RENOVATION OF THE PURI ADHIMELATI OFFICE BUILDING AND FACILITIES (EXIM MELATI)

BY DAVID WHITE, HARI M. SANTOSA, AND HARTONO HIOE

The growing economy of Indonesia has generated a rapidly increasing demand for new office space, especially in the capital city of Jakarta. The Puri Adhimelati office building is a 20-year-old structure that was considered to be architecturally inconsistent with the surrounding office buildings (Fig 1.). It is located in the Thamrin Nine complex that is situated in the central business district. While renovating some of the interior space in the building, the owner decided to modernize the building by making changes to the architectural design of the structure (Fig. 2).

The city of Jakarta is located in an earthquake zone and the building was built in accordance with an older standard of seismic design. At the time of the architectural renovation, the building owner requested that the designer reevaluate the building's structure based on the current standards for seismic design.

The structural evaluation concluded that the beam and column elements required a seismic strengthening plan to bring the building into compliance with the current building code. To upgrade the existing beams and columns, the engineer selected carbon fiber-reinforced polymers (CFRPs). This material was chosen because it could provide the desired structural strength capabilities without adding significant weight to the structure. This material also allowed for flexibility during construction and was easy to apply. The project ended up being the largest CFRP strengthening project ever undertaken in Indonesia.

STRUCTURAL CHARACTERISTICS

The building has 13 floors and a basement and has a footprint of approximately 100,000 ft^2 (9300 m^2). The existing building was designed using a reinforced concrete frame structure with a specified minimum concrete compressive strength of 3600 psi (25 MPa). The structure is supported by 14 columns total, with 12 columns having dimensions of 39.5 x 39.5 in. (1000 x 1000 mm) and two columns with dimensions of 25.5 x 25.5 in. (650 x 650 mm). Beams on the main portal have various dimensions, including 16 x 32 in. (400 x 800 mm), 18 x 32 in. (450 x 800 mm), and 18 x 33 in. (450 x 850 mm), while the floor slab has a thickness of 5 in. (120 mm).

Fig. 1: Before renovation

Fig. 2: After renovation

EVALUATION OF THE STRUCTURE

Reevaluation of the building structure kept the floor plan of the original building design and used a live load of 50 lb/ft^2 (250 kg/m^2) for the anticipated load from the new offices. The seismic loads were based on the new standards of seismic design that revised the earthquake zone to one category level higher than the previous standard.

The structural evaluation modeled the building with a combined loading and a summary of the results reveals different actions that needed to be performed to strengthen the various components.

- **Foundation:** The capacity of the foundation still met the criteria of loading, so it did not need to be strengthened.
- **Columns:** The strengthening of columns was necessary on the basement floor and ground floor. A total of 18 columns were upgraded in confinement using CFRP wrap (Fig. 3).
- **Beams:** Shear capacity in almost every beam (approximately 231 beams) did not fulfill the loading criteria, so shear strengthening with carbon wrap was necessary. The CFRP wrap was applied from one to three layers onto three sides of the beam for a U-wrap application (Fig. 4). In addition, flexural strengthening was done on six beams located on the ground floor using carbon plates (Fig. 5).
- **Slab:** Slab capacity still met the loading criteria, so it did not need to be strengthened.

Fig. 3: Columns strengthened with carbon wrap

SELECTION OF STRENGTHENING MATERIALS

Carbon wrap and carbon plate were selected as the strengthening materials for the project because these materials have high tensile capacity, are lightweight, and the application of the materials required minimal access. The limited access needed for applying the strengthening materials minimized demolition of the existing walls. In addition, the use of these materials allowed for occupation of the building while it was being repaired.

