Aurora Municipal Center's Stunning Design Showcases the Possibilities of Precast Concrete Solutions

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To better serve a growing population, the city leaders in Aurora, Colorado, recognized the need to replace an outdated city hall with a new Municipal Center. Set on a sprawling site, a new 35-acre (14.1 ha) civic campus consolidates twenty-six municipal departments in an ambitious master plan that combines open space with a five-story, 286,000 sq ft (26,570 m^2) building and an 800-car parking structure. The City Council did not want a "trendy" facility, but, rather, one that would reflect the dignity of their rich governing tradition. An all-precast concrete solution provided the timeless look of loadbearing masonry appropriate for a government center and also offered significant schedule advantages over a steel frame structure. This article presents the plan, design, construction, and architectural features of this stately project, including a two-story precast concrete loggia and the state-of-the-art Council Chamber with 70 ft (21.3 m) clear spans, and a four-story parking structure. This fast track project took 26 months to be completed.

Looking toward the future, city leaders in Aurora, the third-largest city in Colorado, recognized that their outdated 1970-era city hall with over 25 municipal departments was struggling to serve its growing population of 290,000 citizens. A master planning effort was begun to develop a "civic campus" organized around a 3-acre (1.2 ha) lawn that would unify a series of existing buildings on a larger 35-acre (14.1 ha) site. In this article, the authors present the innovative design and production techniques of an award-win-

Fig. 1. Looking westward, an aerial photograph captures the visual impact of the clean, classic design lines of the east elevation of the new City of Aurora Municipal Building. The stately structure works in harmony with landscaping and existing city buildings. [Photography courtesy of Aerial Arts]

ning all-precast concrete solution that produced a stunning municipal complex (see Fig. 1) while affording significant design-construction schedule advantages over alternative systems.

Barber Architecture designed a new civic campus to efficiently incorporate existing buildings and roadways on the site into a cohesive, functional, and flexible plan. The elimination of a redundant street allowed the new Aurora Municipal Center (AMC) to join the existing composition of structures at the eastern edge of a new lawn, and completed the visual and physical connections between the older facilities. The site plan in Fig. 2 illustrates the fluid blend of open space with logical connections between structures. This grand gesture of open space reserves additional parcels of land for future development.

The length of time between the letting of the AMC contract and expected occupancy was short for a project of this size, and non-negotiable.

Fig. 2. Site drawing shows the City of Aurora's "civic campus" and the relationship between the new Municipal Center and existing city buildings.

Table 1. Construction schedule and project costs.

Design start	January 1, 2001
Construction start	October1, 2001
Onset of precast concrete production	October 1, 2001
Precast concrete erection start	February 1, 2002
Precast concrete erection finish	June 2002
Building occupancy	March 1, 2003
Precast concrete package cost	**$11,200,000**
Total project cost	**$71,800,000**

Compressing the completion calendar for the new structure was critical, as the existing city hall was overcrowded with woefully inadequate amenities. The tight schedule for completing a new Municipal Center seemed in juxtaposition, however, to creating a timeless structure with state-of-the-art construction. Only 26 months was allotted – from the beginning of architectural drawings to building completion – for both the 286,000 sq ft (26,570 m^2) Municipal Center and the 241,000 sq ft (22,390 m^2) parking structure (see Table 1).

Beyond the functionality of the master plan, the City Council and staff requested a facility that would not be perceived as faddish or trendy, but rather would reflect the rich tradition, stability, and dignity of Aurora's history and government. The flexibility and inherent beauty of precast concrete made feasible the creation of the timeless look of loadbearing masonry in a neoclassic style appropriate for a municipal center – with significant schedule advantages over a steel frame building with brick or stone cladding.

In addition to the high expectations for the building's aesthetics, proximal placement of the city's largest municipal departments required a 56,000 sq ft (5200 m^2) floor plate with spans of 70 ft (21.3 m) in many areas. Figures 3 and 4 show plans of Levels 1 and 2, respectively, of the Municipal Center.

