Construction of a Concrete Roundabout in a Major City Environment

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ABSTRACT

With the opening of the new convention center, the City of Overland Park had to begin planning how to handle the traffic flow to and from the facility. Based on traffic studies, the city traffic engineers determined that a two-lane modern roundabout should be constructed to provide intersection control at the intersection of 110th Street and Lamar Avenue. The roundabout was constructed out of concrete pavement due to life-cycle cost, maintenance issues, and the stability of concrete given the fact that vehicles are moving in a circular motion as they travel through the roundabout. The roundabout design was horizontally and vertically complex with many cross slope and width transitions. This paper will discuss the procedures used to establish grade control for the curb and gutter sections, both on the outside edge as well as the central island. Because the construction consisted of concrete pavement, a unique jointing plan was developed. The process of establishing the jointing plan with consideration of other control features such as curb inlet transitions, crosswalk pavement and splitter island radii points as well as the method used for controlling the transfer of loads between the circulating lanes and the approach pavements is also discussed. In addition to the technical aspect of construction, the paper identifies key components of managing a successful project in a major city environment including, project management techniques, citizen outreach, project safety and some of the unusual circumstances and challenges that were overcome during construction.

EXECUTIVE SUMMARY

The City of Overland Park celebrated the grand opening of the new Overland Park Convention Center on Sunday, November 17th, 2002. The Overland Park Convention Center sits on a 26-acre site at the corner of College Boulevard and Lamar Avenue in the heart of Overland Park, the largest suburban city in the Kansas City metropolitan area and the second largest city in Kansas. Adjacent to the convention center is the new 412-room Sheraton Hotel. The convention center itself features a 60,000-square-foot exhibition hall, a 25,000-square-foot ballroom, more than 14,000-square-feet of meeting space and an extensive pre-function space including a 25,000-square-foot courtyard.

Figure 1: Photograph of the completed concrete roundabout, looking north-northwest. The conference center is in the foreground. Note the two vegetated berms in the central island, behind the retaining walls.

With the opening of the Convention Center, City officials had to begin planning well in advance how to handle the traffic flow to and from the facility. With the Convention Center bounded on the north by Interstate I-435, by College Boulevard on the south, Woodson Avenue on the east, Lamar Avenue on the west, and 110th Street through the middle of the site, city planners and traffic engineers wanted to ensure that traffic would flow smoothly in and out of the facility. It was recognized that with Lamar being a north/south collector across the Interstate that many local people would use Lamar to travel in and out of the facility. Also, 110th Street, a commercial street, parallels I-435 and College Boulevard. The intersection of 110th St. and Lamar would become congested and signalizing the intersection was deemed undesirable due to the close proximity of the signalized intersection at College Boulevard and Lamar Avenue.

Based on traffic studies, the city traffic engineers determined that a two-lane modern roundabout should be constructed to provide intersection control at the intersection of 110th Street and Lamar Avenue. The project was designed and bid with two alternatives, one as an asphaltic pavement for the entire roundabout project and the other as concrete pavement for the approach lanes and roundabout with the west, north and south tie-in locations as asphaltic concrete. The City chose to award the concrete pavement alternative to the successful bidder after considering life-cycle cost, maintenance issues, and the stability of concrete given the fact that vehicles are moving in a circular motion as they travel through the roundabout. The project was completed ahead of schedule, within budget, and with no lost time accidents in spite of utility conflicts, coordination issues, and material delivery problems.

PROJECT SCOPE

A two-lane modern roundabout, serving traffic from the adjacent Overland Park Convention Center, was constructed to provide intersection control at the intersection of 110th Street and Lamar Avenue, which is the intersection of a collector and a commercial street. The inscribed circle diameter is 197 ft and consists of two 15 ft-6 in circulating lanes. The central island has a diameter of 131 ft.

The pavement in the roundabout, including the flared approaches between the circulating lanes and the entry nose of the splitter islands, is 10 in of concrete placed on 5 in of drainable aggregate base course and 8 in of fly ash treated base. The tangent approaches prior to the splitter islands are constructed of 10 in of asphaltic concrete on 8 in of fly ash treated base. An under-drain pipe system was installed to convey subsurface water from under the pavement to an enclosed storm drainage system consisting of curb inlets to remove surface water runoff.

