Location	**Suva, Fiji**
Client	**China Railway First Group on behalf of Fijian Holdings Limited**
Project Type	**Full Design Consultancy Services & ESD**
Year Completed	**2022 (programed)**
Project Value	**$67 M (FJD)**
Total Area	**18650m^2**
Height	**65m**

FHL COMMERCIAL TOWER

PROJECT DESCRIPTION

The FHL Commercial Tower is an 18 Storey high rise "Green Building" situated in the middle of the Suva Business District. This iconic addition to the city of Suva consists of commercial space, offices and recreational functions hall at top storey.

Ecologically Sustainable Development (ESD) seeks to create buildings that lessen the environmental impacts of the built environment, that save money, and that result in healthier environments in which to live, work and learn. Achieving this relies on the whole life cycle of a building – its design, construction, commissioning, operation and eventual deconstruction – being considered from the earliest project stages.

Buildings that embrace this approach are often called 'Green Buildings'. The design of a green building involves selecting the most appropriate of these ESD initiatives as well as others that may arise, to create a cost effective, high performance, healthy building.

The design intent for the Fijian Holding LTD (FHL) Tower project is to make this a green building that demonstrates good practice in sustainable design principles and meets several key environmental objectives which would reduce the overall life impact of the building on the environment. This includes reduction in overall carbon emissions and environmental impact, siting and structure design efficiency, energy efficiency, water efficiency, material efficiency and waste reduction.

The following engineering services highlights covers important green initiatives and environmentally sustainable designs to achieve the goals of a green building. The mechanical services design includes high indoor air quality, air tightness of building envelope, energy efficient controls and monitoring including building wide Building Management System (BMS) to monitor full controls and operations of the entire HVAC, lifts, electrical, lighting, power, hydraulics and fire system.

Moreover, the Hydraulic services has focused on the water efficiency methods to make this building more efficient and sustainable including water consumption monitoring and control. Fire engineering services considers both wet fire and dry fire systems including sustainable selection of materials, effective spatial management of assets, energy efficient modes of operation and water management. This is further achieved using fire hydrant system and water sprinklers combined within a common well engineered risers.

Electrical engineering services reduces energy consumption by balancing day lighting and energy efficient sensor lightings in designs. Also, all the electrical power will be monitored via the power energy meter and the BMS controls.

Compliance with Section J of the BCA (NCC 2019)

In additional to ESD initiatives built within the design elements the building also had a mandatory minimum compliance with Australia's National Construction Code Section J which requires minimum levels of energy efficiency to be achieved for non-residential buildings. This includes:

- Building Sealing
- Air-conditioning and ventilation performance
- Artificial lighting and power performance
- Building Fabric – Efficient thermal, roof and ceiling construction, roof lights, walls and floor, glazing, shading factors and treatments
- Heater water supply
- Facilities for energy monitoring

OUR ROLE

Kramer Ausenco (Fiji) Pte Ltd role on this project was the primary building services consultant and civil engineering. Kramer Ausenco was also engaged to provide environmentally sustainable engineering services through Green Star Accredited Professional for the entire project including as built design, construction, waste management, end user engagement and reporting.

Our role was a traditional consultancy service from design through tender, construction and handover scheduled in 2022.

GREEN INITIATIVE

The building incorporates a range of initiative to reduce energy demand and to manage energy usage in an efficient manner. Identifying areas of energy consumption is the first step to understanding where we can improve efficiency and make savings. A simple list is provided below for the building's energy monitoring and reduction strategies.