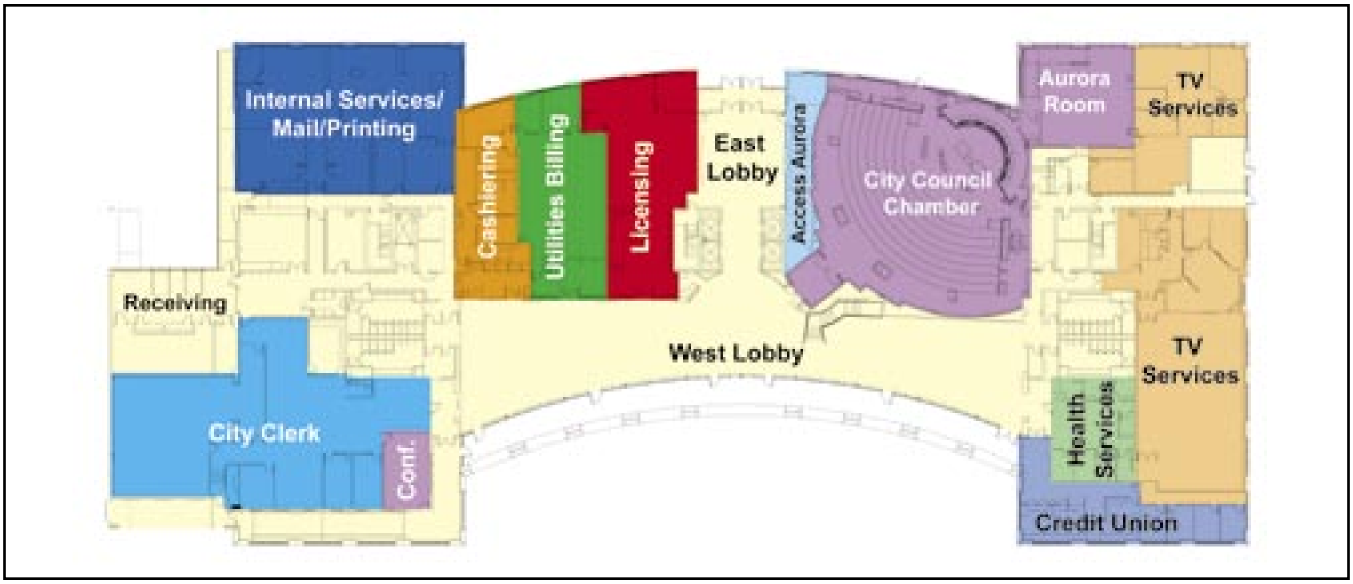

Fig. 3. A plan drawing of Level 1 represents the first floor positioning of the departments most frequently used by the public.

Fig. 4. A Level 2 plan view shows the efficient consolidation of all departments vital to obtaining and reviewing permits.

Fig. 5. The expansive open space in the City Council Chambers has 70 ft (21.3 m) spans, which are made possible by precast concrete double tees. [Photography courtesy of Michael Peck Studio]

PLANNING OF PROJECT

The proposed site for this project was originally a stand-alone parcel of land bounded by four roadways near the corner of East Alameda Parkway and South Chambers Road in the City of Aurora. Barber Architecture of Denver, Colorado, conducted an intense master planning effort and, with the participation of city officials, identified the major site strategies that were refined and presented to the Aurora City Council.

The City Council unanimously approved the creation of a civic campus to unite the existing library, justice center, police station, and the museum with an expansive landscaped lawn. This comprehensive plan necessitated the vacating of Alameda Drive, which had originally bisected the city property. Ultimately, the city campus provides more flexibility for city planners by creating additional sites for future buildings, including a cultural center, and expansion to the museum and library.

City Goals

Early in the project's conception, city planners and Barber Architecture developed three goals for a new municipal center. The master plan called for a civic center that would:

- Create a strong image and enduring identity for the city.
- Be inviting and promote customer service for citizens.
- Enhance the employee experience, thereby helping to recruit and retain quality personnel.

With the concepts for these goals in hand, detailed programming and schematic design for the city's 26 departments commenced. This ambitious project program included a striking state-of-the-art, 300-seat Council Chamber (see Fig. 5), a consolidated permit center, a studio and production facility for Aurora Public Television, and an employee cafeteria with an exterior dining terrace.

Teamwork

Barber Architecture and The Weitz Company, of Denver, Colorado, worked in concert to address the needs of the city. This groundbreaking project was by far the largest ever undertaken by the City of Aurora using the design/build method of delivery. The City of Aurora carefully prepared an initial detailed program of needs that allowed the Weitz/Barber team to accurately quantify project requirements and costs, and schedule design and construction activities to achieve the city-specified move-in dates.

Fig. 6. Punched window detailing in wall panels is testimony to the design versatility and inherent attractiveness of architectural precast concrete.

Fig. 7. Custom bronze medallions are recessed within the detailed precast panels.

Fig. 8. The neoclassical style continuity of both structures is apparent in this aerial photo of AMC from the vantage of the parking structure. [Photography courtesy of Aerial Arts]

Documentation, however, proved to be just the starting point. Over the course of the project, changes in city requirements and in the state of the economy provided both the need and opportunity for adjustments to the plan. The City of Aurora representative met regularly with the design/build team to review progress of design and, later, the actual construction. This teamwork ensured that critical day-to-day decisions were addressed promptly with full coordination with the City Administration and City Council.

As a result of this mutual effort, without increasing the budget or changing the occupancy dates, substantial enhancements to the original program were achieved; these improvements included a larger building, a full-service Café, a larger fitness center, and upgraded exterior finishes.

DESIGN OF FACILITY

Consistently throughout the design process, City Council and staff reiterated the desire for a dignified, classic structure. Consequently, the final facility, including the parking structure, was rendered in a neoclassical architectural design. The two, five-story office wings feature acid-etched architectural precast concrete panels with punched windows and deep reveals. The building's wings are connected by a glassy, central six-story curving element with a sloping metal roof (see Figs. 6 to 9).

Municipal Building

AMC is an all-precast concrete structure with architectural precast loadbearing wall panels, precast concrete core walls, beams, and double tees. With five floors plus a mechanical penthouse, the Municipal Center rises to a height of about 116 ft (35.4 m). The Aurora Municipal Center is about 376 ft (115 m) long and 186 ft (56.7 m) wide (see Figs. 10 and 11).

On the building's west façade, facing the lawn, an impressive two-story, double-sided precast concrete loggia rises from a plaza and shades the lobby beyond. Fig. 12 illustrates the classic lines of the double-sided free-standing precast columns. The dramatic loggia required concealed connections in the columns to create the desired architec-

