Production of Brick Veneer Precast Concrete Panels

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The continued interest in brick veneer panels has resulted in many different methods of brick positioning to ensure proper location and secure fit during production. All of these methods involve a grid system, the most popular consisting of either a rubber form liner or a wooden base tray with shaped wood joint sections.

In some cases, this grid system has successfully incorporated rubber joint sections and it is conceivable that other systems using urethane, plaster or sand may be common. However, these latter grid systems are not within the experience of the author.

The appearance of brick veneer panels is principally achieved by the selected brick with type, size and texture contributing to overall color. Also, the clarity with which the brick is featured will depend upon the profile of the joint between bricks, thus requiring a choice between recessed, flush or concave-tooled joints. The final element in the appearance of the panel is the mortar or concrete used in the joints.

The blending of the above factors into unit sections and proportions suitable for a given structure is within the scope of the architect. Panel sections shown in this article will illustrate the freedom of expression available through precasting techniques, which could not economically be accommodated in field applications.

Freedom of aesthetic expression is only one advantage precasting affords over site laid-up masonry. Other advantages include less efflorescence since precasting techniques do not require chloride accelerators in the mortar; absence of unsightly galvanized shelf angles to support site laid-up masonry; absence of the scaffolding network; and lower unit costs afforded by precasting techniques.

Any disadvantages in using brick veneer precast units lie with the precast manufacturer. The inflexibility of the joint-forming method in plant work does not compare to the simplicity of site laid-up brick which may be readily seated and moved in a bed of mortar. The precast manufacturer is also casting

The popularity of brick veneer precast facing units has resulted in many production methods being attempted. This paper outlines one production method used successfully in British Columbia.

Step-by-step production procedures, as well as potential production problems and solutions are also included.

into his panels a product (brick) with which he is unfamiliar in terms of tolerances, color and absorption rate.

Furthermore, handling of panels with brick veneer requires special care since the bricks will easily chip and spall if the panels are improperly stripped, stockpiled, shipped or erected. Therefore, effective communication is especially relevant to veneer applications. The precast manufacturer must develop a rapport with both the architect and the brick supplier so that all parties are aware of mutual expectations and potential problems.

PRODUCTION OF BRICK VENEER PANELS

Precast brick veneer panels have been successfully produced and used in British Columbia, a region of temperate climate and ample rainfall. Our production facility, though under a roof, is open-sided. The casting tables are steel with under form radiant heat and wooden side forms. In such an environment, a wooden grid on a heated, steel casting table is unsuitable. And, past experience has shown that applying rubber liners to heated, steel casting tables was ineffective. This is primarily due to the expansion and contraction of the steel tables during the curing process which results in the stretching and eventual deterioration of the rubber liner.

Therefore, the simple practice of using loose rubber strips to form a "build-as-you-apply-brick" grid was developed. Here, all the joints are recessed and made with structural concrete, as used in the structural component of the panel. Mortar is not used. Also, colored concrete in the joint is not necessary, although such an architectural choice can be readily accommodated.

The loose strips of rubber used to separate the bricks are an extruded section equal to the selected joint width and recess depth. The most popular size has been ½ in. wide x ⅜ in. deep (12.7 x 9.5 mm). The rubber is Shore A, 60 Durometer hardness and black in color. A softer rubber can be used but is not recommended since brick alignment will be more difficult.

Since 1978, we have completed five brick veneer panel projects, ranging from flat panel sections through C-shaped spandrels and U-shaped column covers (see Figs. 1 through 5). Initially, the returns on spandrels or column covers were cast as separate, flat units lifted and braced into place and the remainder of the section was then poured to them. This two-stage method of casting was not always economical, however, and

Fig. 1. Office building, 1130 West Pender St., Vancouver, British Columbia. Architect: Musson Cattell Mackey Partnership, Vancouver.

the cold joints always provided a potential problem area to the producer. Our latest project featured C-shaped spandrels and U-shaped column covers cast in one operation, with brick-faced returns being successfully incorporated with flat areas in a single pour (see Fig. 6).

Production rates for brick veneer panels vary according to the unit profile and the tolerances of the supplied brick. Flat panel production rates to cut, handle and place the bricks, including form setup, placing reinforcement and hardware, and pouring and finishing the concrete, will be in the range of 0.19 to 0.215 man hours per sq ft of brick elevation. The lower number would apply to spandrels, the higher number to column covers. Face finishing rates would be about 0.035 man hours per sq ft. And, although handling of brick veneer panel requires special care, rates of 20 to 30 minutes per unit can normally be anticipated, depending on the manufacturer's equipment.

