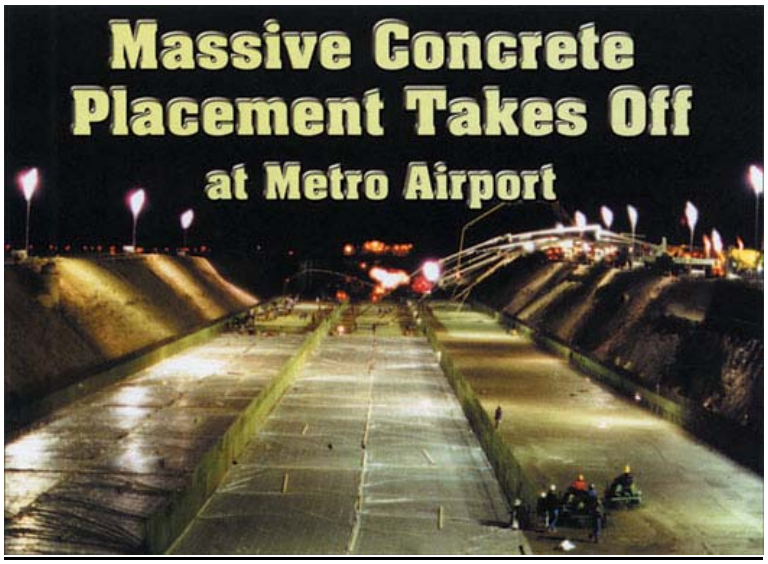
Pumping volume surpassed in under 24 hours



Vice President of Walbridge Concrete Services Kenneth L. Beaudoin discusses a record-setting achievement.

by Keith A. Tosolt and Susan C. McCraven

The roar of fully throttled jet engines in the distance momentarily joined with the percussive sound of a dozen concrete pumping machines aligned in a row. Concrete mixer trucks, approaching in a steady stream, shared the same tarmac as DC-10s taxied to their terminal gates. Into this setting, laborers, supervisors, and engineers banded together to "climb the mountain," in a figurative sense, and claim a spot in the record books after a remarkable show of productivity and endurance. What makes the concreting accomplished at the Detroit Metropolitan Airport all the more impressive is that those who undertook it reached a new plateau in heavy concrete placement within the center of the fifth busiest airport in the world, while overcoming an almost limitless potential for logistical and safety problems among the live runways.

The contracting firm of Walbridge Aldinger, Detroit, Mich., set the performance bar higher when 20,917 yd3 (16,000 m3) of concrete were placed in a time span of 22 h, 57 min. on May 15-16, 1999, for the mat foundation of the North Tunnel Project at the airport. A 4 ft (1.2 m) thick foundation, 950 ft (290 m) long and 150 ft (46 m) wide, was needed for the 30 ft (9 m) deep tunnel completely below grade. When finished, the tunnel will ultimately support the load and provide resistance from impact for a jet runway and permit through access for three roadways into a planned midfield terminal now under construction.

What was achieved in so short a duration is reflected in the material, equipment, and personnel numbers for the project — a joint venture of Walbridge Aldinger and Posen Construction, Utica, Mich., through a contract with the Michigan Department of Transportation (MDOT). The placement, using a 5000 psi (35 MPa) mixture design without air entrainment, consumed 18,900 tons of aggregate, 15,750 tons of sand, 7078 tons of cement, and 4400 gal. (17,000 L) of midrange water-reducing admixture, translating into roughly $1.5 million in concrete materials alone. The foundation, which contains 1600 tons of steel reinforcement, accounts for fully one-third of the entire volume of concrete that will be used in the North Tunnel Project.

To deliver that much concrete quickly to the job site, 150 concrete mixer trucks completed 4600 round trips from six different batch plants — three on site and three off site, which combined to supply concrete at an average rate of 1160 yd3 (890 m3) per hour; 300 drivers were used in two shifts. An arsenal of 12 concrete pumps, with booms ranging in size from 105 to 170 ft (32 to 52 m), continuously pumped concrete from their positions on top of the open-cut excavation to waiting work teams 30 ft. below.