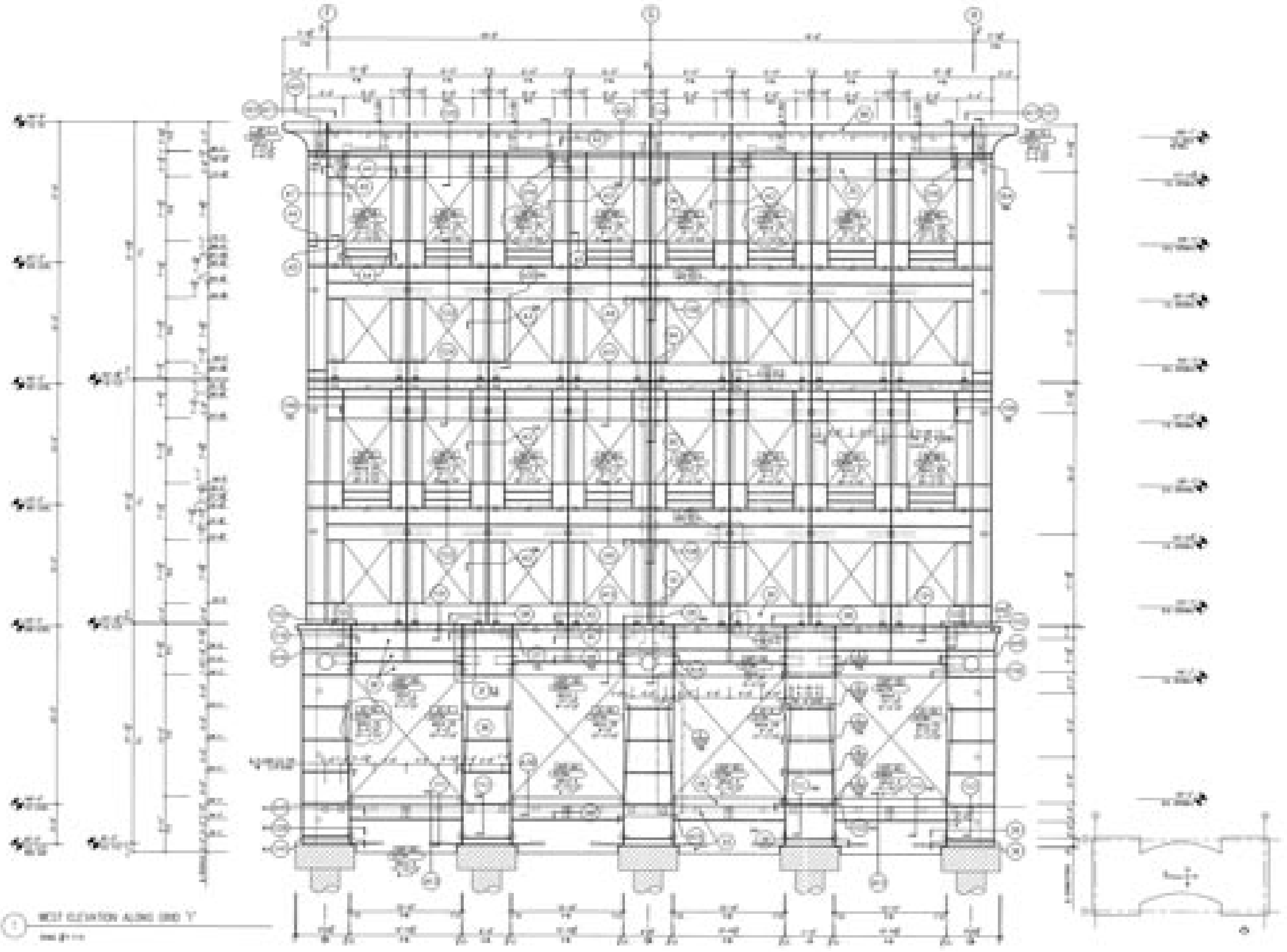

Fig. 9a. West elevation of the Aurora Municipal Center at Grid Y.

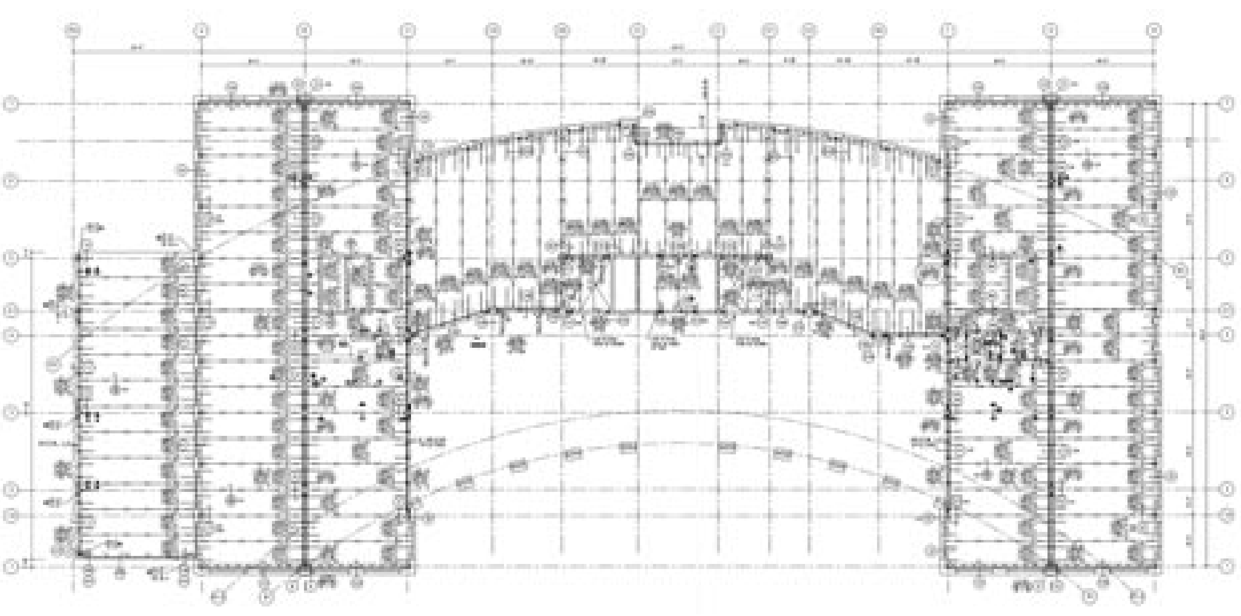

Fig. 9b. Plan of the Aurora Municipal Center.