The brick sizes used on our projects vary and both stack and running-bond patterns have been used. Also, the bricks in our region are dimensionally inaccurate: they conform to an ASTM specification suitable for laid-up applications yet are not manufactured accurately enough to permit their use in a

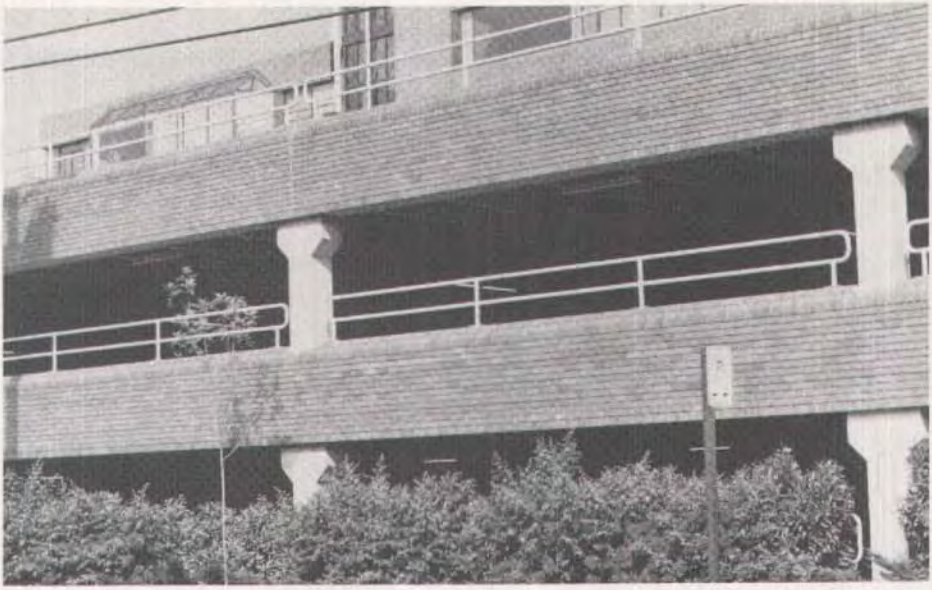

Fig. 2. Office building and parking garage, 1818 Cornwall St., Vancouver, British Columbia. Architect: Dirassar James Jorgenson Schaeferle, Vancouver.

Fig. 3. Commerce Court, Lougheed Highway, Vancouver, British Columbia. Architect: Raymond Letkeman, Vancouver.

preformed grid. Furthermore, tolerances in an individual brick of $\pm 3/32$ in. (2.4 mm) also cause problems for the precast producer. Such tolerances must be changed by saw cutting each brick so that it will not be rejected.

The bricks used on our panels are extruded, saw cut units with score lines connecting the extruded holes (see Fig. 7). The purpose of these lines is to enable the opposing brick faces to be split apart by simply tapping the end of the brick with a mason's hammer. Both sides of the brick are used as facing veneer. Special bricks with a sloping face are used at soldier courses or at the junction with a sloping face. The side cuts on these units are made with a masonry saw and the brick is tapped on its end to remove the waste section.

Fig. 4. McGinnis Road Overpass, New Westminster, British Columbia. Architect: John Moore, Vancouver.

Fig. 5. Office building, 1125 Howe St., Vancouver, British Columbia. Architect: Eng and Wright Partners, Vancouver.

Bricks, like most materials used for architectural facings, suffer from various surface defects (Fig. 8). Defects such as chips, spalls, face score lines, cracks and edge "finger marks" are common and the defective bricks have to be culled from the bulk of acceptable units according to the architect's and applicable ASTM specifications.

Another potential defect is brick color. Here, it is essential that the producer ensures that the brick supplier preblends any color variations and provides bricks which fall within the color range selected by the architect. If these latter requirements are not met, the visual appearance of the completed panel will be unattractive and be cause for rejection.

Once the pallets have been unloaded, the polyethylene wrapping is opened to expose the bricks. Prior to use, the bricks are wetted using a garden hose or sprinkler and sawed as necessary to obtain profile or correct brick size and tolerance. After culling for defects, the bricks are broken apart (using a mason's hammer) for use as veneer units.

Upon separation, the brick face is dipped into a surface retarder contained in a wooden tray as shown in Fig. 9. Penetration of the brick into the retarder soaked sponge is regulated by nails driven into the sponge and tray base. This simple procedure prevents excessive retarder on the brick edges from affecting the concrete joint fill.

