Toronto airport people mover gets ready to roll

By Ron Richardson

Travellers at Canada's busiest civil aviation hub are going to find on-site ground transportation much more convenient later this year at the terminal complex now in the midst of major expansion. In December, the $140-million Automated People Mover (APM) system goes into operation at Toronto's Lester B. Pearson International Airport. It will provide a 1.55 km (0.9-mile), three station elevated guideway connection between two terminals and parking areas.

The cable-propelled system's design allows for the future addition of one more station and an extension of up to 2 km—plus a possible downtown connection rail link by diesel multiple unit trains.

The shuttle service calls for two six-car trains to carry 25 passengers per vehicle and operate on an elevated, self-supporting, V-shape steel tube truss guideway at a speed of 43.2 km/h (26.84 mph). The guideway itself is supported atop concrete piers spaced 25 to 35 meters apart.

The transit system is part of Pearson's $4.4-billion terminal and landside and airside expansion in a 20-year development program now taking shape in spectacular fashion. The flight centre currently serves an average of 25 million passengers a year and more than 300 worldwide destinations. But by 2010 the forecast is 39.9 million passengers, and 49.7 million travellers by 2020.

The APM system design comes from Austrian-based Dopplemayr Cable Car GmbH (DCC), a worldwide leader in ropeway transportation systems. Its fully automated cable-propelled systems are widely used at ski lifts, airports, city centres and amusement parks to move passengers quickly and safely. With a century of experience in engineering and building cableways, the Doppelmayr Group has supplied 13,000 installations in 71 countries.

Manufacture and testing of APM machinery was carried out at DCC's plant in Wolfurt. At the same time, in neighbouring Switzerland, partner CWA Construction assembled the custom-designed trains.

The APM's ability to operate in any weather—unaffected by freezing rain or icy conditions—was a major factor in its selection over other installations that require friction contact with guide rails.

"Also, we have no motor or gear box on board our cars, so we save design weight. That means we can use a very light, see-through guideway structure," says Markus Haemmerle, the DCC's safety officer at the airport site. "In addition, having all the essential drive, braking and train control equipment located away from weather and other hostile environments means that there is far less likelihood of failures. And, because these units are always accessible, less labour and downtime are needed to maintain and repair essential components."

The contract for piers and stations is being carried out by Toronto-based Ellis Don Construction DCM Erectors Inc., also based in Toronto, which is handling installation of the guideway, the station doors and mechanical and electrical segments.

A member of the Davis Group of structural steel companies, DCM's project manager at Pearson is Gabriella Cristante, who has supervised construction of tunnels, bridges and auto plants. General superintendent on the job is Gary Counsell.

Fabrication of the guideway's structural components has been carried out by Montreal-based Au Dragon Forge Inc. Jim Boyd, senior project manager with ADF, says that the "combination of 3-D geometry and exceptionally tight fabrication and alignment tolerances presented a special challenge."

The guideway consists of 152 individual trusses with an average length of 20 metres. Each truss has two-flange beam top chords that support and guide the rubber-tired cars.

"The fabrication of the guideway is further challenged by the very tight alignments set out by DCC to ensure superior ride comfort in the finished product," explains Boyd.

"The surfaces of the top chord that come in contact with the rubber tires of the people mover cars must be smooth and free of bumps and deviations from the theoretical 3-D geometry are limited to two millimetres in any two-metre length of guideway. The top chord space must also be maintained to 10 millimetres over the entire length of the structure."

Although the tolerances specified greatly exceed typical structural requirements, they are commonly achievable on weldments that are machined or linear/flat components that can be mechanically-straightened after welding.

"On the large, three-dimensional guideway trusses, which are typically 25 meters long, these tolerances are unheard of and border on the impossible," Boyd stresses.

Drawing on years of experience in the fabrication of special weldments—including bridges, specialized structural steel—mechanical equipment and CANDU nuclear reactor components, the ADF project team developed a manufacturing process capable of fabricating the guideway trusses to the strict specifications set out by DCC engineers.

Boyd explains that the "heart of the manufacturing process was a series of customized jigs and fixtures."