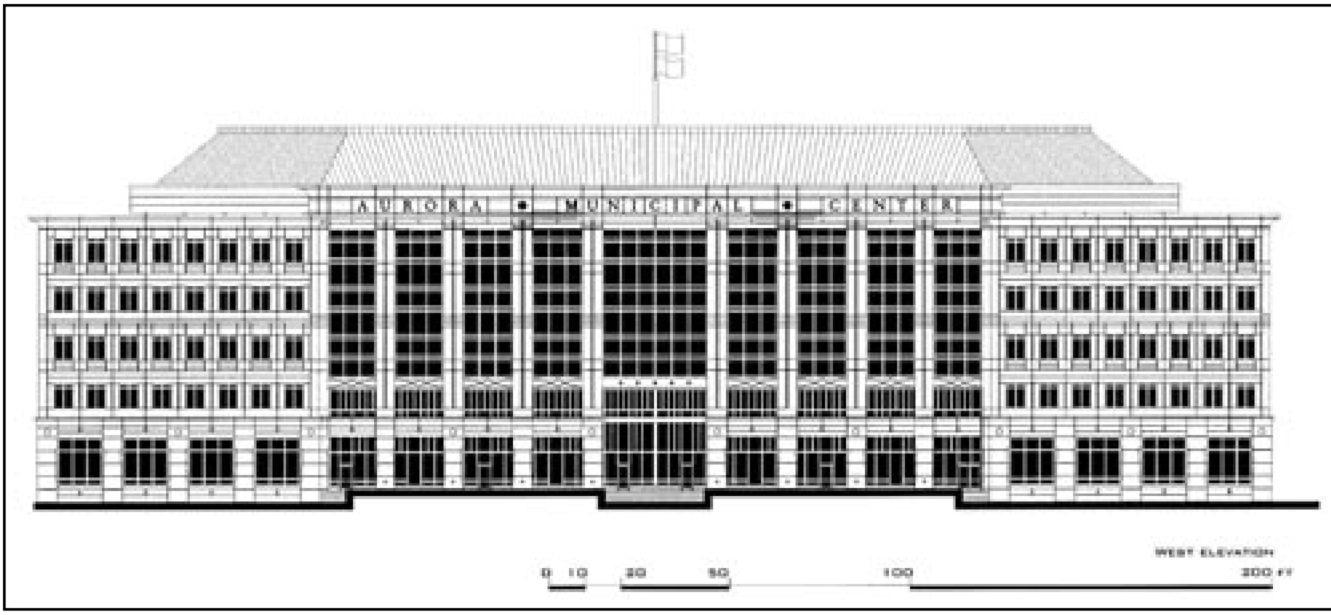

Fig. 10. Elevation of the Municipal Center provides scale and dimensions.