The bricks are now ready to be laid into the form. It is normal to lay one brick on each horizontal row down the left side of the panel. This ensures that all coursings fit the dimension being filled. Due to brick heights (on elevation), it is occassionally necessary to use a narrower rubber strip, for example ⅜ in. (9.5 mm) wide, in one row in order to fit all the bricks on the panel.

It is important for the producer to note where this is done so that the same license in joint sizes is carried onto adjacent spandrels or column covers to ensure horizontal continuity of the joints. The different joint width will not be dis-

Fig. 6. C-shaped spandrels, U-shaped column covers and curved-on-plan spandrels with brick veneer finish.

cernable in the completed unit, especially if such adjustments can be made in the joint adjacent to a slope or soldier course.

With the bricks laid flat down the left side of the panel, and with the continuous rubber strips used in longitudinal joints projecting like spaghetti, the top row of bricks is then laid in the form. Short rubber strips are laid between the bricks to form vertical joints in the completed face (Fig. 10).

Again, adjustments in the width of the rubber strips may be necessary to ensure that the full course of bricks is accommodated. And, with running bond it

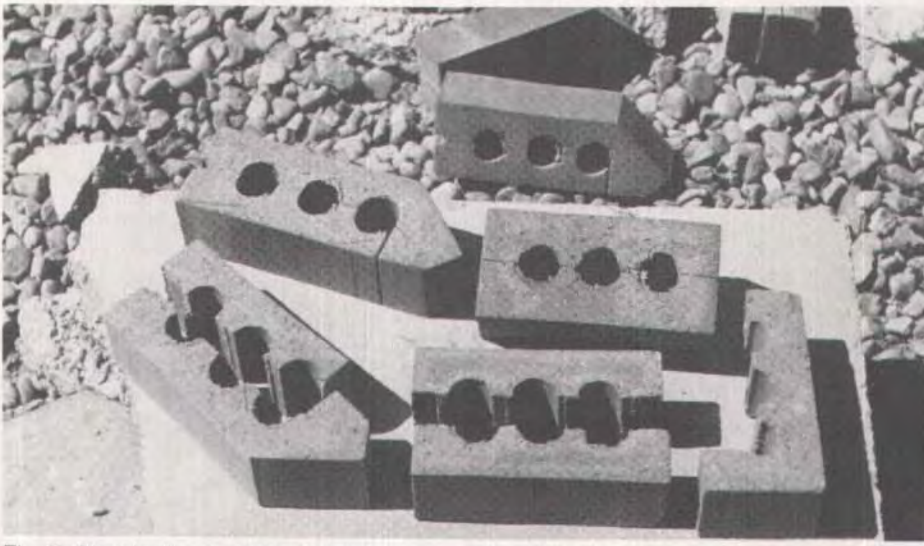

Fig. 7. Standard and custom bricks are shown in full and prepared states. Saw cuts are clearly distinguishable from supplied score lines.

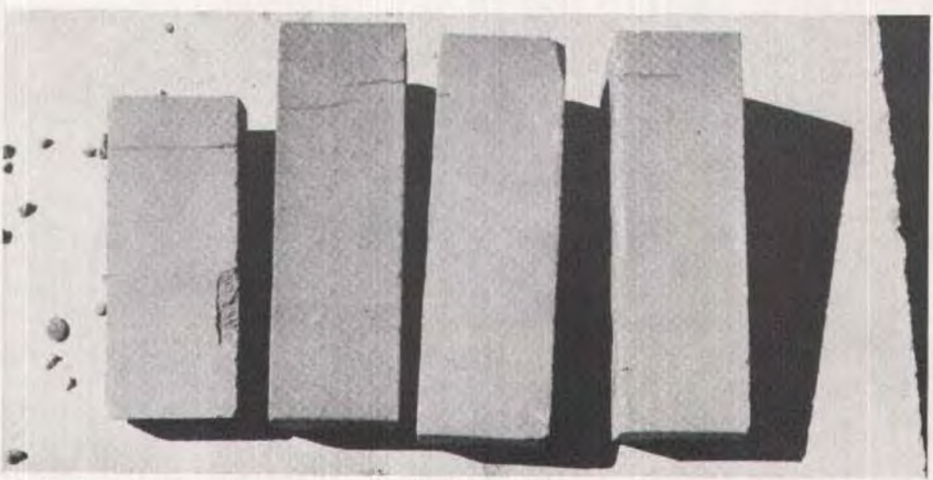

Fig. 8. Samples showing chips, spalls, face score lines, finger imprint (on edge of brick) and a crack.

is essential that courses start and finish with the required half or full bricks to match adjacent spandrels or column covers (see Fig. 11a). Information on brick sizes (full, half or special) is obtained from shop drawings which show the brick elevations for each panel (see Figs. 11b and 11c).

