ANCHOR CONCRETE PRODUCTS LIMITED
1645 Sydenham Road
Kingston, Ontario K7L 4V4
Tel: (613) 546-6683 1-800-223-0012
Fax: (613) 546-4540
www.anchorconcrete.com

MANUFACTURED CONCRETE PRODUCTS

CREATIVE USE OF PRECAST AWARDS

Bombardier Monorail Test Track

The future of transportation is high speed mass transit. Bombardier Transportation Systems are world leaders in this area. Their innovative BOMBARDIER* INNOVIA* Monorail 300 system requires a very exacting monorail to achieve the ride Bombardier's customers expect. Bombardier Transportation Systems invited Anchor Concrete Products Ltd. (Anchor) and several other pre-casters to enter into a competitive bid for the supply of a 1.8km (1.125 miles) of pre-cast concrete track. Based on cost and technical compliance, Anchor was awarded the contract to manufacture and supply the beams.

The monorail test track was proposed to put a new generation of monorail cars through their paces. To achieve the foregoing and serve as a test bed for real world monorail projects in Saudi Arabia and Brazil, the track geometry was intentionally complex with a variety of horizontal and vertical curves, together with super-elevated slow and high speed curves with associated transition sections which proved to be the most challenging.

Anchor successfully produced 166 pieces of 30 tonne (33 tons) reinforced concrete beams incorporating curves, super-elevated curves and gradient beams (see Diagrams 1 and 2) with extremely tight tolerances on fit. The first pour was May 12th, 2011 and the final pour was October 26th, 2011. There were 127 straight beams produced with lengths ranging from 6.69m (22') to 11.6m (38'), 19 transition beams (flat surface to super elevated curve) were produced at 10m (33') in length and 20 super-elevated curved beams also at 10m (33') in length. All beams were 0.69m (2' 3") wide and 1.5m (5') high.

To provide an exceptionally smooth ride, all beams had extremely tight tolerances of +/-1mm (3/64") in a 1.5m (5') straight edge, +/-2mm (3/32") in width at any location and +4/-8mm (3/16" / 3/8") in 11.6m (38') length. Our negotiations with two major mould manufacturers eventually failed when both were unable to conform with the exacting precision required. We were forced to find another economic solution to the variable beam geometry and ultimately ended up achieving this in house by employing many innovations such as:

- Building two straight moulds in tandem to resist deflections during concreting;
- Creating jigs for accuracy and repeatability of rebar cages;
- Suspending rebar cages in the moulds for precise adjustment of cover;
- Producing very detailed drawings for production personnel to assemble the super elevated curved form work;

- Implementing a procedure of how to flip and roll the units to eliminate surface damage;
- Pouring the beams upside down to ensure consistent textured (form liner) finish on the top surface;
- Creating a method to position the beam end bearing connection plates which required a high degree of coordination with the rebar cage due to the quantity of Nelson studs which were used to create the steel to concrete connection (see Diagram 3);

By far the greatest challenge was in producing the super-elevated curved beams and the associated transition beams. It was uneconomic to build specific moulds for each type of the 19 special beams required and so a system of proprietary adjustable moulds was designed to provide both spiral curvature and continuously varying super-elevation.

For Quality Control checks we implemented a targeting system for lasers, used laser cut templates, calibrated tape measures and laser measuring devices. Systems of go/no go gauges and a custom designed recording spreadsheet were used to show compliance with tolerances.

Project schedule savings such as manufacturing all beams prior to the start of installation, creating a rebar jig, using adjustable moulds and the use of a curing compound after de-moulding the beams ensured rapid turnover and reduced labour costs.

Installation of the monorail track at site was faster than planned. At project planning stage the installation schedule was for 4 beams per day. Due to the accuracy of both construction and our precast elements, 12 to 16 beams were installed some days, reaching as many as 18 installations on the final day. We continue to receive requests for information on our forming process from foreign contractors.

Our precision with the extremely tight tolerances produced an incredible looking track (see attached pictures). In order to provide a skid resistant finish to the top running surface the product was poured upside down and a fine textured form liner was used in lieu of the traditional broom finish. This consistent architectural skid resistant finish on the top running surface of the track will be a large selling point. The future use of monorail systems utilizing a smaller foot print coupled with our processes of producing precision concrete beams with complex curves will pave the way for the future of urban transportation.