- Life Cycle Impacts – The project has undertaken a whole of building, whole of life comparative LCA with reference cases to demonstrate best for life material, plant and equipment selections
- Reduced mass of steel framing – 5% reduction when compared to a reference building
- Reduced use of steel reinforcement
- Sustainable products and product transparency
- Reduction of construction and Demolition Waste

COMMITMENT TO SUSTAINABILITY

Kramer Ausenco was fully committed to working with the design team and builder to make this a innovative green building for Fiji with our strong design emphasis on:

- Reduced operational costs associated with building and facilities;
- Reduces the environmental impacts of construction, refurbishing and operating buildings;
- Improved energy and water efficiency of building and facilities;
- Provides a healthy indoor environment inside buildings;
- Design suitable for region's current and future climate;
- Reduces reliance on non-renewable grid electricity;
- Green buildings produce fewer greenhouse gas emissions than an average building;
- Green buildings produce fewer greenhouse gas emissions than if they had been built to meet minimum industry requirements;
- Green buildings use less electricity than an average building or if they had been built to meet minimum industry requirements; and
- Demonstrates leadership to the community by adopting and promoting sustainable building.

Figure 1 - Green Building Initiatives

WASTE MANAGEMENT

Kramer Ausenco was heavily involved in the development and monitoring of a Construction and Operational Waste Management Plan for the project with a focus on waste avoidance through the "Prescriptive Plan" that outlines specific best practice requirements can be applied to promote sustainability in building design, construction and operation stages. As an initiative to manage waste for FHL Tower the following waste stream components has been collected at site;

- Sludge of a mixture of water and mud resulting from the watering of pile driving pits to facilitate the placing or driving of a pile by means of hydraulic displacement of parts of the soil.
- Off-cuts from steel beams that have been trimmed to appropriate sizes for instalments to building foundation works

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- Off-cuts from construction timber materials
- Other construction waste materials
- Waste timber materials dismantled from end of construction works
- Surplus excavated soil material

ENERGY MONITORING SYSTEM

All power and water meters are linked to the Building Management System (BMS) for ease of monitoring and collection of data. The BMS is used to provide a means to centrally monitor energy and also control the designated equipment installed on the site. Training and full documentation of the BMS interface is provided as part of the commissioning of this building. In addition, there are separate meters per tenant area per floor that allows tenants to monitor their lighting, power and air conditioning energy use separately. The building will be an education tool promoting energy efficiency and water savings. Monitors will be provided in the foyer displaying the buildings energy and water usage.

Figure 2 Monitor displaying the buildings energy and water usage

WATER REDUCTION STRATEGIES

The building incorporates a range of initiative to reduce water demand and to use water in an efficient manner. The project utilises high efficiency fixtures and fittings. Toilets shall be flushed with harvested rainwater. All rainwater from the building roof is harvested, filtered and then reused as non-portable water for the building. This strategy ensures reduced mains water consumption. Numerous water saving fixtures initiatives have been built into the project including: Wash basin taps, water closet, shower and sink.

Water Monitoring System - Main bulk water meter, potable water make-up, non-potable for treated rainwater and tenancies water meter shall have pulse output such that water consumption rate can be read from the centralised BMS system. This will allow the user to read water usage remotely.

INDOOR AIR ENVIRONMENT QUALITY

In an office environment people spend majority of their time indoors therefore providing a healthy and safe indoor environment is an important aspect of the design of this building. Initiatives incorporated in the building to reduce and avoid exposure to Volatile organic compounds VOCs, formaldehyde and other indoor pollutants.

CO2 sensors are installed in occupied spaces to monitor CO2 levels and to communicate with the Air Handling Units and Ventilation System control through BMS for the supply of high filtration efficiency fresh outdoor air into the building.

MECHANICAL SYSTEM DESIGN

The air conditioning system selected and designed for the project includes an air-cooled chilled water (ACCH) system. A life cycle cost analysis was carried out during the concept stage of the project to select the most suitable system for this project. An ACCH system promised to be ideal system for this application due to the large magnitude of cooling required and based on the usage of the conditioned spaces. The overall life of a chilled water system is more compared to any other type of system at high efficiencies for reduced operational cosy during project life.