After each course is laid, the bricks are dogged into line by pressing the edge of the whole course with a rubber faced 2 by 4. This will align and compress any looseness resulting from lay-up.

Where bricks are to be set in a vertical mode during the production sequence, temporary wedges will be needed to hold them in a vertical plane. These small wooden wedges prevent the bricks from tipping over once seated on the rubber joint former and they should be removed only when more permanent securing is completed.

The bricks can be secured by several methods as shown in Fig. 12. One such method incorporates stretched wire held taut against the brick flutes while another method uses reinforcing bars in the brick flutes. The reinforcing bar is held against the wood outside the form by tie wire in the brick joints. Once the reinforcing bar is tied, all wood wedges are removed. The decision to use galvanized or ungalvanized reinforcing bars will depend on brick thickness, joint depth and weather exposure.

After the bricks are secured, steel reinforcement is positioned in the panel and hardware is located and secured to a template. Inside or hung forms are positioned and readied for concrete pouring (see Fig. 13).

At this point, several fundamental inspection items are advisable, in addition to the normal dimensional checks carried out. Brick coursings should be rechecked for alignment and all bricks should be fully seated against the form face. The bricks should also be tested for tight fit and wedged if inappropriately secured, especially on return sections.

Prior to concrete pouring, the back of the bricks should be lightly wetted with water spray from an airless sprayer to limit the amount of mix water absorbed. Once the bricks are wet, the concrete is then poured in a normal manner for flat

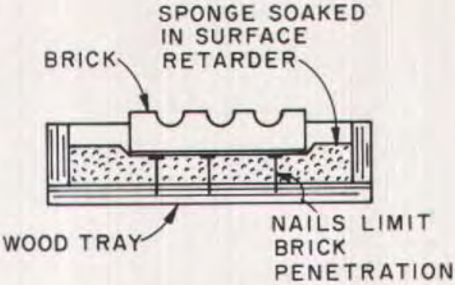

Fig. 9. Tray for dipping bricks into surface retarder.

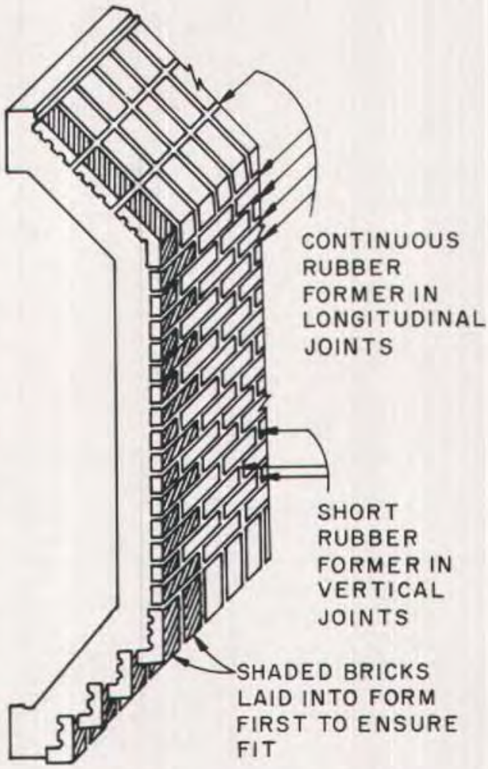

Fig. 10. Typical spandrel showing brick placement sequence.

