



PROJECT SUMMARY

Organization: L&T-RAMBØLL Consulting Engineers Limited

Solution: Bentley Civil

Location: Bangalore International Airport

Products Used: Bentley® MX®
Bentley® STAAD.Pro®

Project Objective: Complete detailed design and construction drawings for inside and landside civil work for new greenfield airport.

FAST FACTS

- New Green field airport to handle 27 aircraft per hour and serve about 7.5 million passengers each year.
- A 4000 meter by 45 meter runway for Code 4E aircraft (Boeing 747, Boeing 777).
- Approximately 3 months of time savings was gained using MX and STAAD.Pro.
- Due to significant changes the tight deadline could be met with use of MX and STAAD.Pro.
- The integration of Bentley products allowed several designers to coordinate their work and meet the deadline.

GREENFIELD AIRPORT TAKES FLIGHT

TRICKY TERRAIN, CHANGING PROJECT REQUIREMENTS CONFRONT BANGALORE AIRPORT DESIGNERS

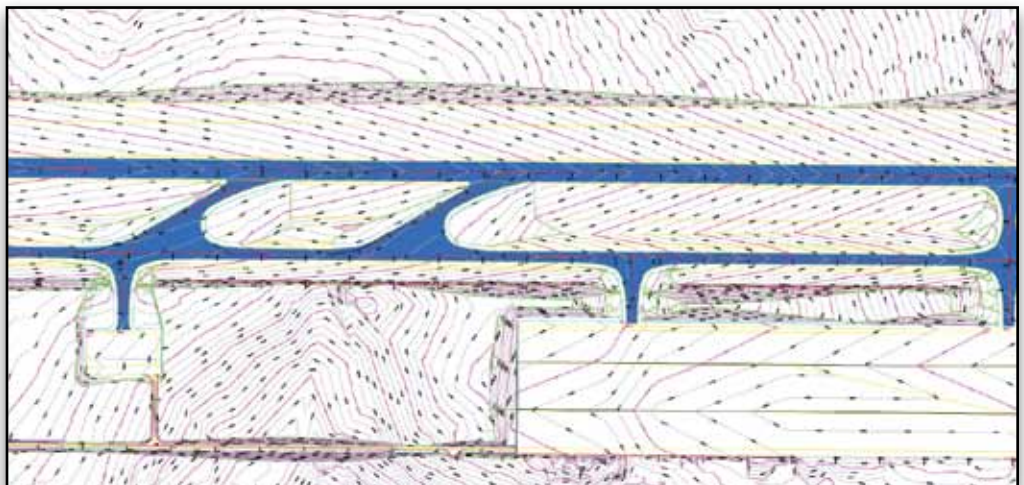
For L&T-RAMBØLL Consulting Engineers, designing the civil infrastructure for a new airport to be built on a greenfield would have been enough of a challenge. The challenge became a Herculean task with the client revising the scope substantially halfway through the project without extending the project commissioning date. This revision of scope came about to make the airport fit for phenomenally large increase in the traffic projection based on its client's new traffic studies.

Located east of the Bangalore-Hyderabad National Highway (NH7), the new airport is 37 kilometers away from Bangalore and four kilometers south of Devenhalli. This is the first greenfield airport to be developed in India through a public/private partnership. The new Bangalore International Airport will alleviate airport congestion in India's third busiest airport, serving 7.5 million passengers each year. Under the current development plan, the new airport is designed to handle 27 aircraft per hour. It features 42 Code C aircraft stands, a terminal building, and cargo-handling facilities for 300,000 tons of cargo each year.

L&T-RAMBØLL's civil works component is budgeted at \$180 million. It includes a 4,000-meter-by-45-meter runway for Code 4E aircraft (Boeing 747, Boeing 777), a parallel full-length taxiway (4,000 meter by 25 meter)

designed for Code F aircraft, two rapid-exit taxiways, and other connecting taxiways. Aprons for the passenger terminal and the cargo area measure 351,300 square meters. An isolation bay takes up an additional 14,710 square meters. Major and minor service roads will connect the apron and service areas. The four-kilometer main airport access road features two rotary intersections and a grade separator. Total road length (both airside and landside) is 30 kilometers, and parking will accommodate 2,000 cars. The civil work also covers surface drainage for the entire airport.