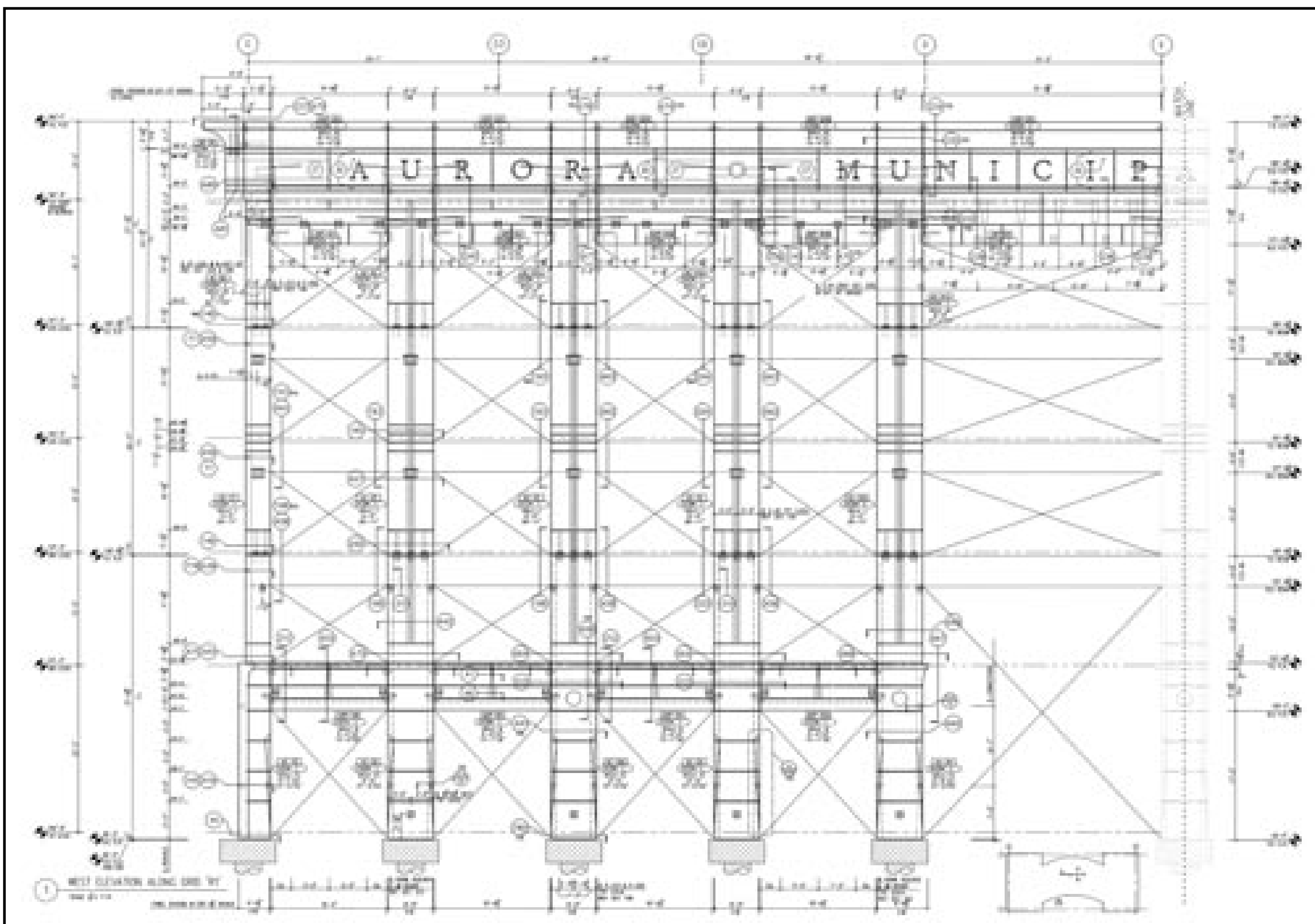

Fig. 11. Entrance elevation drawing at Grid R1.

tural style. The lobby, plaza, and lawn are intended to be used simultaneously for public events and serve as a unifying element for the existing, as well as future, buildings on the site. The height of the lobby and first level is 22.2 ft (6.8 m), and all other levels are 15 ft (4.6 m) in height.

The facility's floor plan is designed for maximum ease of use for both the public and the city's 800 employees by locating similar services adjacent to each other, and placing the most often visited departments on the lower two floors, easily accessed from a two-story lobby. Abundant use of natural light, high-tech infrastructure, indirect lighting, and training space improve the quality of the work environment for city staff.

As part of the City of Aurora's commitment to serving citizens, a one-stop permit center was conveniently located on the building's second floor. This integrated center was provided for obtaining permits and securing reviews from several municipal offices, including the departments of Planning and Zoning, Building, Utility and Public Works. All local construction project plans must pass through these service departments for review and permitting procedures; the central location of these offices saves time for the developer, architect, and contractor.

Offices most visited by the public were made accessible by locating these departments on the building's first two levels, providing efficient inter-office logistics and public convenience. Open to visitors as well as employees, the Café on the second level offers 250 indoor and terrace seats. Four high-speed passenger elevators and one dedicated service lift expedite public access to all offices. The location and integration of municipal functions adds not only to the quality of public service offered, but also improves communication among the various city departments.

The Municipal Center includes an impressive state-of-the-art, 300-seat Council Chamber displaying 70 ft (21.3 m) clear spans (see Fig. 5). This unobstructed open space was easily accommodated by using 32 in. (813 mm) deep precast double tees. Other precast concrete features on the civic campus include custom light bollards, signs, wall caps, and gateway walls at the main public entry drive.

Fig. 12. An elegant loggia with free-standing precast concrete columns greets visitors to the complex.

Parking Structure

The four-level parking structure has architectural precast concrete perimeter spandrels, beams, double tees, columns and other structural components. The exterior of the parking structure matches the architectural style of the adjacent municipal center with highly detailed exterior precast concrete spandrels (see Fig. 8). The parking facility is 33 ft (10 m) high, 180 ft (55 m) wide and 352 ft (107 m) in length. Bays are 61.67 x 30 ft (18.8 x 9.1 m) and 58.3 x 30 ft (17.8 x 9.1 m) in overall dimension.

The 241,000 sq ft (22,390 m^2) parking structure can accommodate about 800 vehicles, with about 63,000 sq ft (5853 m^2) of space on each level and is designed with a central two-way ramp leading to 90-degree parking spaces. Both the Municipal Center and parking structure used about 4660 cu yd (3563 m^3) of architectural concrete and 8780 cu yd (6713 m^3) of structural concrete. The total amount of space created in both the AMC and the parking structure was 527,000 sq ft (48,960 m^2).

The first level of the parking structure provides an 8.5 ft (2.6 m) height clearance for vans and city vehicles with roof racks and light bars. Two hydraulic elevators provide access to all levels. Enclosed entryways from the structure are afforded on the first and second levels. In Colorado, where the average annual snowfall can exceed 25 in. (635 mm), snow gates facilitate the removal of snow and avoid the loading problems caused by plowing ice and snow into the corners of the parking structure. The cost of the parking structure was $7.8 million, or about 10 percent of total project cost of $72 million.

PRODUCTION OF PRECAST COMPONENTS

Precaster Challenges

One of the challenges for the precaster, Rocky Mountain Prestress, of Denver, Colorado, was the complicated fabrication and erection of the large cornices that project 3.0 ft (0.9 m) and curve in two directions (see Figs. 13 to 16). To facilitate faster production, the cornices were cast integrally with the wall panels.

By deciding to change to an integral casting of the cornices, the precaster was able to reduce the number of fabricated pieces required. In addition, this change meant that production would accommodate the tight project schedule, ensure better alignment between precast panels, and avoid the need for large connections from the wall to the cornice. However, at the corners of the building, the cornice was cast separately in a V-shaped mold so that the acid-etched finish would be consistent on both sides. Both of these changes required more extensive formwork, but produced higher quality finishes and a faster erection schedule.

Fig. 13. View of corner cornice detail.

