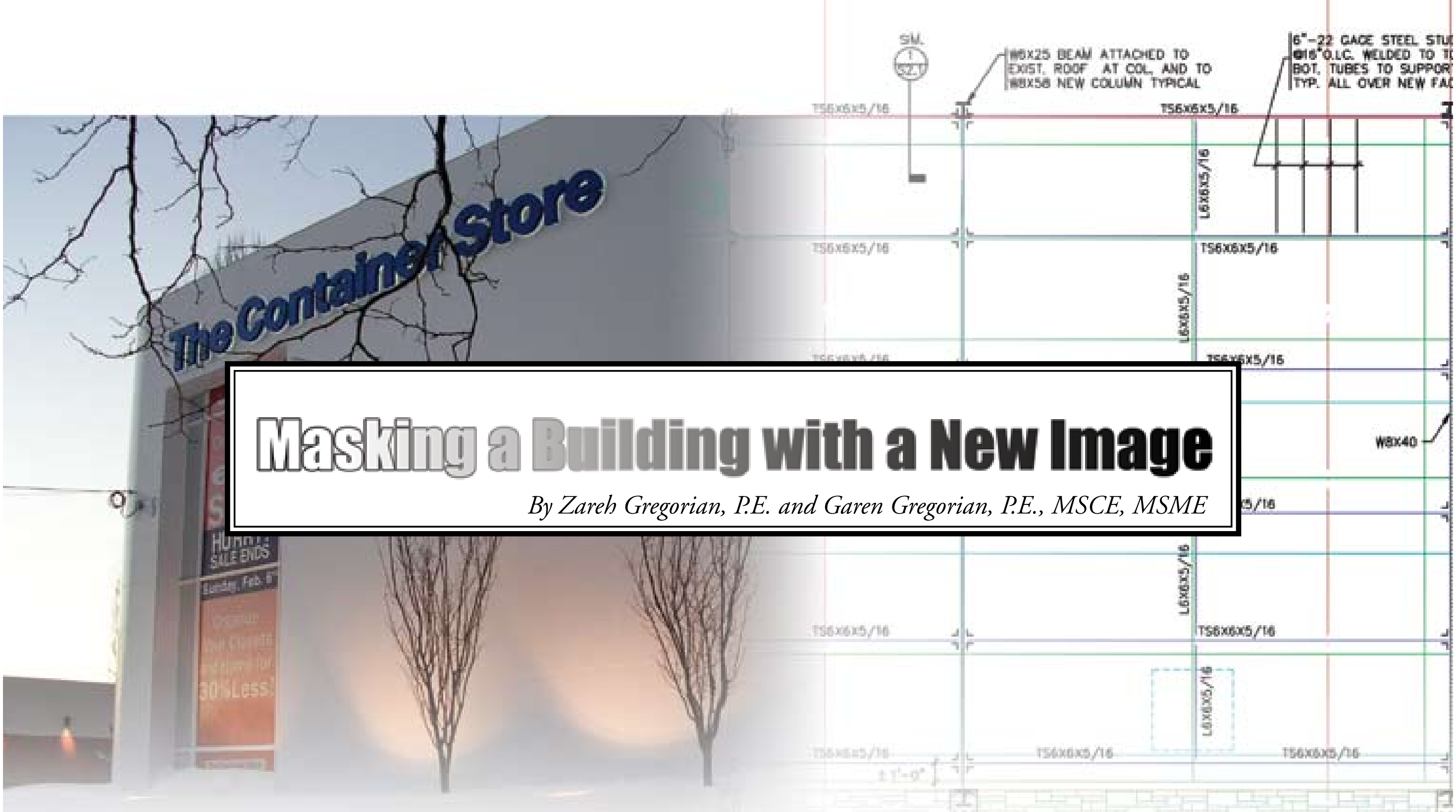
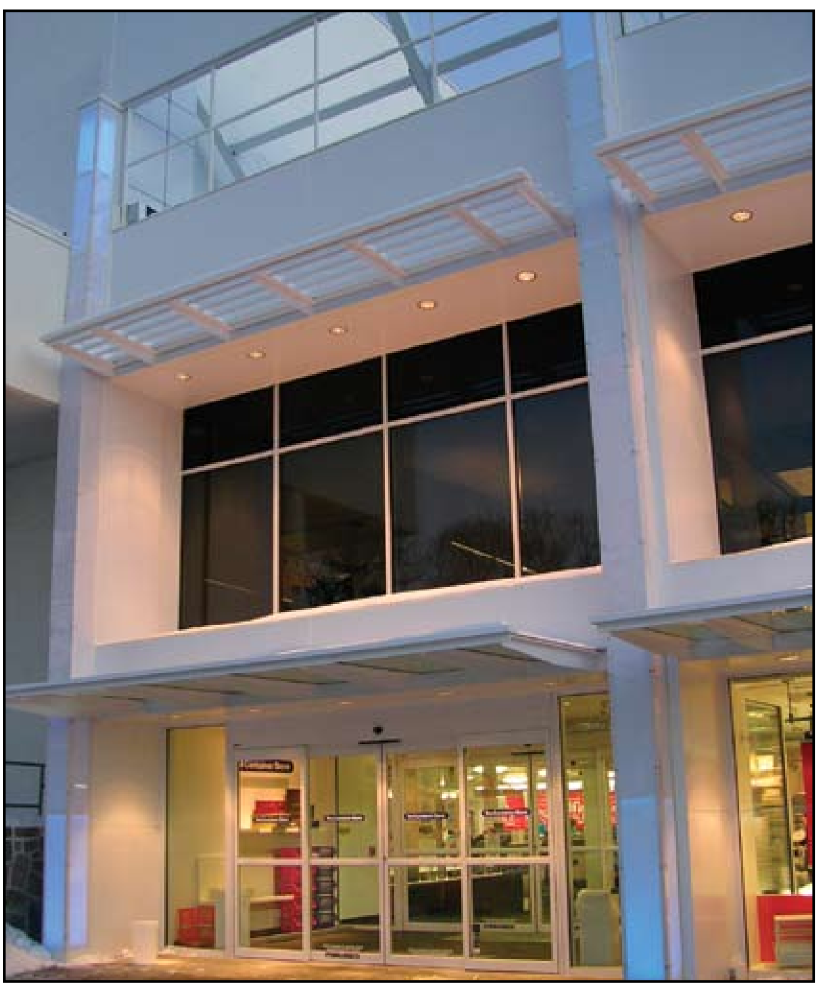