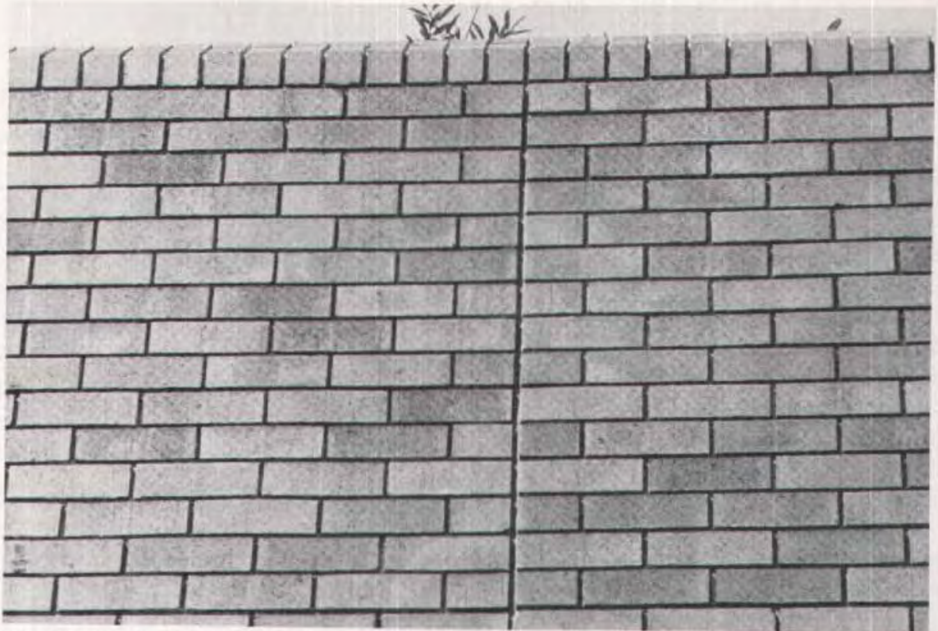

Fig. 11a. Brick patterns must be continuous through adjacent components.

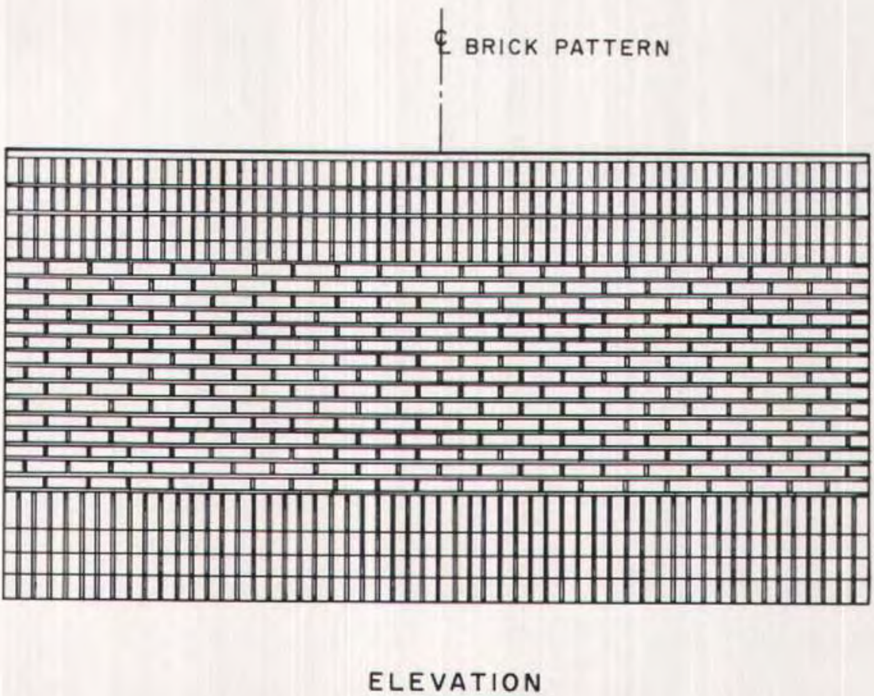

Fig. 11b. Typical spandrel brick elevation.

surfaces and in a layer technique on returns. This latter technique ensures penetration of the concrete into all joints. Wire ties should be removed as soon as the returns are poured.

The aggregate in the concrete has a maximum size of ½ in. (12.7 mm) to suit joint width and a slump of 4½ in. (114 mm) to accommodate all sections. Vibration with internal pencil vibrators only is essential and care must be taken to avoid any contact with the bricks. Bricks touched by the vibrator tip will bounce, resulting in either a depression