The entire construction labor force — 100 laborers, 25 finishers, and 15 vibrator operators — volunteered for this assignment, with the chance of getting into the record books being a major motivation. Also, 40 members of the supervisory and support staff directed the placement, and a total of 50 county building inspectors monitored concrete quality. Upper management employees of Walbridge Aldinger were enlisted and armed with cellular phones to serve in a key safety capacity as members of the flag team that controlled vehicle traffic inside the airport proper.

But without an extraordinary amount of advance planning, spirit of cooperation, and attitude of commitment among the key participants involved, this project — let alone the record — may never have gotten off the ground.

Setting sights on the record

Actual scheduling began more than a year prior to the 23-hour placement in May. Construction plans initially called for the foundation to be placed in 16 separate sections. Early on however, it became apparent to owner and contractor alike that the concept of one combined placement seemed preferable. Otherwise, operations at Detroit Metro Airport would have subsequently had to be interrupted for each individual sectional placement. Also, if construction activities were scheduled continuously during late night and early morning hours — a time when air traffic is usually minimal at Detroit Metro — the issue of conflict with airport operations would be eliminated. After an extended period of consultation and negotiation with officials from Wayne County (the airport owner), the Federal Aviation Administration (FAA), and Northwest Airlines, the go-ahead was granted for the single continuous placement. With this green light, the potential to set a new 24-hour placing record presented itself. And the motivation behind the push to do so became a "self-inflicted goal," according to Ken Beaudoin of Walbridge Aldinger. Beaudoin rose up through the field superintendent and supervisor ranks to serve as general supervisor of the company from 1983 to 1994. In his present position as vice president of Walbridge Concrete Services, he is in charge of the company's equipment division and manages an average of 250 employees (including all superintendents, layout crews, carpenters, laborers, finishers, and operators). "I've been in the concrete construction business for 30 years and we've done some large pours. But the reality was that the opportunity had never existed before to do something like this. In fact, that possibility was a driving force before the job was even bid," Beaudoin explains. "Easily, we could have done the job in 16 pours according to the drawings. But once everyone agreed that a one-shot run would be a lot better to limit the problems for the airplanes, we decided to try to break the record."

"Pushing the envelope" of supply

Still, securing the permission to use a one-shot approach to the tunnel foundation placement only set the Groundwork in motion. Supply demands were being contemplated that would tax local resources, and which were essential to the success of the project. "Once we had the concept in mind," he continues, "we had to have an agreement up front from the concrete supplier to give us an excess of 1100 yd3 (840 m3) an hour, which is a tremendous commitment from one company. There really was no way it could have been done without that kind of commitment from the very start.

"We pushed the envelope of supply way beyond the means of most suppliers — in this state anyway. If you analyze it, to pull 21,000 yd3 (16,000 m3) of concretefrom one plant would be equivalent to running a single plant for a month. Even if a supplier had the plants — or say, if a number of suppliers had joined together — too many of the plants would likely be located too far away geographically, so logistically they could never have gotten the job done. The advantage with our supplier, Michigan Foundation, was that it had plants within a short radius around the job site.

"The logistical nightmare of putting it all together and planning everything took over a year. But that really wasn't a long time when you consider the suppliers had to give their total commitment. And it required 'major league' commitment," Beaudoin emphasizes.

He cites the steel supplier as one example. Not only did the company have to provide more than 1600 tons of reinforcing for the foundation, it all had to be installed within a 4-week period to keep the other phases of the project on schedule. "It's never been heard of before," according to Beaudoin. "That's probably a year's worth of work for most companies — it's just an unbelievable amount of steel."

The cement supplier for the project extended a similar level of commitment. Early on in supplier negotiations, some concerns had been raised about the possibility of getting one supplier alone to agree to participate in a job of this magnitude. But once management executives of the eventual supplier chosen were apprised of the advance planning going into project, they informed the contractor that no other cement

company would need to provide material for the job. They reaffirmed this stance by sending a shipload of cement exclusively for the placement.