Each wing of the AMC building was framed using the massive architectural columns and spandrels at the second level to support all the loadbearing two-story architectural walls above (see Fig. 9). Since the architectural precast concrete walls had large window openings, 3 in. (76 mm) deep reveals and an integral cornice, special attention was paid to the handling of each piece.

The requirements for stripping, storage, transportation, and erection (including tripping and shoring) were analyzed carefully to ensure the utmost efficiency. This analysis was completed early in the project and drove the decision to produce the walls in that configuration.

Parking Structure

The primary challenge of the parking structure was actually faced during the design phase. The garage needed to complement the office building's architectural features yet remain cost effective. Weekly design meetings allowed the project team to explore architectural details that would be aesthetically

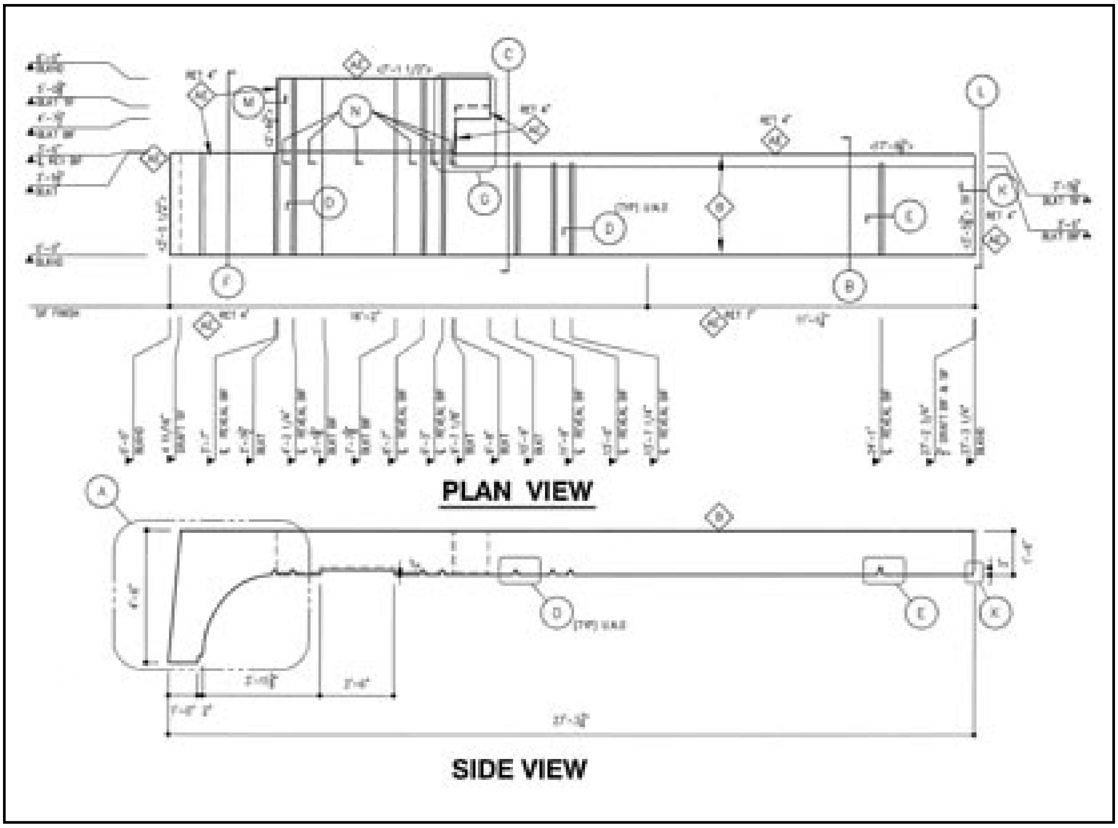

Fig. 14. Plan and side view of typical panel with attached cornice.