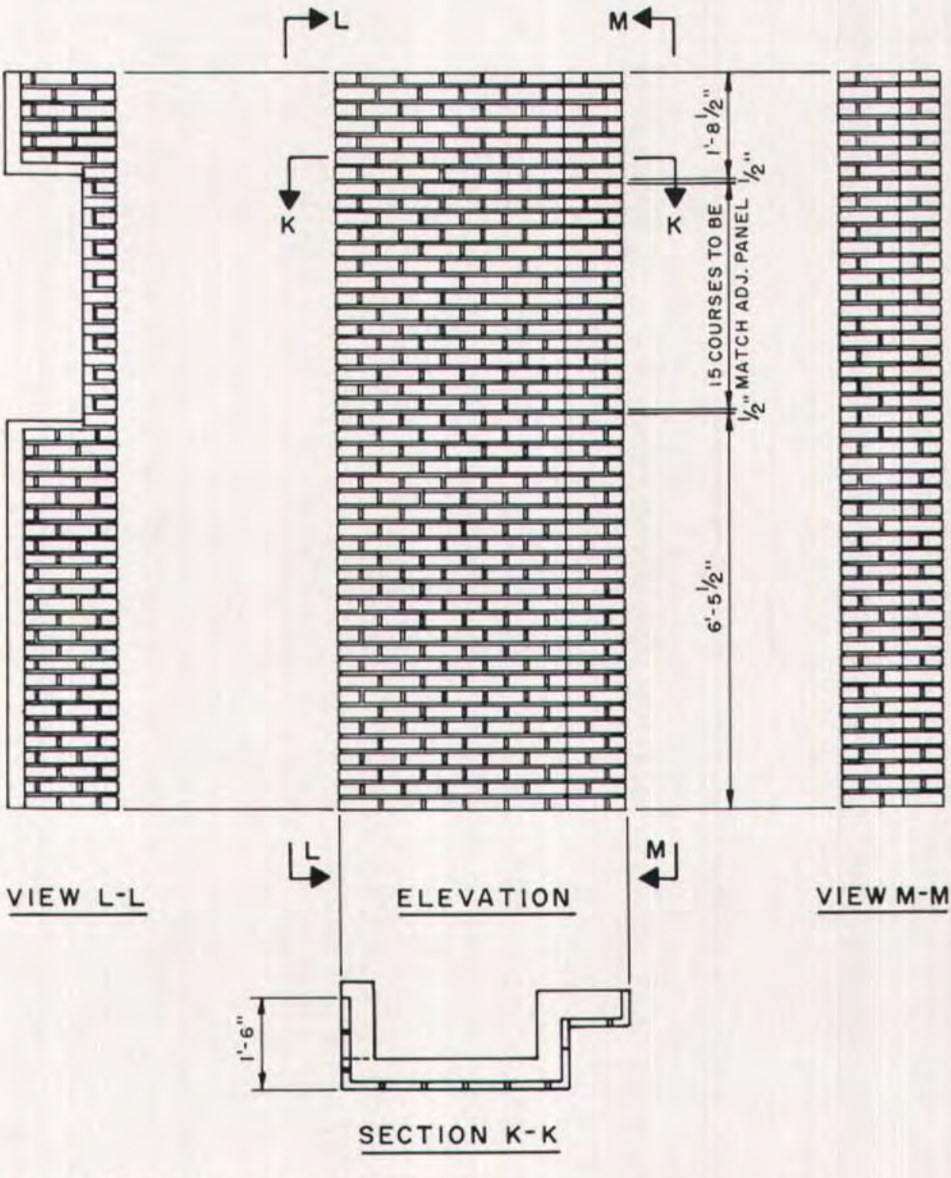

Fig. 11c. Typical column cover brick elevation.

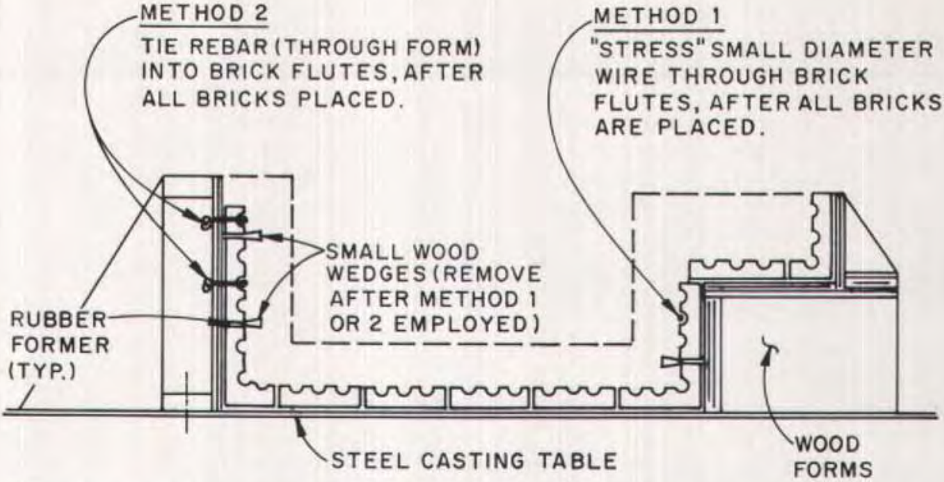

Fig. 12. Section through column cover showing method for securing vertical bricks in position.