The project also included 24 in wide concrete curb and gutter with 4 in curb height, 5 ft sidewalk and wheelchair ramps constructed of 4 in and 6 in thick concrete respectively, 6 in thick concrete drive entrances, and concrete curbing for splitter islands and central island. The splitter islands and central island are constructed with concrete paver stones or limestone pavers on a concrete base with a raised concrete edge curb to retain the soil in the landscaped planting areas.

The landscaping in the central island consists of two large earthen berms behind two decorative retaining walls. The retaining walls are constructed of structurally reinforced concrete with limestone facing and raised bronze lettering attached to the face. A location in the central island has been reserved for a future sculpture. The plantings are a variety of annual flowers, perennial wild flowers and ornamental grasses. An irrigation system with quick hose couplers was installed to supply water to the landscape planting areas. A lawn irrigation system was also installed for the surrounding lawn areas. In addition to a street lighting system for roadway lighting, low voltage aesthetic lighting was constructed in the central island with varying color filters to accent the planting material. Proper pavement markings and permanent signing was installed to provide the appropriate guidance to the traveling public.

The total construction cost for the project was $1,427,058.61. Funding for the project consisted of 90% Surface Transportation Project (STP) federal funds administered through the Kansas Department of Transportation and 10% City at large matching funds.

CONSTRUCTION MANAGEMENT TECHNIQUES

Pre-Construction Meeting

Upon contract award, a Pre-Construction meeting was arranged and conducted at the Overland Park City Hall. Attendees included key City personnel, utility company representatives, the engineering designer, the construction services inspection team, the contractor and the contractor's sub-consultants and representatives from the construction company, who was responsible for the design-build of the Convention Center and hotel complex. The contractor was required to submit a construction schedule to the City to insure the contractor had scheduled the completion of the project within the contract time frame. Adherence to the completion date was deemed to be extremely critical since the roundabout needed to be open for traffic to coincide with the grand opening of the Overland Park Convention Center and Sheraton Hotel. The meeting clarified procedures, introduced all parties, and provided an opportunity to emphasize the importance of identifying challenges and working together to seek solutions to ensure the successful completion of the project on schedule and within budget.

Weekly Project Status Meetings

After the Pre-Construction meeting and until the completion of the project, coordination meetings were held weekly to discuss scheduling, safety, quality control, submittals, information requests, and work through details as-needed. The meeting provided an opportunity to review the actual progress of various construction items compared to the construction schedule. Benchmarks were established which were compared to individual construction items from the contractor's schedule and to the opening of the convention center. These benchmarks were used to determine if the project was on schedule.

The contactor was required to provide a work plan describing the work that would be undertaken the week following the status meeting. The contractor was required to communicate what steps were to be taken to meet the scheduled completion date of each construction item and to regularly update the construction schedule if potential delays were identified. This ensured the project would be completed on schedule, and in fact, aided the contractor in completing the work ahead of schedule.

Coordination with Adjacent Convention Center Project

The east leg of 110th Street extends through the newly constructed Overland Park Convention Center. The Convention Center, in addition to the site work and roadway improvements to 110th Street between Lamar Avenue and Woodson Avenue, was under construction at the same time. Due to the nature of the Convention Center construction and the labor union agreements, the roundabout construction vehicles could not use the union gate at the east leg of 110th Street. Therefore, access was limited to the remaining three legs of the intersection.

In addition, the coordination of construction activities at the match point of the roundabout and Convention Center projects between both contractors presented some unique challenges. Both projects were at different stages of construction during most of the construction. It was rare that similar construction activities occurred during the same timeframe.

Partnering

The need to deliver the completed roadway improvement on schedule, with no allowance for weather delays, made partnering a necessity, but the arrangement was an informal partnering arrangement. This method allowed the stakeholders to quickly and effectively establish common goals, to develop trust and to foster commitments from everyone involved to successfully complete the project on schedule and within budget. This attitude was emphasized during the weekly progress meetings.

Contractor's Revised Schedule

All roadways leading into this intersection were closed during construction to expedite the completion. Construction began in March 2002. The roadway and intersection was scheduled to be complete and open to traffic by October 15, 2002. All work including landscaping was scheduled to be complete by November 15, 2002. The contractor revised his schedule mid-way through the project to fast track the completion of the entire project, including the landscaping, by October 15, 2002. This was accomplished including punch list items and site cleanup.