Diaphragm subassemblies were assembled in specialized jigs developed by fitters on the shop floor that adjust to the individual super elevations of each diaphragm. As well as assuring that the diaphragms were properly assembled, these jigs were used to verify the accuracy of the plate burning to ensure good fit up for welding.

The overall assembly of each truss section was done upside down in a specially-designed assembly jig that could be configured to the geometry of any individual truss in about two hours. The jig was fully machined and located the critical surfaces of the top chords that support and guide the trains to their required 3-D geometry positions within thousands of an inch. Sufficient welding was done on the pieces while they were in the jig to lock in the geometry.

After the truss section was removed from the jig, final welding was done in stages in a controlled sequence to minimize distortion.

"Another key element in the fabrication was the accuracy of the cutting of the vertical and horizontal pipe bracing," says Boyd. "All the connections to the bottom chord are pipe-to-pipe joints at varying angles. The weld profile of these joints is further complicated by the 3-D geometry of the structure, resulting in thousands of different configurations of bracing.

"Any variation in the profile of the weld preparation would result in uneven amounts of weld metal deposition, which adds to the welding distortion. To ensure fit up with consistent weld profiles, DCC provided us with detailed geometry information for each pipe brace configuration and the pipe bracing was cut using a Vernon 5-axis CNC pipe-cutting machine."

The final verification of the geometry of the trusses was done in a trial assembly operation in the shop. The guideway track was set up in the shop in 34 individual trial assemblies, with some of the sections exceeding 120 metres. The individual trusses were trimmed to their final length and the connections made to adjacent pieces.

Boyd says that "at that time the expansion joint connections were completed and aligned and the gaps were set with the appropriate temperature compensation factors. At the final trial assembly, the sections were supported at the same locations that they will be supported in the field."

The top chord spacing was measured with a micrometer every metre over the entire length of track and the guideway geometry was measured every two metres using a Leica TPS 1200 Total Station.

"The shop readings were compared to dead load geometry calculations provided by DCC," says Boyd, "and final adjustments to the geometry were made by heat straightening as required to bring the geometry into acceptable limits."

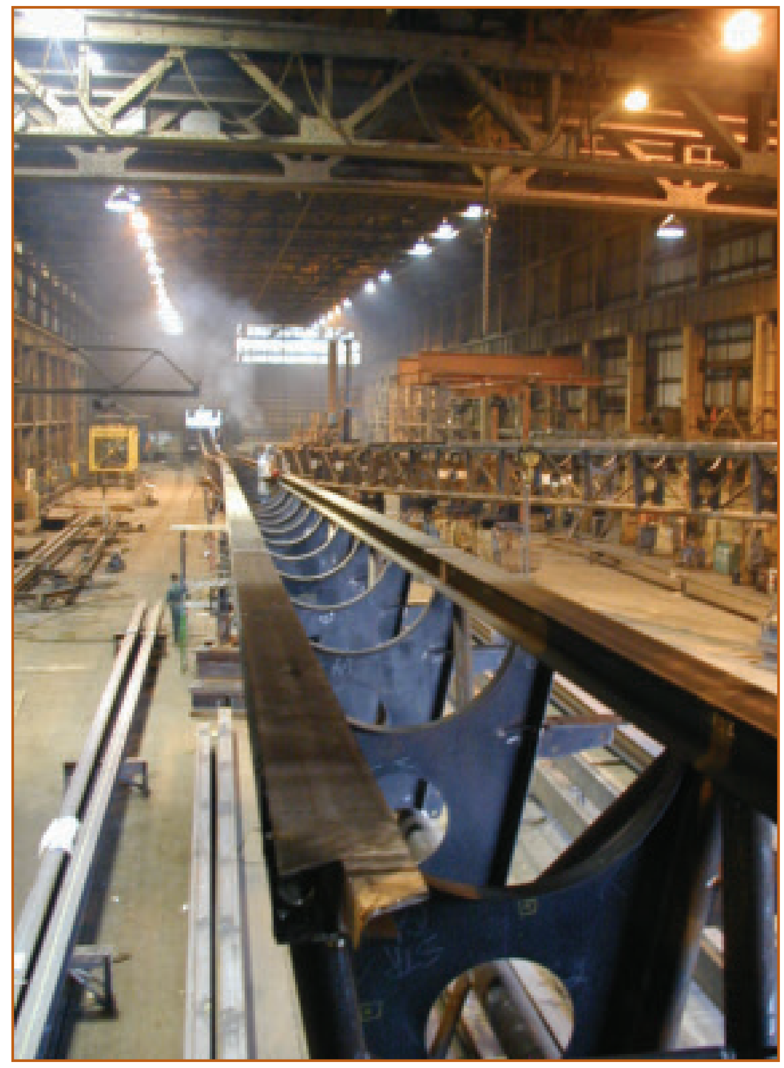
The completed segments were then blasted and protected with a four-coat paint system by Dry-Tec Industries before being trucked to the airport and crane-lifted into assembly position.