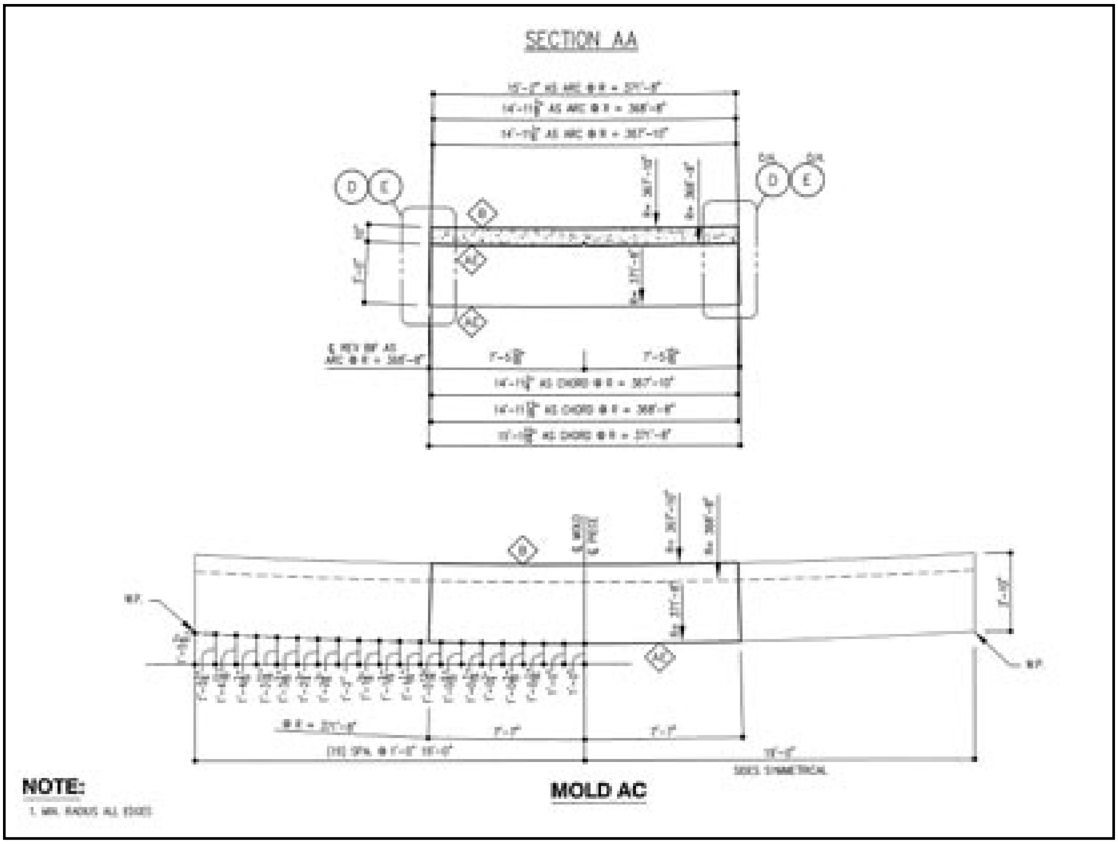

Fig. 15. Side view and section of mold for casting curved parapet.

pleasing yet keep costs in check. These weekly meetings proved very successful, not only for solving design issues, but also in establishing a forum that kept all members of the project team informed and up-to-date on the critical forming and erection schedule.

The double tees of the parking structure also presented a design challenge. Because the roof span was a little longer than that of a typical garage structure, and snow loading was a significant factor, the double tees required extra attention to detail. Initially, there was some concern that use of a 10dt24 double tee would not be feasible, but after several design iterations, a reasonable design was reached, thus eliminating the need to use a deeper member. The total precast concrete cost for the AMC and parking structure was about $11.2 million (see Table 1).

Fig. 16. Trailer bed transport of two curved precast concrete parapet pieces. Production of these projecting parapets required high skill and tight tolerances.

A Proactive Approach

The office building utilized about 15 forms to produce the required shapes. The scheduling of form fabrication proved to be complex. It was critical to balance the production of every form with the demands of the erection scheme. Because the building was erected all the way to the roof in selected areas, a few pieces from each form needed to be available at the start of the job. In order to balance form building and piece production with the erection schedule requirements, the erection sequence for each precast concrete piece needed to be scheduled prior to establishing the form-building schedule.

To facilitate the accelerated schedule, a drafting and engineering team of 10 people worked together to produce the precast concrete designs and shop drawings. Although the project occupied about 50 percent of the architectural plant's production capacity, the key to the precaster's success was not based on an increase in staff or production rates, but rather on the efficient scheduling of the product. A very proactive approach was taken by Rocky Mountain Prestress and The Weitz Company to carefully analyze and reanalyze the erection sequence for the building.

Several schemes were thoroughly assessed before the final production model was determined. This difficult analysis was well worth the result: a tight, yet efficiently-managed, schedule. Ultimately, the cooperation and collaboration in the planning stages and the efficient execution of that resultant plan ensured success in achieving the production goals established for the project.

Finishing and Transportation

Unlike past projects, the specified architectural finish for the AMC required the precaster to produce a deep acid etching technique using a new concrete mix design. Since the cornice and massive architectural columns had an acid-etch finish on vertical returns and the concrete mix design was untried, Rocky Mountain Prestress cast a mockup specimen with a large return to confirm the finish quality of the return surface. This simulation was completed and analyzed before any final determination was made on the best methods to panelize the architectural elevations or configure the formwork.

Fig. 17. Weighing 34,000 lb (15,422 kg), a 32 x 10 ft (9.8 x 3.1 m) loadbearing precast concrete wall panel is tripped from the flatbed.

Table 2. List of precast concrete components.

Precast component	Dimensions	Gross weight, lb	Total number
Architectural loadbearing wall/spandrels	Varied	55,000 max.	555
Grey precast concrete walls/spandrels	10 and 12 in. thick	26,500 average	270
Beams	29ITB44-12	35,000	130
Double tees	10 ft wide x 18, 24, and 32 in. deep	45,500	931
Columns	18, 20, 24, 30, and 12 x 48 in., and 24 x 72 in.	54,000 max.	345
Other			± 230
Total			**≈ 2500**

Note: 1 lb = 0.4536 kg; 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Storage and Transportation

The precast yard was located about 17 miles (27 km) from the AMC construction site. Since most of the precast concrete pieces were very large, some weighing upwards of 28 tons (25 tonnes) (see Fig. 17 and Table 2), the trucks only carried an average of 1.4 pieces per trip. Even though the job site was relatively close to the precast plant, 15 to 25 trucks were needed each day to supply all the cranes on the site. In addition, some trucks were able to transport and deliver four loads in one day. All the logistics of this fast-paced schedule resulted in a very busy construction site and production plant.

ERECTION OF FACILITY

Contractor's Perspective

Originally, the City of Aurora issued a request for proposal (RFP) for either a precast concrete structure or a steel structure with a brick or stone exterior for the new Municipal Center. The same RFP, however, specified a daunting completion date for occupancy. After analysis of alternatives, it became clear that precast concrete was the best solution for an on-time project delivery according to the project contractor, The Weitz Company. Because a precast concrete exterior would be in place as soon as the loadbearing wall panels were erected, the labor and time-consuming construction of a masonry façade over a steel or concrete structure was eliminated.

For the contractor, the feasibility of meeting the on-time delivery of the structure for occupancy was a major benefit in building a precast concrete system. The contractor also took advantage of additional erection savings and efficiencies: a precast concrete system required less on-site labor and material delivery traffic as compared to that of typical brick construction. Selecting precast concrete for the building, however, required value-engineering changes that could generate about a 15 percent reduction in cost for the precast concrete portion of the budget; this savings represented about $2 million, or 3 percent, of the overall project cost.