Masking a Building with a New Image

By Zareh Gregorian, P.E. and Garen Gregorian, P.E., MSCE, MSME

A prime location in an area adjacent to two of Boston's most prestigious shopping malls was desired to house the city's first "Container Store". The building was originally built in part to extend a movie theater and for office occupancy. At the time of selection, portions of the second and third floors were vacant. A busy travel agency occupied the first floor.

To preserve the image of the "Container Store", Good Fulton and Farrell Architects were required to install a new façade, signage and exterior lighting attached on the existing structure. The new tenant was to occupy and lease close to one half of the building for the new store.



View of finished product entrance to the store.

To create the new image, distinguishing the new store and attracting shoppers, elevations on three sides of the existing building had to be refaced.

A new steel grid system was chosen as the backbone for attachment of the new façade, as it provided the flexibility, strength, and connectivity enabling the designers to achieve the desired result.

Requirement for Occupancy of the Building

Construction had to proceed without disrupting the operation of existing tenants. Construction inside the building was to be avoided on the second and third floors. Installation of the new façade had to be performed with the least amount of disruption to the existing façade. The final solution provided an option wherein, if the owners were to remove the new façade at a later date, the existing could be reused without any repairs or modifications.

Structural System of the Existing Building

The original building was a two story steel structure supported on reinforced concrete spread footings and periphery foundation walls. Steel columns on the periphery were supported on reinforced concrete piers. An additional story had been added to the original two-story building sometime in the past. The structural grid consisted of 25 by 50 feet in the north-south and east-west direction, respectively.

In order to resist the wind loads the front entrance welded steel tube framing had to be braced back diagonally to the existing roof framing.

Plans for the original building were not available. Unfortunately, no demolition work was allowed to be performed to identify the structural members of the floors below. Only the renovation drawings of the construction of the additional story were available.

The new roof structure utilized 33 WF220 girders spanning the 50-footlength. 16 WF40 beams spaced 7 feet on center spanned the 25-foot length, supporting a 1½-inch steel deck and 3½ inches of concrete for a total roof thickness of 5 inches. At the column lines, 18 WF50 beams were used as framing. The exterior façade of the building was composed of 12-inch concrete masonry units with stucco facing, supported on the exterior steel edge beams.

Options to connect the new façade to the existing were reviewed as follows:

1) Attach the new façade directly to the exterior CMU walls.
2) Extend steel outriggers from the exterior columns to support a new steel grid which would support the new facade.
3) Suspend the exterior steel grid and tie back to cantilevered framing from the existing roof structure, and provide additional support framing at the base. The existing exterior façade would remain unharmed.