Even the excavating contractor worked under constraints that tested the company's capabilities. Roughly 1 million yd3 (800,000 m3) of earth and fill had to be removed from the job site.

"Because a new taxiway was going to be created, one area had to be steelsheeted. This really hindered the timing as far as starting to cut the tunnel and getting the area graded," Beaudoin states. "At one point, more than 14,000 yd3 (11,000 m3) of earth was being removed per day." In addition to the steel, all underground drainage piping, electrical ductwork, and other structures, including a 7 ft (2 m) water force main, were placed and inspected in conformance with specifications.

Cooperating on a major scale

Meetings were held with material and equipment suppliers on a constant basis for 6 to 8 months prior to the placement in an attempt to foresee and forestall any potential problems. However, Beaudoin points to one special meeting as being a pivotal aspect of the planning involved in this project: a dinner meeting held 4 weeks prior to the anticipated target placement date. Everyone participating in the project was invited to attend.

Personnel from the general contractor, and all the subcontractors, including some 300 laborers and drivers met for more than 3 hours. "We had to have this meeting!" Beaudoin stresses. "You couldn't have all those people show up on the job site and ask, What am I going to do today?" At the event, all individuals received a sheet detailing how the job would progress and exactly what would be their assigned responsibilities. Questions were fielded from those assembled. The discussions also covered the safety measures in place.

Overall, that prejob meeting helped foster a "one team" approach that prevailed throughout the remainder of the project due to the camaraderie established early between labor and management, claims Beaudoin. To minimize injury risk and promote productivity, the general contractor spent an extra $60,000 for additional steel mesh, positioned on top of the reinforcing mat and left in place, so workers could walk on the resteel without the danger of their feet falling through. The cooperation was also extended by the labor force, who were essentially all volunteering to work as many hours as needed straight through the all-night placement. In a move that blurred the usual lines of demarcation between labor and management, the unions themselves — Laborers Locals 334 and 1067 — bought provisions to stock the on site canteen that the general contractor had set up and staffed for all the workers.

Going with the flow

The record placement at the Detroit Metro Airport presented many challenges for the admixture supplier, represented by Warren McPherson, Michigan regional manager of the Euclid Chemical Company."Essentially, to break the record, the concrete would have to be very user friendly. It would have to be easy to pump, consolidate, and finish. With dense reinforcing bar at the top and bottom of the footing, a somewhat flowable mix was needed," he states.

Of prime consideration was the fact that the Wayne County Construction and Inspection Departments agreed to allow a maximum 6 in. (150 mm) slump going into the pump, rather than their typical specification of 3 in. (75 mm) maximum slump, if a midrange water reducer was used.

According to McPherson, a 6 in. slump requirement obviously not only allowed for speed of placement and consolidation, but it also allowed speed of inspection. Wayne County inspectors stationed at each of the 12 concrete pumps were permitted to visually inspect the slump, and slump tests were only run on those loads suspected to be above a 6 in. slump. "Of the more than 2000 loads of concrete, only one or two were rejected for exceeding the specification," he recalls.

"As an admixture supplier, my biggest concern during the placement was that a dispenser would malfunction. I am happy to report that there were no equipment malfunctions, and as a result, our admixtureteam was able to relax and watch history in the making," McPherson concludes.

Perhaps the toughest logistical problem faced prior to and during the placement had to be securing the federal and local security clearances required for access to the airport. "Every truck and driver had to be 'badged' with authorized identification. This was also required of every individual on the job site, and it's a tedious process," Beaudoin explains. "The trust the airport authority and its security group gave to us was just absolutely incredible. But the FAA had the final say. Without their approval, we couldn't have done it."

The FAA had the authorization, right up to the actual start time, to cancel the placement permissions if there had been dissatisfaction with any aspect of the construction plan as it related to airport operations.