SAFETY PERFORMANCE

Safety Meetings

The agenda for each weekly progress meeting contained a "Safety Issues" discussion item. The construction representative identified safety infractions that had occurred during the previous week and the contractor was required to explain the steps that were necessary to prevent future infractions. The contracting company also held regularly scheduled safety meetings with representatives from their organization to ensure full compliance with safety procedures.

Traffic Control Inspections

The detour routes were driven twice each day, early in the morning and late in the afternoon. The daily checks included inspection of traffic control devices and signs for proper position and placement. Occasionally storms would cause some barricades or signs to blow over or move out of position. The traffic control sub-contractor would be contacted and corrective action would be taken. If required, the general contractor would take immediate action to correct deficiencies.

Pedestrian Safety

During the construction, several bicyclists attempted to ride through the construction zone. Protective orange mesh safety fence was installed and "Sidewalk Closed" signs were placed across all sidewalk entrances to discourage this type of traffic. Verbal warnings as well as written warnings were issued to violators. Constant vigilance by the contractor and City employees helped to prevent any construction zone accidents from occurring.

COMMUNITY RELATIONS

Public Information Meetings

Lamar Avenue is a major north/south artery in the City of Overland Park that residents and commuters travel to avoid heavy congestion on parallel roadways with I-435 highway interchange access. Formal public information meetings were held to inform the adjacent property owners of the project and potential impacts. Public notices and invitation letters were sent out, as well as published in the Kansas Register newspaper, to the adjacent property owners and surrounding community. One meeting was held at the preliminary plan stage and an additional meeting was held prior to the final plan stage.

Property Owner Notification

Due to the complexity and tight time constraints, Lamar Avenue and 110th Street were scheduled to be closed during construction. Businesses that generated significant amounts of traffic along this route were notified in advance of construction and were asked to inform their employees of the planned street closing and suggested detours. The adjacent property owners were contacted by telephone to inform them of the schedule of construction. The surrounding residential community was notified by mail of the planned construction and detours. The information packet also contained literature explaining the purpose for constructing a roundabout. The media was contacted one week prior to the closing, to publicize the road closure and a variable message board was placed at the intersection several days in advance to inform motorists of the upcoming road closure.

City Web Page Construction Updates

The City of Overland Park maintains a website where the Public Works Department posts information on street closures and the status of project construction. The City posted information on the website regarding the planned street closure and detours. The public was provided with names, email addresses, and telephone numbers of City personnel to contact for information or to answer questions. Additional information was posted on the website to educate and inform the public about roundabout design and the benefits for traffic flow. During construction, pictures of the work-in-progress were posted as well as explanations of the construction process. Updates to the web page were made weekly after the project status meetings. The web page also contained drawings and instructions for driving a two-lane roundabout.

Parallel Detour Routes

The 110th Street and Lamar Avenue intersection is situated just south of I-435, a major east/west urban interstate and north of College Boulevard, which parallels I-435. Lamar Avenue was closed to traffic just north of the Lamar Bridge over I-435 and at the College Boulevard intersection. 110th Street had been previously closed to the east of Lamar Avenue for the construction of a new combined Sheraton Hotel and City of Overland Park Convention facility. 110th Street was closed to traffic about 100 m west of the 110th Street and Lamar Avenue intersection. Local access to the Chase Suites Hotel and College Boulevard Business Center businesses was provided at all times by staging of the construction as needed. Multiple drive entrances were available to each of the developments. Access was maintained to at least one drive entrance at all times.

Motorists experienced some minor inconvenience and delay by having to re-route their travel because of the road closure, but the close proximity of the parallel roadways facilitated traffic detours. The longest detour only added one mile to the overall length of travel for the motoring public. Upon completion, the project was quietly opened to traffic to allow the traveling public to adjust to driving the two-lane roundabout with a gradual build up of traffic.

Property Owner Meetings
The construction engineer met regularly with the adjacent property owners to address any concerns that they had during the construction phase of the project. Issues relating to access, parking restrictions, approved contractor vehicle parking areas, alleged damages, which required repair and general project status was discussed throughout the project.

ENVIRONMENTAL PROTECTION

Physical Features
The contractor was required to install straw bale ditch checks and silt fences throughout the project to control sedimentation as well as ditch erosion. Inlet openings were protected with silt fence to minimize the amount of sediment that was washed into the storm drainage system. The construction engineer inspected the site monthly and within 24 hours after each rainfall event of 0.5 in or more. Additional silt fence or ditch checks were installed when warranted due to construction activities or conditions.