STRENGTHENING PROCESSES

SHEAR AND CONFINEMENT STRENGTHENING APPLICATION

The existing concrete surfaces were prepared by diamond-grinding the surfaces and rounding the corners to a minimum radius of 0.6 in. (15 mm). Epoxy adhesive was then brushed onto the prepared substrate and carbon wrap was placed in the

Fig. 4: Reinforcement of beam with CFRP

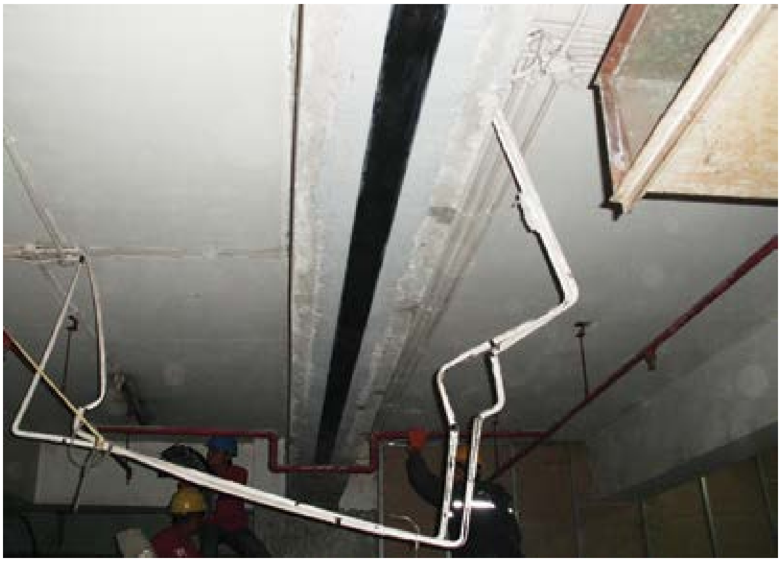

Fig. 5: Reinforcement of beam with carbon plate

required direction (Fig. 6) onto the epoxy adhesive and then pressed with a plastic impregnation roller. The carbon wrap was rolled parallel to the fiber direction until the resin was squeezed out and distributed evenly over the entire wrap surface. For additional layers of carbon wrap, epoxy adhesive was applied onto the previously placed layer (Fig. 7) and the wrap application procedure was repeated.

FLEXURAL STRENGTHENING APPLICATION

The concrete surfaces were prepared by hand with a chisel and epoxy adhesive was then applied onto the cleaned carbon plate and prepared concrete substrate with a special "dome"-shaped spatula. The carbon plate was then placed onto the prepared substrate with both epoxy layers facing each other and the plate was pressed into place with a rubber roller until the epoxy was forced out on both sides of the plate; the excess adhesive was then removed.

Fig. 6: CFRP being placed on adhesive

Fig. 7: Application of adhesive to previous CFRP layer

UNFORESEEN SITE CONDITIONS

- Poorly consolidated concrete with voids was found at the corner of one column, which was not anticipated (Fig. 8). The column was repaired prior to the strengthening operation by using the form-and-pour method with nonshrink cementitious repair materials (Fig. 9).
- After surface preparation of beam members, numerous small air bubble voids were found. They were repaired by using an epoxy patching adhesive prior to strengthening (Fig. 10).
- Existing walls underneath beams around the elevator core wall and at external locations could not be removed. In these cases, the carbon wrap was not able to be applied onto the three sides of the beams to achieve a U-wrap (Fig. 11). After the engineer reevaluated the loads in accordance

