reinforcement or the stinging reinforcement. Similarly, the thickness of the concrete cover on several columns, beams and plates does not in accordance with SNI 2847-2019 article 20.6.1.3.1, which is 40 mm for the structure of the beam, column and 20 mm for the slab structure.

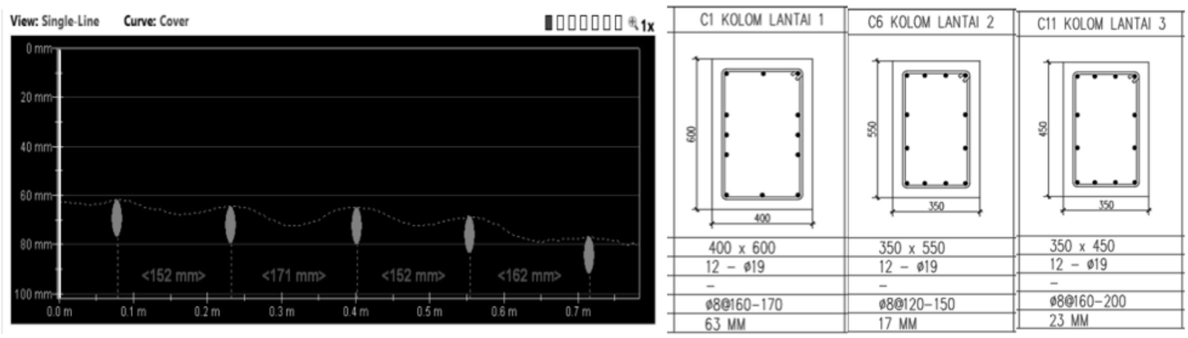

Fig. 3. Covermeter and Scaning Rebar Test (Example)

4.4. Core Drill Test Result.

Core drill testing or also called core concrete drilling is the testing of cylindrical concrete test pieces from drilling on building structures that have been implemented. A common way to measure the strength of concrete in the actual structure is by cutting the concrete with a rotating round drill. The sample taken (cylindrical shape) is then taken to the laboratory for compressive strength testing. The standard used in this test is ASTM C 42, SNI-1974-2011 Concrete Core Compressive Strength Test Method Drilling Concrete cylinders are obtained depending on the size of the drill bit diameter, generally between 50 mm to 150 mm. The results of the Core drill Testing on 8 structural elements were obtained from the core drill with a size of D = 45 mm L = 90 mm obtained with an average compressive strength estimation of column concrete of 25.58 MPa, beam 34.61 MPa, and slab 35.89 MPa. For the evaluation of the calculation of the structure of the weed, a strong pressure value of concrete fc' 25 MPa was taken. From the results of compressive strength testing is accordance with SNI-2847-2019 regulation as the standard for the minimum structural quality concrete compressive strength requirements of 21 MPa.