Contractor Activities
The contractor adjusted his schedule to postpone a majority of the clearing and grubbing activities along the construction limits of the project to minimize the potential for erosion and sedimentation. The existing sodded areas were not graded until the last possible moment.

UNUSUAL ACCOMPLISHMENTS

Equipment

The tight radius of the roundabout prevented the contractor from using a paving machine unless the machine was altered to allow for the tight tracking radius. Therefore, a hand operated concrete roller screed was used instead. One end of the roller screed ran along the inside curb and the other ran along the forms. It was critical to keep the curb clean so the screed was running on a smooth surface. The concrete finishing crew worked immediately behind the roller screed. The surface was hand floated. The edge adjacent to the curb and gutter section had to be slightly built up to maintain the proper elevation so the float did not pull too much material towards the outside. The surface was broomed radially outward from the center of the central island.

Figure 2: The concrete was placed between the concrete curb of the internal island and wooden forms and a roller screed was used to provide the initial finish of the circulating lanes. Both of the edges the roller screed rested on had to be kept clean to ensure a smooth finish.

Complexity of Design
The design of a roundabout presents unique challenges since there are almost no straight-line grades or horizontal geometry. There was very little that was standard about this project in terms of horizontal and vertical geometry and pavement width and cross-slope. The pavement was designed to slope outward from the central island. The cross-slope varied from 3% on the 110th Street approaches to 1% on the

Lamar Avenue approaches. The cross-slope transitioned uniformly between each of the approach legs. The elevation of the pavement at the outside edge of the circulating lanes was held at a constant elevation. Therefore, to achieve the correct cross-slopes, the profile of the central island curb was designed to replicate a sinusoidal wave that created two low points for drainage. Cross-slopes were warped at each radius point to match the instantaneous cross-slopes of the approach pavement and the outside edge of the circulating lane pavement. The pavement width at the entry point of the roundabout was designed to accommodate two approach lanes and two departure lanes that merged back to one lane on the entering and exiting roadways respectively. Therefore, the pavement had a continuous width transition from two lanes to four lanes throughout the entire project. Vertical curvature of the profile occurred simultaneously with horizontal curvature of the roadway along with variable cross-slopes and transitions throughout most of the project. Triangular splitter islands with offset approach noses and monolithic flush crosswalks added to the complexity of the design and construction. Diligent inspection of the grade control was necessary to ensure that the ride would be smooth and the pavement would drain adequately. The contractor also took extra precautions to ensure elevations were accurate.

Pavement Load Requirements

The main portion of the roundabout extending from the central island to the approach of each splitter island nose was constructed of concrete pavement. The approach pavements on the north, south and west legs of the intersection were constructed of asphalt. The east leg was constructed entirely of concrete from the central island to the end of the project limits to match the concrete pavement that was being installed on 110th Street. In order to get the subgrade covered with pavement and eliminate saturation during rainfall events, the contractor installed the first lifts of asphalt prior to constructing the concrete pavement. The requirements for the City of Overland Park did not allow the contractor to haul loads on single lifts of asphalt. The requirements also limited concrete delivery truckloads greater than 8-cubic yard loads on surfaces that are constructed of two asphalt lifts. Therefore, the construction of the concrete pavement could not begin until at least one other leg of the intersection was constructed of two lifts of asphalt pavement.

QUALITY CONTROL

Base Preparation

The construction of the roundabout required the construction of a new storm water system. Precast concrete inlet structures were placed according to survey staked information and reinforced concrete pipe was installed to convey storm water run-off. Fill areas were constructed according to a visual inspection of the fill as it is constructed. The soil is required to contain sufficient moisture such that it will compact and a sheepsfoot compactor will walk out of the fill. Once the subgrade elevation was reached, the upper 8 in was fly ash treated. Proctors were prepared which showed that eighteen percent fly ash with 18% moisture produced the greatest strengths.

During the fly ash manipulation, moisture was controlled by performing a Speedy Moisture test for each pass of the tiller. After several days of cure, nuclear density readings were taken to ensure proper compaction. After the subgrade was fly ash treated, edge drains and underdrains were installed to transport water away from the pavement sub-base. A 5 in aggregate drainable base known as OP Special, (the specification was written by the City of Overland Park), was then constructed on the fly ash subgrade.