For option one, with the support and physical condition of the exterior CMU, and final façade material and weight unknown, this option required too many contingencies.

Extending steel outriggers from the exterior steel columns (option two) was eliminated because the extension would occur at the floor level which would disturb the beam to column joint connection. Extending the outrigger above the floor was also considered as an option, but was eliminated after strength evaluation of the existing structure yielded a deficiency. In addition, as the connection of the exterior CMU walls to the steel frame was not identified on the drawings, cutting openings to allow installation of the outriggers was not logical as it would decrease the contribution of the walls to the lateral load resisting capacity and energy dissipation during a postulated seismic disturbance.

Option three was chosen as the final design, and called for the façade to be attachment free throughout the height of the building. The new facade had therefore to be connected away from the face of the existing building by extending the new structure at the roof, and incorporating support beams from the foundation walls around the periphery of the building.

At most locations, the columns were covered by concrete blocks. To verify that as-built conditions matched those indicated on the structural drawings, the contractor was asked to chip away and expose a representative number of columns. Destructive investigation was not required for the entire building, as only the façade was being changed. First floor occupancy changed to retail and the slab was investigated for load carrying capacity. The upper stories remained offices.

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Welded Steel tube system has been installed and supported at the base. Cold formed metal stud framing and new facade installation is in progress.

With only the roof framing members clearly identified, on the renovation and addition drawings, it was decided to use the roof structure and columns on the periphery to support and hang the new façade. At the foundation level, cantilever support beams would then contribute to the vertical and transverse lateral load resisting system and the overall stability.

New Steel Grid Columns

On the north elevation where the new façade structure would extend down to the exterior grade, spread footings with base plates were installed to support the new grid columns. On the west and south elevation, the façade stopped approximately 3 feet above the exterior grade in order to meet existing construction. Steel brackets were installed and anchored to the existing concrete wall to tie and support the new grid columns.

The spacing of the columns was arranged to align as closely as possible with the existing steel structure of the building. The tops of the columns were extended from the existing roofline, tied with a horizontal member above the existing roof EPDM membrane and attached to preinstalled extended columns that bear on the existing structural members of the roof structure.

The extended columns were installed from the top by cutting the existing membrane and welding to the existing structural members. Waterproofing membrane was then reinstalled and sealed prior to installation of the horizontal cantilever roof extension members. As the gravity loads due to the façade weight were minor compared to wind loads, the exterior columns were designed as beam columns with bending being the primary concern in the design. The roof support structure could not extend more than 2 feetabove the roof line for aesthetic reasons; thus, shallow steel beams had to be used to support the load.

Because the location of the new columns were fixed architecturally, thorough coordination with window frame locations was required for creating the grid used to transfer the wind loads to appropriate bottom and top supports. Where auxiliary cantilever members were required, structural transfer beams were installed between the main extended members above the roof membrane in order to transfer the loads to adjacent main members.

Base connection of the steel grid consisted of prefabricated 16-x16-x¾-inch steel plate with a W8 beam extension welded to the plate to develop the full moment capacity of the beam. The plate was then anchored to the concrete foundation wall with 6 #6 undercut expansion anchors with 5-inch minimum embedment length. The expansion anchors were tested for pullout by the inspection and testing agency.

Structural Design Issues

The major loads acting on the new façade are mainly wind loads. The weight of the new façade members, columns, the grid, and stud wall, were secondary..

According to the Massachusetts State Building Code, Sixth Edition, the building was located in a region classified on the wind map as Zone B exposure category C, with a total wind pressure of 21 pounds per square foot, of which 60 percent is applied on the windward side as direct pressure and 40 percent is applied as suction on the leeward side. On the corner salient areas, the pressure was increased to 1.7. Both direct load and suction were considered in the design. The allowable deflection of the new façade material provided by the manufacturer was considered for the design of the columns, grid members and the steel stud wall supporting the new façade material. W8 sections were selected for the columns, 6x6 tube steel was used for horizontal grid members supporting 6-inch deep vertical cold form steel studs spaced 16 inches on-center. New composite aluminum panels were attached to the 6-inch studs to create the new façade.

The required image for the store was created by the addition of the new facia, combined with beautiful lighting at night, without touching the existing façade of the building. The store was ready for clients as planned on Thanksgiving Day.▪

Cantilever extension support at base.

Project Team

Structural Engineers: Gregorian Engineers, Belmont, Massachusetts
Architect of the Project: Good Fulton & Farrell Architects, Dallas, Texas
Steel Fabricator: Malatos Ironworks

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