Once in operation, the shuttle's operation for opening and closing doors, start-up and acceleration will be monitored from a central control room, eliminating the need for drivers or on-board attendants. The trains will run 24 hours a day, with on-demand service between 1 and 4 a.m.

The cable wheel drive in the tensioning tower weighs about 75 tones and is powered by two 1,500 kW motors. The eight-strand galvanized rope runs in one continuous loop into the guideway. A fixed grip assembly forms the mechanical connection between the train and the cable, which is accelerated, decelerated and stopped by a stationary machine drive system. Should there be a power failure, an emergency diesel kicks in to provide power for communication and for heating, ventilating and air conditioning.

The undercarriage of each car consists of two bogies including the components, such as grips, rubber wheels and suspension elements. Each bogie consists of two nitrogen-filled rubber tires for vertical suspension and four horizontal guide wheels, which are locked into the upper I-beams of the guideway and effectively eliminate the possibility of derailment. The bogie can bend with the contours of the guideway and the connection with the undercarriage of the vehicle allows for three-dimensional movement.

DCC Doppelmayr Cable Car's on-site liaison official, Markus Haemmerle, says that his company has also been



awarded with the operation and maintenance contract for the next eight years. Despite the rigorous inspections performed in the shop and the careful assembly in the field, the full success of the fabrication will only be confirmed in when DCC conducts a series of ride tests this summer in which accelerometers are used to measure the ride smoothness under various load conditions. de

Visit dcc.at for more information.

Ron Richardson is business writer based in Toronto, Ont.

Birmingham International Airport Sky Rail Technical data

Length: 585.5 m
Configuration: Dual track shuttle with two trains operating independently
Operating speed: 36 km/h
Travel time: 90 sec.
Dwell time: 30 sec.
Guideway: Elevated steel tube truss on concrete substructure
System Capacity: 1608 pphpd
Stations: 2
Trains: Two 2-car trains
Train Capacity: 27 passengers per vehicle, 54 passengers per train

Mandalay Bay Shuttle, Las Vegas Technical data

Length: 838 m
Configuration: Dual track shuttle with two trains operating independently
Operating speed: 36 km/h
Travel time: System One: 119 sec., System Two: 101 sec.
Dwell time: 50 sec.
Guideway: Elevated steel tube truss
System Capacity: System One: 1300 pphpd; System Two: 1900 pphpd
Stations: System One: 4; System Two: 2
Trains: Two 5-car trains
Train Capacity: 32 passengers per vehicle, 160 passengers per train

Toronto's Lester B. Pearson International Airport Automated People Mover Technical data

System length: 1473 m
Configuration: Dual track shuttle with two trains operating independently
Operating speed: 43.2 km/h
Travel time: 3 min. 35 sec. Terminal 1 to Viscount Rd. with scheduled stop at intermediate station
Dwell time: 36 sec.
Guideway: Elevated steel tube truss
System Capacity: 2150 pphpd (passengers per hour per direction)
Stations: 3
Trains: Two 6-car trains
Train Capacity: 25 passengers per vehicle, 150 passengers per train