Stringline

The roundabout design was horizontally and vertically complex. The construction engineer wanted to maintain tight tolerance control for the concrete pavement. It was determined that the best way to accomplish that goal was to construct the curb and gutter first, which would establish vertical and horizontal control for the concrete pavement and jointing.

Curb and gutter grade control was established with stringline. Steel pins were placed and the stringline was set according to survey hubs. The stringline was visually examined and additional pins were placed as needed. Further visual examination was performed and the stringline was fine-tuned and adjusted to a smooth line. Concrete curb and gutter was machine placed using electronic grade control, which established good grade control for concrete pavement. Forms for concrete pavement were set using stringlines and checked with engineers' survey level. A final grade check using stringline, level and eye was performed prior to concrete placement.

Joint Pattern Techniques

Spray paint was used to lay out the jointing plan on the drainable aggregate base prior to construction of the curb and gutter sections. This established the saw cut patterns that would ultimately extend across the concrete panels and driving surface. These paint markings were freshened as needed to aid in the joint layout for saw cutting of the control joints. Wooden forms were set along the planned locations of the longitudinal joint lines. Epoxy coated dowel bar baskets were centered on the painted joints prior to placing the concrete. This ensured that the concrete dowels were aligned properly with the control joint saw cuts.

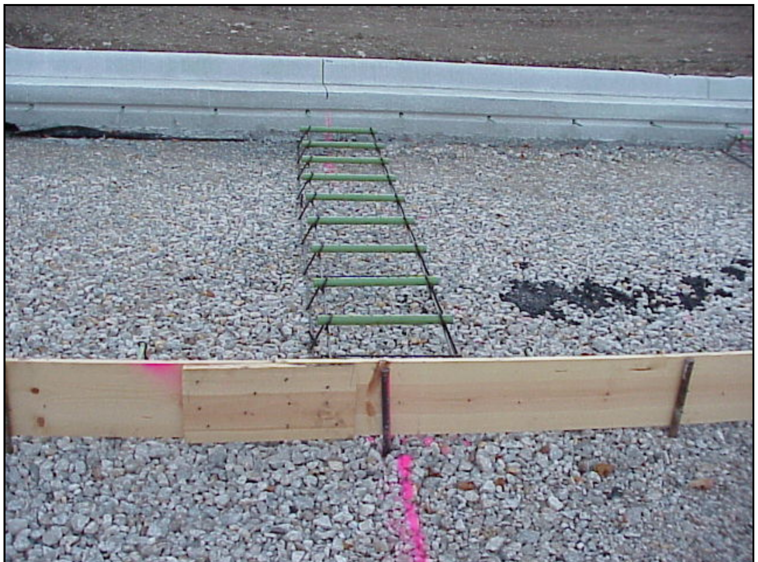

Figure 3: The joint pattern was spray painted on the aggregate base and projected from inside to outside curb to ensure the joints lined up across the circulating lanes. This also provided a guide for placement of the dowel bar baskets.

Quality Control for Concrete

The City of Overland Park Public Works Department took an active role in the development and implementation of the Johnson County Concrete Board (JCCB) for assuring that quality concrete would be available to the City and surrounding municipalities. The JCCB is a cooperative effort of public works organizations in Johnson County whose goals are to standardize the use of improved concrete technology and simplify the process. The Board agreed in the fall of 2000 to implement improved technology by requiring compliance with a new Johnson County Concrete Specification for municipal and county projects constructed after April 1, 2001. The mix designs developed consisted of granite aggregate instead of limestone, which had previously been determined to cause premature disintegration of the concrete. Additionally, the City retained the services of an experienced certified inspector and licensed professional engineer who specializes in construction. This individual worked full-time on-site to ensure that quality construction was emphasized throughout the entire construction process.

Concrete Batching and Hauling Techniques

The concrete supplied was a mix with granite aggregate that provided 4000 psi strength. Chilled water was used to control the temperature of the concrete mixture during the hot summer weather. The concrete mixture was delivered from the plant to the job site with ready mix trucks. The concrete mixture was tailgated by chutes for placement as much as possible. When the concrete could not be placed by tailgating with the truck's chutes, a concrete pump truck was employed.