Fig. 8: Poorly consolidated concrete found on column

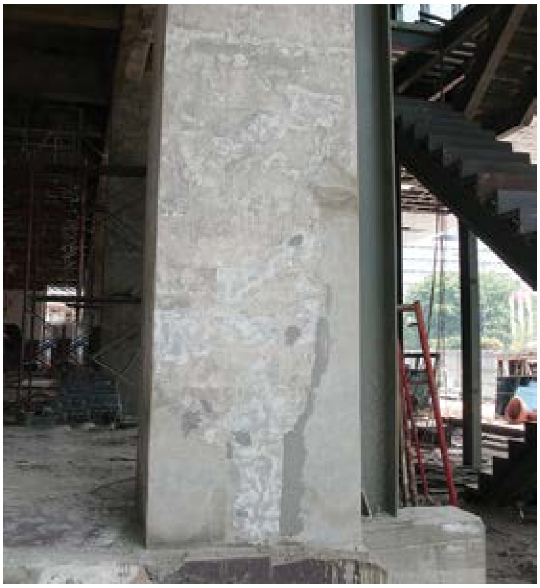

Fig. 9: Patched column section

with ACI 440.2R, a two-sided application was found to have enough strength to handle the expected shear loads.

CARBON PRODUCTS ENABLE SUCCESS OF PROJECT

This project is currently the largest CFRP strengthening project ever implemented in Indonesia for this type of building. There was a total volume of 24,560 ft^2 (2319 m^2) of carbon wrap and 112 ft (34 m) of carbon plate used for this project.

The project successfully strengthened existing building elements with minimal demolition needed to apply the strengthening materials (Fig. 12).

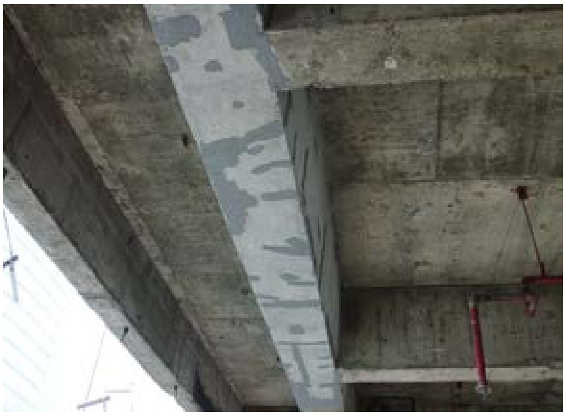

Fig. 10: Patched air voids on beam

Fig. 11: Beam strengthened without removing wall

Fig. 12: CFRP installed around existing obstacles

Because of the lightweight and high-strength capacity of the carbon wrap and carbon plate, the strengthening materials did not affect the loading of the building. In addition, the inability to remove the existing walls at specific locations was solved by the two-sided application of the carbon wrap solved.

Strengthening by using carbon wrap and carbon plate for this project was an efficient choice that fulfilled the desired expectations.

__David White,__ PE, is the Technical Director for Sika Corporation in Lyndhurst, NJ. He has over 25 years of experience in the engineering and construction industries and holds a BS degree in civil engineering from Columbia University and an MS degree in civil engineering from Polytechnic University (now NYU-Poly). He is a licensed professional engineer in New York, New Jersey, and Florida, and active in many professional associations, including the American Concrete Institute (ACI), ICRI, the American Segmental Bridge Institute (ASBI), and the American Society of Civil Engineers (ASCE). White is a member of ACI Committees 440, Fiber-Reinforced Polymer Reinforcement, and 548, Polymers and Adhesives for Concrete.

__Hari M. Santosa__ is a Managing Director at Conspec Pertama Indonesia (specialist contractor for refurbishment and strengthening projects) established in 2001. Before his time with Conspec Pertama, he worked for Sika Indonesia as a Market Field Manager for Concrete Repair and Strengthening from 1991 to 2000. He received his degree in civil engineering from Petra Christian University, Surabaya, Indonesia, in 1986. During his career, he has been involved with rehabilitation on numerous projects that needed to be repaired and strengthened, and he has also assisted the structural consultant with investigation, evaluation, and design.

__Hartono Hioe__ is a Business Unit Manager Contractor at Sika Indonesia and has been working for Sika since 1989. He received his degree in civil engineering from Petra Christian University in 1989. During the last 18 years, he has been involved in numerous investigations, evaluations, and design of refurbishments, incorporating the use of strengthening materials for deteriorated structures, and is a speaker at many refurbishment and strengthening seminars.