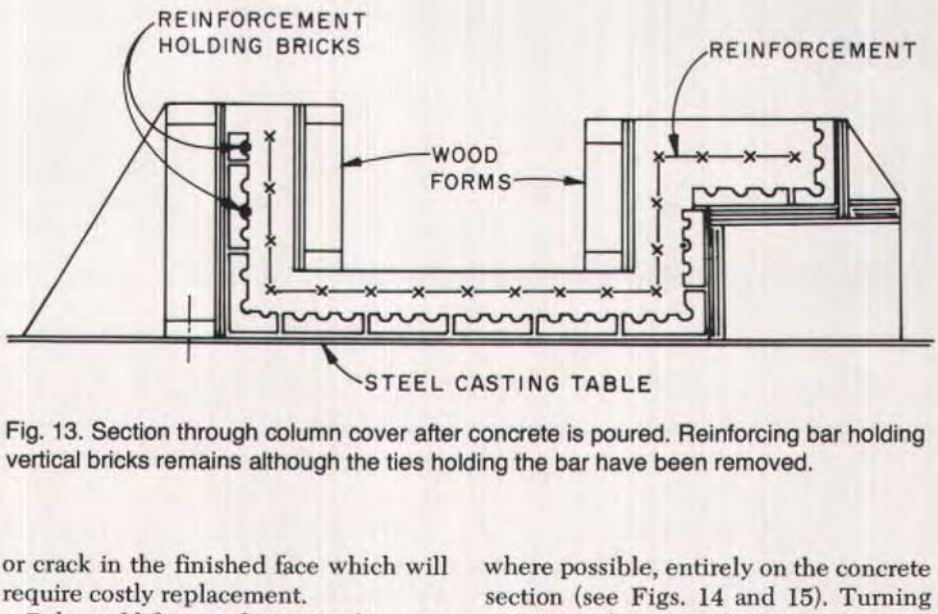

Fig. 13. Section through column cover after concrete is poured. Reinforcing bar holding vertical bricks remains although the ties holding the bar have been removed.

or crack in the finished face which will require costly replacement.

Balanced lifting at the section's center of gravity is a well known principal and is especially important with veneer panels which will chip or spall if the edges are not cleanly lifted. Similarly, dunnage used for yarding, stockpiling or loading should be kept away from the edges of the bricks with the major weight of the panel being supported, where possible, entirely on the concrete section (see Figs. 14 and 15). Turning units into the vertical plane is best accomplished using two crane hoists although turning units on a sand pile or in turning frames can also be used if proper care is taken to protect the brick edges.

The loose rubber strips should be left in the joints until after spray washing using a 1000 to 2000 psi (7 to 14 MPa) washer to remove laitance from the face

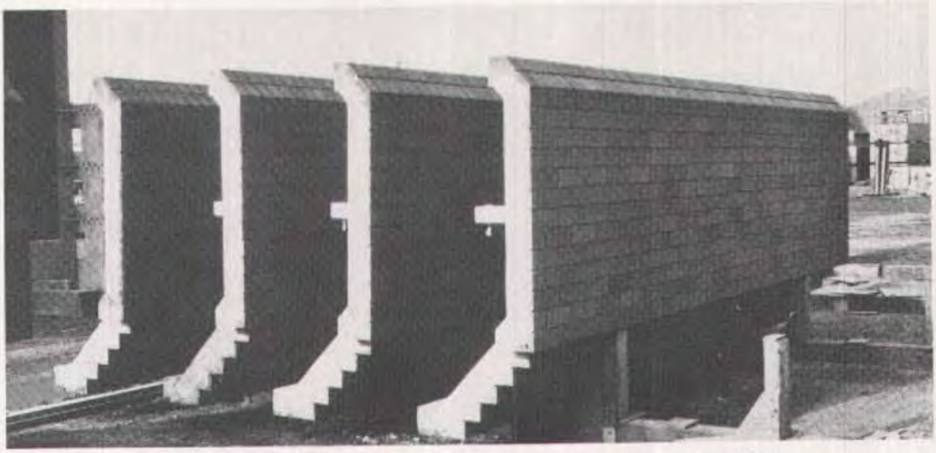

Fig. 14. Support framing is kept away from brick edges to prevent spalling.