Concrete Placement and Testing
It was required that placement of concrete be completed within one hour of batching concrete at the plant. Additionally, the contract specifically stated that the "Contractor shall submit a plan of work and schedule of concrete delivery a minimum of 24 hours in advance of concrete placement. The contractor and concrete producer shall work diligently to deliver the concrete within the specified time limits and at regular intervals to avoid delays in placing the concrete." The contractor producer, assigned personnel to the point of delivery to ensure the concrete arrived within the required time and to monitor the quality of the concrete. When the trucks arrived on-site, the concrete was visually inspected for granite aggregate by hand washing a sample of the concrete and checked for slump. If it was determined that the slump needed to be increased, water could only be added to the concrete load one time and had to be introduced into the drum mixer by hand in calibrated 5-gallon plastic buckets. Concrete materials testing was performed on the first load delivered and additional tests were performed for each 50-cubic-meters of concrete placed per day. The concrete was tested for slump, temperature, unit weight, aggregate, and strength. One set of beams was made for each day of concrete pavement production and a set of six cylinders were made for each 65 cubic yards of concrete placed per-day.

Consistent Concrete Mix Design
When concrete was placed using a pump truck, the percentage of entrained air was increased due to losses realized through the pump. The concrete air content was tested after discharge from the pump to ensure the air content was within the specified limits. The resident engineer constantly monitored the placing and consolidation of the concrete mixture. Careful attention was paid to the concrete vibrating to prevent over-consolidation, which would result in loss of entrained air and segregation of the concrete mixture.

Materials
Readily available materials were incorporated into the project to control cost. Granite aggregate was required to be used in the concrete mixture, instead of limestone. The construction engineer rinsed out handfuls of the aggregate several times per truckload during placement to insure the use of granite aggregate.

Materials Testing and Acceptance
An independent testing laboratory was hired by the City to conduct materials testing throughout the construction phase. The tests followed the Kansas Department of Transportation frequency and testing procedures. Moisture/density tests, fly ash testing and field density tests were conducted to verify the proper compaction of the subgrade. Moisture/density tests, plasticity tests, aggregate sieve analysis and field density tests were conducted on the aggregate base course to insure compliance with the specifications. The concrete testing included cylinder testing, slump tests, unit weight tests, aggregate and deleterious materials testing, temperature and air content testing as well as beam tests. In addition, asphalt concrete assurance tests were conducted to validate the asphalt testing conducted by the contractor according to the specifications.

Contractor's Quality Control Program
The contractor's quality control program was tailored for this project to specifically address the contract requirements and acceptance criteria. The contractor's project manager personally supervised the construction process and worked closely with the resident engineer to ensure that 100% of the acceptance criteria was incorporated.

Pavement Smoothness
A ten foot straightedge was used to check surface smoothness due to horizontal and vertical geometry of the roundabout design. The variation of the surface from the testing edge of the straightedge between any two contact points, longitudinal or transverse, with the surface was not to exceed 1/8 in.

Asphalt Mix Design

The City has developed an asphalt mix that has been successful in reducing rutting and shoving. The specifications have close tolerances on aggregate gradations, VMA, percent voids and asphalt content. Each asphalt producer is required to provide test reports that prove they can meet the required specifications. The specifications require one set of tests for each mix produced for Public Works Department contracts to be taken during the initial production each year and one set of tests for each 10,000 tons produced that year. Certified test results of the mix design and materials were submitted 30 days prior to commencing construction for review by the City Engineer. The test results are required to include all detailed raw calculations for the composition of the mix design and all specific gravity calculations. The contractor's testing laboratory was required to verify the properties of the mix by sampling and testing the uncompacted mix placed behind the paver. Extraction and gradation tests were required as well as a determination of the minimum VMA of the samples that were obtained behind the paver. Strict acceptance criteria based on percent voids and a void filled was used as a basis for either accepting or rejecting the asphalt. The City employed testing laboratory also took random assurance samples to verify the tests that were performed by the contractor's laboratory.