Engineered changes took advantage of the inherent flexibility of precast concrete designs. To help reduce erection expenses, value engineering was applied to the design of the curved spandrel pieces in the center portion of the building. Computer modeling predicted that the spandrel chord would generate very small variations in curvature; as a result, straight segments were used, and the original compound curves – extremely difficult forms to fabricate – were avoided in the center section of the building.

Additionally, a concerted effort was made to reduce the total number of molds required for the project. This was accomplished by maximizing piece sizes and utilizing similar precast components whenever possible. The goal of reducing the total number of required molds led to the decision to combine other precast concrete elements, and this option also minimized erection costs.

Several examples illustrate the design flexibility of precast concrete in economical reductions in total number and size of required pieces:

- Loadbearing exterior walls were used rather than a column and beam system.
- Structural tees were designed 32 in. (813 mm) deep and 70 ft (21.3 m) in length with additional prestressing tendons (avoiding the erection complications and loss of space that would result from beams and columns).
- The parking structure was reconfigured to utilize standard size precast double tees.
- Rooftop loads were reduced by replacing mechanical screening with a lightweight metal enclosure, consequently reducing the size and cost of the supporting members below (see Fig.18).

Coordination Between Precaster and Contractor

As soon as the decision was made to proceed with precast concrete for the structure, Rocky Mountain Prestress of Denver, Colorado, began work detailing the pieces. At the same time, the contractor was able to start the foundation work and begin sequencing the erection process. Two different approaches were evaluated for the erection sequence.

The first erection sequence considered was "plating," or construction of the entire floor plan one level at a time. The alternative sequence was to break the building footprint into smaller pieces, and erect the structure as separate sections, or "towers." The latter option was chosen by the contractor as it allowed concrete slab placement and above-ceiling rough-in work to start on at least a portion of the building sooner than the first "plating" option. The second alternative, or tower option, had several advantages.

The contractor's safety procedure required that two floors be erected between on-going precast concrete erection activities and any crew or trade member working on levels immediately below. In other words, the precaster would be required to fabricate pieces for three entire floors prior to the mobilization of the erection crew.

The tower method of construction allowed the contractor to begin work on floor placement and rough-in earlier, before even half of the whole structure was erected (see Fig. 19). Because the AMC complex was so large, the contractor was able to schedule as many as three erection crews at one time on the building, as well as an additional crew on the parking structure.

A CONSERVATION-MINDED APPROACH TO LANDSCAPIING

Like many western states in America, fresh water resources are limited in Colorado, requiring conservation whenever possible. Out of a concern to minimize fresh water used for landscaping, all the planting materials surrounding Aurora's new Municipal Center were chosen for their low water requirements. Lawn and grassy areas that have high irrigation needs were limited to only those spaces where intensive pedestrian traffic is anticipated.

Irrigation systems for the site recycle used water, sometimes referred to as "gray water," pumped through a new pipeline from the municipal water treatment plant. Using non-potable water, the irrigation system was extended to include all of the city's adjacent existing landscaped areas at the Municipal Courts Complex and Library.

Fig. 18. Rooftop loads were reduced by using a lightweight metal enclosure around the mechanical penthouse.

Fig. 19. A "tower" construction method facilitated erection in several locations at once.

An accelerated schedule dictated that three cranes, and sometimes four, were able to work simultaneously on the project, allowing up to 55 pieces to be erected in a single day (see Fig. 20). Consequently, the attached 800-car precast concrete parking structure was erected at the same time as the Municipal Center. The building and parking structure contain about 2500 separate precast components (see Table 2) requiring 11,827 cu yd (9043 m^3) of concrete.

CONCLUDING REMARKS

Aurora's new Municipal Center is much more than just a new building; it is a place where the city can reinforce its sense of community, pride, and civic focus (see Fig. 21). In addition to meeting the city's desire for a dignified structure, the all-precast concrete solution also had the added benefits of durability, permanence, and a strong resemblance to traditional masonry construction preferred for historic government buildings.

In February 2004, after the 11-month warranty review of the completed Municipal Center, the Deputy City Manag-

Fig. 20. Three cranes worked simultaneously towards completion of erection.

Fig. 21. Spectacular by night, a fountain sculpture graces the entrance of the Aurora Municipal Building. [Photography courtesy of Michael Peck]

er of Community Services for the City of Aurora, Frank Ragan, attested to the success of the project: "I can only offer positive comments about how well it has been working for us. The project has received accolades from every media... and [the city and the project team] exceeded the original [project] scope in both aesthetics and functionality – well beyond everyone's discerning expectations."

According to the city administration, the sunlit two-story lobby has become a gathering place for both employees and the public, and the expansive, state-of-the-art, City Council Chamber is the envy of other local municipalities. Ragan summarized the city's satisfaction with the new Aurora Municipal Center: "...the spaciousness and enduring quality of this building has contributed to public pride and a stronger, positive identity for our city."

The outstanding results of the AMC project team's efforts did not go unnoticed by their professional peers. "This project provides a worthy addition to the civic campus," noted PCI judges in naming the Aurora Municipal Center and Parking Structure as the co-winner in the Best All-Precast Solution Category for Public Buildings. "The total precast concept allowed for a significantly faster construction schedule with long spans to accommodate interior needs. The 800-car parking structure is integrated well, using the same finishes throughout to present a unified whole. Indeed, the City of Aurora can be justifiably proud of its new Municipal Center."

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