Working through the logistics

Concrete placing commenced on Saturday, May 15, at noon, under ideal weather conditions. Twelve concrete pumps were first positioned on the north end of the tunnel cut, and only on the west side. Conveyance and placement of the concrete were in conformance with ACI standard practices and MDOT standard specifications.

Though continuity was maintained, the foundation was placed in two main sections (with 8 subsections each) — a temporary bulkhead was designed and utilized to permit this approach and minimize risk. In fact, the success of the pumping strategy was pinned on thebulkhead maintaining the liquid head as the direction of pumping reversed. As the individual sections in the north side of the foundation were completed, pumps were systematically moved to the south end as the work progressed.

Original plans called for pumping to take place from both sides of the tunnel cut (three pumps per side) and on the bottom of the tunnel cut's south end (with six pumps there). "It was really fortunate when the airport authority decided to cutoff one taxiway, which allowed us to position everything on one side," Beaudoin states, "otherwise the maneuvering space would have been too narrow." Still, when a 757 airliner approached the runway for takeoff, only 150 ft (45 m) of clearance remained.

Coordinating mixer truck deliveries to provide a nonstop flow of concrete to the 12 pumps amidst live, active runways demanded keeping the lines of communication open — and keeping the trucks out of the way of the airplanes. This vital communication consisted of a network of 18 flag people, positioned at strategic points along the delivery routes north and south of the job site, to control truck traffic in and around the airport.

At least half of the concrete deliveries were made from the north end, where the trucks traversed 4 mi (6.5 km) of existing taxiways at a maximum speed of 15 mph (24 km/h). Of course, whenever airplane traffic had to cross over the delivery route, truck movement came to a grinding halt. More expedient entry to the site could be found from the south, where drivers made use of existing new access roads (also built by Walbridge Aidinger) with a relatively generous speed limit of 35 mph (55 km/h). A grader, front end loader, bulldozer, andwater truck combined to maintain the haul roads.

Relying on cellular phones, Walbridge Aldinger supervisors and superintendents had critical responsibility for directing the heavy traffic in the pumping area. To keep the pumps constantly supplied with concrete, trucks were dispatched on a continuously rotating basis — once a mixer truck emptied its load, another one moved into position. Teamsof seven laborers were stationed at the business end of each boom pump outlet to place, vibrate, and grade the concrete; two concrete finishers were also assigned. Each work group had the freedom to determine its own schedule of rest breaks, basically relieving workers as needed; a minimum five person crew per pump was generally in force at all times.

A wet concrete edge had to be maintained to avoid construction cold joints. To ensure this, a minimum of 400 yd3 (300 m3) of concrete per hour would have to be placed. As it turned out, the concrete placement volume actually generated readily exceeded that required amount throughout the operation. In beginning each section, concrete was first pumped to a depth of 1.5 ft (0.5 m) in the foundation reinforcing mat. For each sectional area, in increments of about 10 ft (3 m) square, laborers maneuvered the pump hoses back and forth to top off a section; the edge was then worked all the way out.

At least four hours elapsed before an individual section sufficiently filled to allow surface finishing. No special finishing requirements were specified; each section only had to be surface closed. Riding trowel machines stood by on site as backup in the event a section did not get closed properly. Sending in a riding trowel to finish a section if needed was quicker and easier compared with having the workers finish the surface by hand. The curing method used was application of visqueen and water.

In a situation where considerable reinforcing steel congestion existed, pumpability of the concrete could not be compromised (see "Going with the flow"). A slump of 6 in. (150 mm) had been specified — and checked at the pump hopper. The location of slump testing had been predetermined with the airport authority to avoid the necessity of having to position close to 50 testing personnel inside an already crowded and hazardous placement area. Consequently, slump testing took place before the concrete went through the pumps.