CONSTRUCTION TECHNIQUES

Field Layout of Jointing Plan

The nature of a circular intersection created a very unique jointing plan. Since the curb and gutter was constructed first, it was critical to have the construction joints in the correct location to avoid reflective cracking across mid panels of the driving surface. To aid in their proper location, the entire jointing plan for the driving surface was painted on the subgrade. The construction joints were then projected to the curb and gutter sections so they would match the final construction joints of the surface. Many things had to be considered during the placement of the construction joints. Radial points in the curbs on the splitter islands and median openings for crosswalks controlled joint locations along the inner edges. The end of inlet curb transitions controlled the joint locations along the outer edges. The joint locations along each edge had to be aligned with the other to attain somewhat uniform panel sizes.

Figure 4: Construction joints on the curb of the internal island needed to align with the construction joints on the outside curb line to avoid reflective cracking across the circulating lanes. There were many control points that needed to be taken into consideration and the painted joint pattern on the aggregate base provided the proper guidance.

Panel Size Control

The two circulating lanes were constructed as three separate rings 10 ft-4 in wide tied together laterally with deformed tie bars. These operate as the longitudinal joints for the circular driving lanes. Radial construction joints uniformly spaced around the circular lanes were saw cut over the top of dowel bars that were placed on the subgrade prior to placing the pavement. Because the construction joints were radial, the panel sizes in the inner ring were smaller than the panel sizes in the outer ring, and the inner edge of each panel was shorter than the outer edge. It was critical to maintain a proper aspect ratio for all the panels across the circulating lanes so the panel sizes did not become too large along the outer ring or too small along the inner ring.

Isolation of the Circulating Lanes

The circulating lanes were completely isolated from the entry pavement by a 1 in fiber expansion material so the radial construction joints would not reflect into the approach pavement. The common edges between the circulating lanes and the entry pavement were thickened to assist with load transfer.

Sequence of Construction

The sequence of concrete pavement construction began with the placement of concrete for the inner ring of the roundabout and sequentially advanced outward and away from the center of the roundabout.

Figure 5: Construction sequence consisted of placing the concrete for the inner ring of the circulating lane first followed with half of the middle ring. The remaining half of the middle ring and half of the outer ring is being formed. Note the monolithic curb and pavement sections on the splitter islands and outer curb line.

The aggregate drainable base was saturated with water prior to placing the concrete mixture. The concrete was delivered with ready mix trucks and was tailgated with chutes or pumped into the forms. The two circulating lanes were placed in three separate rings. The inner ring was placed first in its entirety. Deformed tie bars were used along the longitudinal joints to prevent differential settlement between the rings in the circulating lanes. Dowel baskets were placed on the painted layout for the radial construction joints.

After the middle ring was formed, insufficient width in the remaining outside ring prevented concrete trucks from negotiating around the roundabout. The middle ring was placed one-half at a time. The concrete was pumped into the remaining rings of the circulating lanes once the forms were in place.

The remaining half of the middle ring and half of the outer ring were placed at the same time. The remaining half of the outer ring was placed along with some of the approach pavements.

The curb and gutter sections at each curb return and around the splitter islands were placed monolithically with the pavement to eliminate small and irregular shaped panels. The remaining portions of

Figure 6: Placement of the concrete in the remaining half of the outside ring of the circulating lanes occurred simultaneously with some of the approach and departure lanes. The concrete pavement ended at the end of the splitter island. The pavement approaching the roundabout was asphalt, except on the east leg which was totally concrete.

the approach and departure lanes were completed last. Careful planning of the sequence was necessary so the contractor could control access of equipment such as water trucks, concrete trucks and grading equipment.

The project required piecework construction for all the approach and departure lanes. The south approach lanes were constructed first to allow access onto the circulating lanes for the remaining concrete placement. The outer lanes of the approach and departure lanes were constructed on each leg of the intersection first. The inner lanes of the approach and departure lanes were constructed last. The remaining work consisted of preparing the splitter islands to receive a 4 in concrete base for the paver stones, the decorative retaining walls, and the grading for the sidewalk.

Figure 7: Sections of the curb were placed monolithically with the pavement around curb returns and splitter islands to control cracking and to eliminate small, irregular shaped panels. Note how the contraction joints lined up across the circulating lanes.

Figure 8: The completed roundabout with a retaining wall and raised bronze lettering serves as an entry marker to the Overland Park Convention Center.

CONCLUSION

Careful planning during construction is a necessity for the successful completion of a concrete roundabout. Although the plans identified the correct jointing pattern, the successful execution of that plan could not have been accomplished without advance planning by the contractor and the inspector.