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MECHANICAL SYSTEM DESIGN

The final selected air conditioning system has been arranged to minimise operational energy input. Typical spaces with extended operating hours and spaces located in the building which will experience similar cooling requirements are grouped/zoned on common fan coil unit or provided with dedicated systems.

- Building Management System:
  The building has Building Management System (BMS) that fully controls and monitor the operation of the HVAC system enhancing energy efficient operation. This enables the system to run in Auto Mode based on timer schedule and the cooling demand from the building. It also has the manual override mode to run the system on manual when the need arises such as during maintenance. Equipment run hours are monitored live and change sequence of operation will be automatically executed through pre-set programs and conditions.

Figure 3 Project ACCH Chillers in Manufacturing Facility

- Air distribution system:
  The air-conditioning and air distribution system for office spaces is served via a variable air volume (VAV) system incorporating electronic VAV diffuser and room thermostats. The system will incorporate pressure sensors in its air distributive system to assist in economical operation of the pre-conditioner unit. The VAV is monitored and controlled by BMS. This is part of the ESD initiative.
- Indoor air quality management system:
  The proposed mechanical systems are designed to achieve high quality indoor air environment. This is achieved by providing fresh air from outside environment to the occupied spaces which reduces existing volatile organic compounds and other indoor pollutants from indoor air. This outdoor air is handled, by a dedicated outdoor air preconditioning air handing unit located on top floor of the building.

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MECHANICAL SYSTEM DESIGN CONT….

- Preconditioning AHU consists of high efficiency air filter, cooling coil and heat recovery wheel to treat outdoor air before it is being delivered indoors. The heat recovery wheel is one of the key components as it reduces overall energy required to pre-condition the outdoor air by recovering low temperature heat coming from building ablution exhaust air and utilizing recovered heat to pre-cool the outdoor air before the air enters cooling coils.

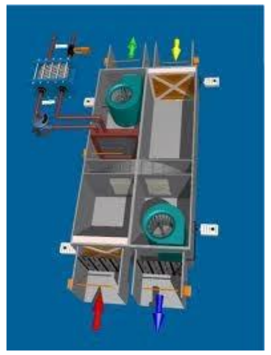

Figure 5 Pre-conditioning Air Handling Unit (AHU)

- Air cooled chillers and Pumps:
  There are four (4) Air Cooled Chillers that will be operating on lead/lag mode during start up and shutting down according to the cooling demand and schedule of operating hours. The Chillers provides total cooling capacity of 2770kW. Primary and secondary pumps are provided to distribute this chilled water to air conditioning equipment of the building.
- Fire safety provisions:
  The mechanical services of the building also has provisions of fire safety. This consist of smoke exhaust and zone pressurization system. The smoke exhaust system is designed to remove smoke in fire from the fire affected floors. The zone pressurization system will work to pressurize all other non-fire affected floors to minimize infiltration of smoke to non-fire affected floors.
- Car Park ventilation:
  Basement floor car park has been provided with mechanical ventilation. This includes high speed Jet fans for make-up and ducted exhaust air system. The CO_2 sensors are provided to monitor floor air quality, the ventilation system of car park only operates when the CO_2 levels exceeds prescribed levels to removes exhaust air and replenishes with outdoor air.
- Air tightness testing:
  Specialized testing for building air tightness is specified for this project in which building envelope will be tested to quantify the air tightness quality of the construction and to measure air leakage rates through building envelope.
  This testing and certification are facilitated by specialized building air tightness professionals. This process is specialized and includes specific compliance requirements to ensure highest air quality and tightness standards are achieved.
  Benefits of building air tightness testing:
  - Detecting air leakage and rectifying building construction cracks eventually significantly lowering energy loss due to air leakage from building construction
  - Potentially harmful CO_2 emissions are reduced, significantly increasing indoor air environment quality
  - Achieving compliance to building regulations