By best estimation, the slump diminished about 2 in. (50 mm) as the concrete traveled an average pumping

distance of 180 ft (55 m). As the job wore on, this small slump loss did have an effect on worker productivity — and morale. "After 16 hours into a pour, and you're getting 4 in. (100 mm) slump concrete, it gets a little tough on the workers — because a 4 in. slump looks like 1 in. (25 mm) coming out of the hose by that time," Beaudoin explains. The challenge of keeping the workers motivated would become crucial in the early morning hours on Sunday.

Trying to beat the clock —and Murphy's Law

Steady progress continued throughout the day and into the evening hours. For the most part, pumping operations proceeded smoothly; two of the ready-mixedmplants did experience some mechanicalm difficulties, but there was no majormdowntime. Some of this good fortune canmbe attributed in large part to the advance planning designed to head off such contingencies in the event that they might occur. But the one equipment mishap that did happen is a perfect example of the ever-popular theory that what can go wrong often will — and at the worst possible time.

Three weeks prior to the start date, all the miscellaneous materials needed by the flag personnel — safety vests, flags, hand-held traffic signal flashlights and batteries — had been delivered to the job site. As twilight approached and the use of the flashlights would be imperative, a missed attention to detail cropped up. "Of everything that could have gone wrong for the flag people — because they had to have lights — when we opened up the supply boxes that nobody had previously checked, it turned out the batteries and the flashlights didn't match. The square peg wouldn't fit in the round hole," Beaudoin laughs as he recalls the event.

It would merely be an inconvenience if this had happened in any other situation. But in the context of a major airport construction site, the ramifications were serious. There was a real possibility that operations could have been halted immediately — at the directive of the FAA. "It is funny now that this was probably the worse thing that went wrong, but it did get hectic for a while because the FAA was getting ready to shut us down because of it," he adds. A runner was dispatched to the local hardware store for the proper batteries.

With mechanical breakdowns at a minimum, the prime concern turned to keeping the workers motivated in the face of increasing physical exhaustion and mental strain. As it is with most endeavors requiring extreme endurance, there does come that point commonly referred to as "hitting the wall" — which in this case happened about 3 a.m. Sunday morning. A pause in the concrete pumping had been anticipated at that time, corresponding with the complete shift of the pumping units from the north side of the tunnel cut to the south. Deliveries of concrete backed up as a result. At one point, an unbroken string of red, glowing brake lights could be seen as 76 mixer trucks waited in line.

Beaudoin continues the narrative: "When we made the switch from one side to the other, we knew we would have a lull when moving the pumps. People would normally panic to see 760 yd3 (580 m3) of concrete sitting there, because you run the risk of expiring the mixing time for the fresh concrete. However, we knew that we had the capability of placing that amount quickly. Every yard of that 760 yd3 was placed within 30 minutes; it was done beautifully!"

Even with that one supply boost, concrete pumping still lagged. To compound matters, Murphy's Law struck again as cellular telephone links were interrupted for three hours at 3 a.m. when the provider arbitrarily took its system down for routine maintenance — without prior notification. This delay in immediacy of communications increased the burden on the WA supervisors trying to direct the constant influx of truck traffic: it was just that much harder to get instructions passed around the job site. With the fatigue factor setting in, the workers definitely needed some encouragement.

"We were behind schedule, but I didn't let the people know. I spent from 3 a.m. to 6 a.m. walking up and down the steel talking to every individual, encouraging them. They all kept asking, 'Are we on schedule?' I would say 'yes,' though it wasn't the truth," Beaudoin admits. "Gradually everyone rejuvenated, especially as the deliveries picked up."

The true picture of the progress being made became apparent by sunrise. "When dawn hit, I realized we could make it! By 9 a.m., I knew we were going to break the record," Beaudoin relates. "Determining the time to stop the trucks was a tough call. It took constant communication between John Formentin, vice president of Michigan Foundation, myself, and Nick Pogrmich, the superintendent. Nick was right inside the placement area, and I was just off to the side. Based on our three-way communication, for the last 45 minutes we were sending in trucks at 500 yd3 (380 m3) a crack. We lost only an insignificant amount of concrete," he recalls.