When the traffic forecast increased in June 2005, the terminal building expanded in size, and the number of aircraft stands and passenger boarding bridges also increased. The layout of the taxiways and the terminal access roads changed to accommodate the increased traffic. Despite these changes, the client required the redesign and construction to be completed within the project's original time frame. Once the scope was increased, the client went through another open tender process before awarding the contract to the original contractor. The design team had to carry out the tender designs, which included studies of various design options and selection of the optimal solution.



L&T-RAMBØLL designers modeled the terrain in MX for an accurate topographic survey

"The automatic generation/extraction of information ensured that human errors in translating this information were eliminated"

ABOUT BENTLEY

Bentley Systems, Incorporated is the global leader dedicated to providing comprehensive software solutions for sustaining infrastructure. Architects, engineers, constructors, and owner-operators are indispensable in improving our world and our quality of life; the company's mission is to improve the performance of their projects and of the assets they design, build, and operate. Bentley sustains the infrastructure professions by helping to leverage information technology, learning, best practices, and global collaboration – and by promoting careers devoted to this crucial work.

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L&T-RAMBØLL credits Bentley's interoperable products with helping it complete the tender engineering and the detailed designs within the tight timetable. The complexity of the project required a sophisticated and integrated design process since all designs had to comply with the design specifications of the International Civil Aviation Organization (ICAO) and U.S. Federal Aviation Administration (FAA). "The unique features of these solutions enabled us to meet the tight schedules for the increased scope of work midway through the project," said senior project consultant Sanjay K. Srivastava. L&T-RAMBØLL has been using MX solutions and STAAD.Pro since the company formed in 1998.

WORKING WITH THE SITE

L&T-RAMBØLL designers modeled the terrain in MX for an accurate topographic survey, with a single terrain model created for use by all design team members. Two engineers used MX to generate and examine various design alternatives to minimize the earthwork quantities and one engineer handled runway, taxiway, apron, and other connecting roads. Five different alternatives were evaluated in a short period of time to freeze the design concept.

The runway had to be designed and built on challenging terrain. Fill heights along the runway were as great as 12.3 meters. The earthwork in cut was about 5 million cubic meters, and the fill was 4 million cubic meters. The drainage system design followed the existing natural drainage patterns as much as possible, with surface runoff water collecting in large flood areas to the north of the airport.

The quantification of the catchment areas after the definition of various surfaces in MX helped speed preliminary drainage design. Surface analysis tools highlighted flat spots, excessive slopes, and other surface discrepancies that did not comply with the stringent ICAO design specifications.

Surface slopes permitted in airports are much flatter than those acceptable for roads. This poses additional surface drainage problems, especially in rapid-exit taxiways where transitions create flat spots unsuitable for drainage. Modeling rapid-exit taxiways has always been a challenge. MX tools helped designers quickly identify problem areas and devise solutions. For example, ridge lines were created at appropriate locations to overcome flat spots while maintaining the slopes within allowable limits.

Another challenge in airport design is locating ancillary services under the apron. These services include drainage

ducts, fuel supply pipelines, fuel hydrants, and electrical lighting conduits. Designers must position these facilities accurately and get them right the first time during construction, because redoing them would be very expensive.

STAAD.Pro helped in modeling and analyzing the impacts of the complex gear configurations of new large aircraft, such as the Airbus A-380, for consideration in the design of drainage structures. L&T-RAMBØLL created a 3D model and carried out finite element analysis to predict what forces would be transmitted to the structures lying underneath.

To meet the tight deadlines, different designers worked independently on various components of the master plan. Their work was then combined to produce a final coordinated and integrated design. The use of input files and careful model management made the design process person-independent.

MX allows users to control roadway details by defining a series of strings with independent or referenced alignments and profiles. The master strings for all the components to be designed were identified on the master plan of the airport before work started on the detail designs. Designers did not have to worry about naming the strings uniquely, and it was a fairly simple task to integrate different designs into the central model.

Srivastava noted, "It was relatively easy to produce construction drawings and additional information required by the contractors and client from the design models developed. The automatic generation/extraction of information ensured that human errors in translating this information were eliminated."

Though the design and construction were targeted toward the initial phase of development, concept designs for future expansions were also integrated into the detailed designs. It is estimated that using MX and STAAD.Pro saved around three months from the time required to create the details drawings, which helped the firm stay on track to meet its original deadlines despite significant changes to the scope of the project. Detail design work started in August 2005, and the construction team was mobilized at the same time. Civil construction is expected to be finished by December 2007, and the airport is on track to start commercial operations in April 2008.

FOR MORE INFORMATION:

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