MECHANICAL ENGINEERING SERVICES – ESD

Designs consider the reduction in greenhouse gas emissions from its activities through greater energy efficiency in the use of buildings on the site. Consideration has been given to areas where energy savings can be achieved through conserving heat and power used for air conditioning and ventilation by measures which include, but are not limited to:

- Use of natural ventilation by maximum utilization of prevailing winds for temperature control and ventilation of carpark spaces (levels 3 & 4);
- Use of heat exchangers in preconditioning AHU for free cooling;
- Using high quality and efficient insulation materials, vapour barriers and weatherproof seals;
- Using energy efficient air conditioning systems with high COP values as per AHRI test procedures;
- Smart / Automated air temperature maintaining sequences on air conditioning units;
- Use of high efficiency EC fans in all air conditioners
- Use of building energy management systems were considered cost effective;
- Use of carbon dioxide sensors for demand control ventilation of office space for varying outdoor air intake.
- Use of environmentally friendly pipework and duct work material e.g., HDPE pipework instead of PVC and copper.
- Refrigerants used for air-conditioning system(s) shall have a zero ozone-depletion potential (ODP),
- Estimated atmospheric life (EAL) and a low total equivalent warming impact (TEWI).
- Efficient Glazing has been incorporated with low heat transfer co-efficient (U-Values).

Figure 6 Double Glazing

HYDRAULICS SYSTEM DESIGN

- As part of the Environment Sustainable Design (ESD) and green building initiative, rainwater harvesting and re-use has been used. Rainwater will be captured from the roof level and stored in the basement level. Capturing rainwater from roof to be used for flushing of water closets / urinals and irrigation, thus reducing water usage from mains supply. To allow for redundancy, mains water supply will act as a by-pass to the system and will top-up the rainwater tank in an event of low rain. Rainwater will then be filtered and with the help of the booster pump, will be provided to all non-potable fixtures.

Figure 7 Braithwaite Pressed Steel Tanks

- Incorporating water efficient fixtures in the building; e.g., WELS rating fixtures. The use of flow-controlled tap ware, shower heads, water closet and urinal to conserve water usage. Please refer to Table 1.
- Using pipe work that are environment friendly; e.g., HDPE or PVC-U pipes.
- Separate pipeline for potable and non-potable water supply system. Potable water supplying hand basin, shower and sink. Non-potable water supplying water closet, urinals and hose tap.
- Both the rainwater pump and water booster pumps will be linked to a control panel. The control panels will be connected to the BMS for fault monitoring. Pump control panels will have a dry running protection connected to the float switch inside the water tanks located in the same level.
- Water tanks will have Hi/Lo level signals connected to a notification panel. From the panel, the signals will be connected to the BMS to enable the user to know the water level in the tanks.
- To maintain water quality, water from storage tanks have appropriately filtered via water filters (coarse and fine filters), chlorine dosing and UV-Filters.
- Minimizing the use of water location. All external location hose tap will be provided with lockable gate valve to control water usage.
- Monitoring system will be capable of capturing and processing from water meters;

HYDRAULIC ENGINEERING SERVICES - ESD

- The use of flow-controlled tap ware and shower heads to conserve water usage in consultation with architect.
- Energy efficient water pumps; the two pump sets for potable and non- potable water supply system consist of duplex pumps configuration.

Figure 8 Energy Efficient Water Pumps

- Select long life equipment with greater manufacturer's warranty;
- Use temperature controllable hot water heaters to control water temperature requirements, e.g., showering;
- Using pipework that are environment friendly; e.g., HDPE;
- Integration of pipe work with other services and minimize route lengths and space where possible;
- Capturing rainwater from roof to be used for flushing and irrigation, thus reducing water usage from mains supply;
- Incorporating water efficient fixtures in the building; e.g., WELS rating fixtures