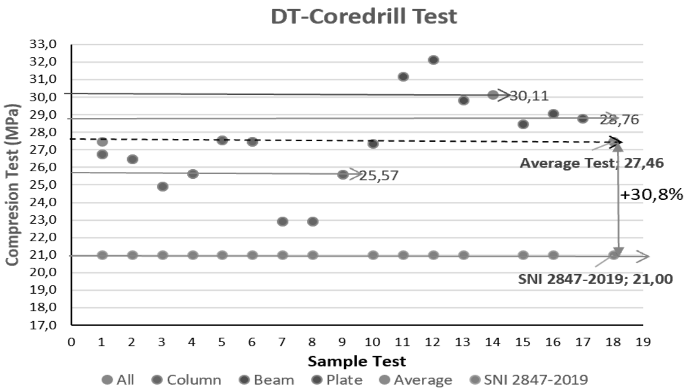

Fig. 4. Core Drill Test Result

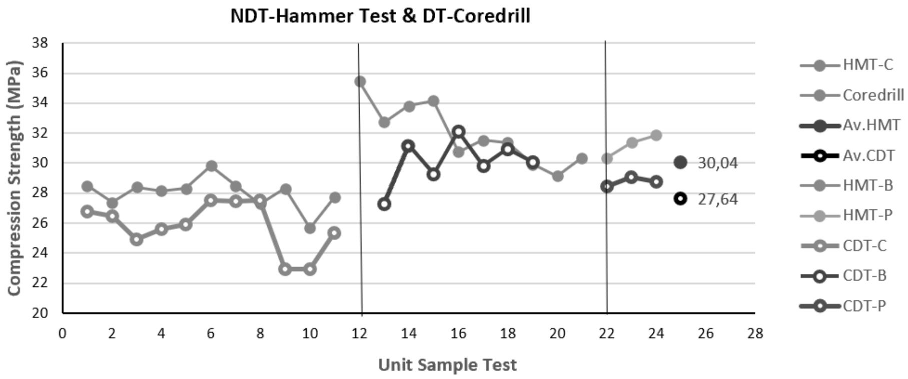

Fig. 5. Comparasion Core Drill and Hammer Test Result

4.5. Brinell Hardness Test Results

Tensile strength testing of the reused steel was not conducted in the laboratory due to building conditions, as sample cutting was not feasible, so only by the Brinell Hardness testing method. Examination of existing steel reinforcement is carried out by the method of dismantling part of the column until the reinforcement is visible and then testing is carried out [37]. The results of the examination in the form of Brinell unit hardness (HB) values were then correlated with the ultimate tensile strength value in accordance with ASTM E140-Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness. The results of steel testing by means of hardness test at 8 points have obtained an average tensile strength of plain rebar fy 363 MPa. The maximum tensile strength result is fy 385 MPa with a minimum value of 360 MPa. This value is accordance with the minimum requirements for building structures based on SNI 2052-2017, which is 350 MPa. In the current regulations for the structure of Building, non-plain finned reinforcement must be used, while the existing reinforcement of Building is deform type. This regulation cannot be used as a standard guideline because in the era of the building around 1970 there was no need for finned reinforcement.

Table 5 . Hardness Test Results

No	Code	Location		Tensile Strength	SNI 2052-2017	According to standards
		D (mm)	As	MPa	MPa	
1	CF1-01	19	G/3	385,0	350	OK
2	CF1-02	8	G/3	370,0	350	OK
3	BF2-03	22	G/3-4	370,0	350	OK
4	BF2-04	8	G/3-4	350,0	350	OK
5	BF2-05	22	F-G/3	360,0	350	OK
6	BF2-06	8	F-G/3	350,0	350	OK
7	PF2-07	8	G-H/3-4	360,0	350	OK
8	PF2-08	8	G-H/3-4	360,0	350	OK
Average				**363,1**	**350,00**	**OK**

4.6. Restructure Design Analysis Results

Based on the test results, the structural redesign analysis used a concrete compressive strength fc' 25 MPa and a steel yield strength fy 360 MPa. In accordance with SNI 1727:2020 on Building Loads, the live load increased from 4.79 kN/m²—applicable for hotel use—to 6.00 kN/m² for commercial or shopping center functions, representing a 125% increase [38]. Structural analysis indicated that several elements required strengthening, with Carbon Fiber Reinforced Polymer (CFRP) identified as a recommended reinforcement method. Application of one strip of MAPEI-type CFRP was found to enhance axial load capacity in columns by 139%, increase shear strength in beams by 543%, and improve flexural capacity by 109%. These findings have been implemented by the building owner to optimize the continued use of the structure, thereby supporting improved utility and contributing to the local economic sector.

V. CONCLUSION

Converting hotel structures older than 50 years into shopping centers leads to an increase in live load of 125%, thereby requiring a full-scale structural reassessment in accordance with Indonesia's building permit requirements. Destructive and non-destructive tests indicate that both the concrete and steel of the current structure achieve the basic structural strength needed. For the purpose of reconstruction analysis, the study adopted design values of fc' 25 MPa for concrete and fy 360 MPa for reinforcement. The overall structural analysis confirmed that about 90% of the elements exhibit satisfactory reliability; however, certain components were flagged for potential upgrade through the use of Carbon Fiber Reinforced Polymer (CFRP). Specifically, calculations based on MAPEI-type CFRP suggest that applying a single strip can improve axial load capacity by 139%, beam shear strength by 543%, and flexural capacity by 109%.

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