Finally, on Sunday at 10:57 a.m., the last portion of the North Tunnel foundation surface was closed, and claim to the new record could be made.

Assessing the record's impact
It is really a story of all-out human effort and commitment at the core of this monumental enterprise of 23 hours of concrete placing — at least in Ken Beaudoin's view. "Everybody was so motivated to get this thing done. These guys all wanted to break the record. They were so excited when we finished," he says. "You can only have 15 minutes of fame, but for those 15 minutes, the 500 to 600 individuals involved were 'gods." Surprisingly, a number of laborers actually called to express thanks for being able to participate in such a benchmark
project.

"Still, to run 23 hours without stopping is the most remarkable feat I've ever seen," Beaudoin reflects. Even under those exhausting conditions, concrete workmanship and quality did not suffer: 3-day core breaks were almost to strength, and the 7-day tests were well above the 5000 psi (35 MPa) specification. Another impressive thing, he points out, is that everyone on the job site made it through without injury: more than 7000 man-hours were logged that day with zero injuries.

And the credit for this success is to be shared by all who participated. "The aspect of this job that I was most pleased with is that we did it with cooperation from everybody," Beaudoin stresses. "There was such a camaraderie between management and labor — one team all the way, with respect for each other. It was listening to my people and taking their suggestions. For example, my General Superintendent Nick Pogrmich first proposed the temporary bulkhead concept we eventually employed," he says.

Beaudoin also feels his professional association with ACI assisted in making the goal of a new record a reality. "Without it, I don't think it really could have been done. For example, the tunnel deck before this one was scheduled to be done in 147 pours; we did it in 18. There is a belief in what we can do as a company, and from my affiliation with ACI committees, the owners have total trust in all I've told them, because we haven't failed in any case," he concludes. Some other tangible benefits to be garnered from this placing record include:

1) A very substantial public relations coup was presented to Detroit Metropolitan Airport, which is now undergoing a massive, and much needed, expansion. The North Tunnel is a part of a second entrance and access road to the airport, which will ultimately service a new $786 million midfield terminal, housing the operations of Northwest Airlines (expected completion date: 2001).

2) The entire North Tunnel project should be closer to getting back on schedule as a result. A delay occurred when the placing of the tunnel foundation had to be pushed back by four weeks due to sewer construction.

On most levels, the record-setting pace that can be claimed by Walbridge Aldinger and the team Ken Beaudoin assembled — assisted by a strong network of suppliers — has to be seen as a truly singular event. At some time in the future, another comparable, massive volume of concrete might be placed in a similar, marathon fashion. However, one thing is for certain: any subsequent attempts will not have to deal with the same exact set of stringent regulatory restrictions and logistical constraints as were encountered in the middle of Detroit Metropolitan Airport.

Principal companies and key personnel involved in this project include:

Walbridge Aldinger, Detroit, Mich., general contractor: Ken Beaudoin, Vice President, Concrete Services; Nick Pogrmich, General Superintendent; Awadh Prasad, Project Director; Jerry Blanchette, Laborer General Foreman; Don Parton, Laborer Foreman; Del Sinclair, Cement Mason General Foreman; Larry Flannery, Carpenter Foreman.

Posen Construction, Utica, Mich., electrical subcontractor.

Michigan Foundation Co., Trenton, Mich., concrete supplier: John Formentin, Vice President of Operations.

Cross Enterprises, Inc., Melvindale, Mich., pump supplier: Charles Cross, President; Frank Feretti, Sr., Vice President.

Quality Resteel, Brighton, Mich., reinforcing steel supplier: Roger Phillips, Rodbuster General Foreman.

Ric Mann LEDDs Development,
Sterling Heights, Mich., excavation and site work: Jim Billicki, Project Engineer; Mike Foley, General Foreman.

Blue Circle Cement, Marietta, Ga., cement supplier.

Euclid Chemical Co., Cleveland, Ohio, admixture supplier: Warren McPherson, Michigan Regional Manager

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Concrete International November 1999.