FIRE SYSTEM DESIGN

- For cost effective solution, the fire hydrant system and sprinkler system are combined together with a common riser. As a primary supply of fire services, wet type sprinkler system is provided for each level with its performance based on the hazard type i.e. Light hazard for office areas, Ordinary hazard 2 for car park areas and ordinary hazard 3 for retail areas. The sprinkler system will consist of sprinkler control assembly in a lockable cabinet located in the fire stairs for each level. The sprinkler system is divided into two zones which will be supplied by separate pump sets. Fire hydrant, fire hose reel and extinguishers are also provided.
- For secondary supply, a standard booster cabinet and wet feeder assembly are provided to ensure supply to the local fire authority on-board fire water pumping appliance. There will be water by-pass from city mains supply to the fire brigade booster assembly and additional boost will be provided by relay electric pump for the high-rise zone.

Figure 9 Fire Brigade Booster

- The two pump sets for sprinkler system consist of duty and standby configuration of which one will be electric and the other being diesel. An electric jockey pump will also be provided for the system for pressure maintenance. Fire hose reel pump is also provided. As a back-up for fire brigade booster assembly, fire relay pumps are provided to boost the water from 18 storey building.

FIRE ENGINEERING SERVICES - ESD

- As part of the ESD and green building initiative re-using of fire testing water is provided. All the fire test pipe shall be provided back to the water storage tanks.
- Fire services test water will be re-used and directed to the water storage tanks.

FIRE ENGINEERING SERVICES - ESD

- Reduce the use of PVC sheathed cables.
- Limit the use of ionization smoke detectors and use alternative photoelectric types.
- Facilities to capture test water and re-use

ELECTRICAL SYSTEM DESIGN

- We understand that the need to use natural lighting where possible. Internal lighting will be designed to suit this requirement by integrating natural lighting with artificial lighting via daylight & occupancy sensors. All lighting will be low glare louvered or diffused and to comply with minimum recommended light levels for the specific area. A maintenance factor of 0.8 has been allowed for to accommodate for dust and reduced lamp output over time and colour rendering.
- Since this is a Green Building, Sensors will control lighting in the toilets and offices. For service areas that have sufficient natural lighting, daylight sensor to control the operation of luminaires. All lighting will be diffused and to comply with minimum recommended light levels for the specific area. Lighting will be controlled via sensors, time delay switches, manual switches and controller as required.

Figure 10 Sensor Lighting

- There are 4 transformers serving the proposed 18 storey building, two of which will serve the Essential and the Electrical Services and the other serving the Mechanical Services. This application also applies to the two Generators, which independently will provide 100% power to each dedicated Services.
- A Type Tested Form 4a Main Switchboard will be installed at the basement level that will serve the building and at each tenancy there will be a dedicated board with Power Energy Meter for BMS monitoring.
- The BMS system will monitor the power consumption for each tenant, Generator Diesel fuel tank Levels, lifts and Generators. For the electrical services the BMS only controls the lighting fixtures.

ELECTRICAL ENGINEERING SERVICES - ESD

- Use of a Master slave generator configuration. Basically, used for load sharing purposes when 2 identical generators are connected to a common load. When there is a utility power blackout the master generator will start and provide back up until there is an increase in load the slave generator will carry the extra load.
- Use of energy efficient lighting system i.e., LED.

Figure 11 Lighting Efficient Dynamic Fixture

- Use of environment friendly conduits and cables e.g., HDPE.
- Use of building energy management systems to control lighting and power.

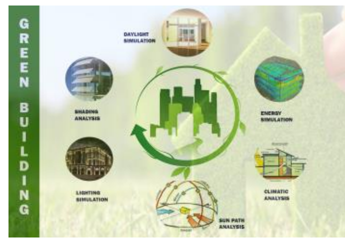

Figure 12 Flow Chart - Green Building Management System

- Select long life equipment with greater manufacturer's warranty and higher star ratings;
- Localized and sensor control lighting;
- The use of Bus Duct system in the distribution of mains to each level, minimizing the use of PVC cables.

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