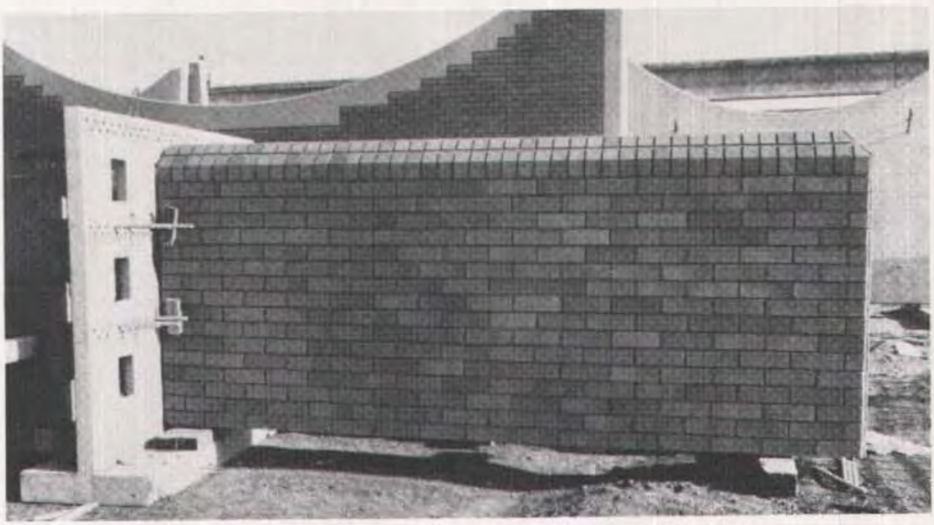

Fig. 15. Vertical easels can also be an effective restraint for stockpiling.

of the bricks (see Fig. 16). This is done while the panels are in a vertical orientation. The rubber formers are left in the joints during washing to avoid removing unset laitance in the joint areas where retarder has crept onto the joint face. They should be removed only after the entire panel has been washed and then cosmetic finishing and touch-up can begin (see Fig. 17).

It is important to determine the quantity of patching that will be permitted since one color will not match all of the various brick hues in use on any one job. Such discussions with the architect might best result in an examination of samples viewed at a distance or height consistent with actual project locations. However, one must remember that the veneer panel must be viewed in its entirety, not just examined for individual brick deficiencies.

Fig. 16. Spray washing is performed while the rubber formers remain in the joints to avoid removing unset laitance.

Fig. 17. Removal of rubber formers and cosmetic finishing is completed in the first 24 hours after stripping.

Fig. 18. Concrete laitance is clearly seen upon close inspection of joints.

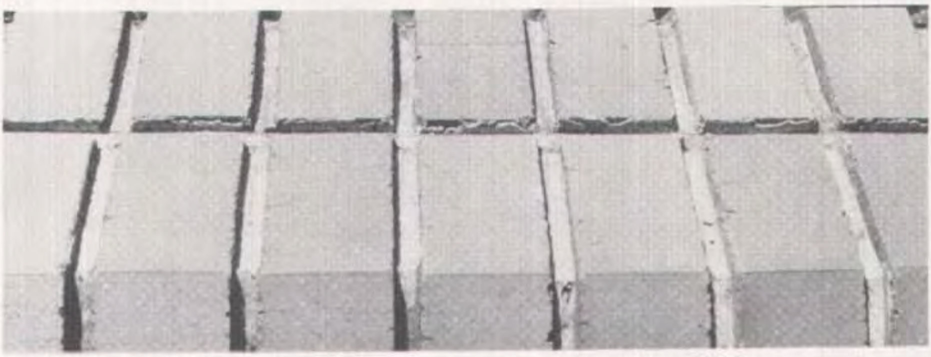

Fig. 19. Concrete laitance is clearly seen upon close inspection of joints.

Fig. 20. The concrete laitance is not evident when the total panel is viewed.

Fig. 21. This second floor spandrel was produced as a single pour operation and shows crisp definition.

Prior to shipping, the panels are brush washed with a 10 percent muriatic acid solution which is flushed off the panel within 5 minutes of application. This final washdown removes yard dust, minimizes efflorescence and presents a crisp, clean veneer unit.

Finally, the rubber joint formers should be cleaned daily and returned to the production area.

PRODUCTION CONCERNS

Genuine concerns have arisen with regard to the production of brick veneer panels. The difference in creep characteristics between concrete and brick, along with the differences in their respective moduli of elasticity, do not pose a problem to the manufacturer of small [less than 30 ft (9.1 m)] panels when good quality brick is used.

However, the comments of one manufacturer who produced prestressed loadbearing spandrels with a brick veneer finish are worth noting. The manufacturer's concern relative to differential creep between brick and concrete was removed once static load tests, performed at a local university to simulate the differential creep phenomena, showed that they were unfounded.

Prism tests were conducted on the proposed brick to establish the modulus of elasticity. The manufacturer then designed the prestressed cross section for a transformed cross section based upon the ratio of the newly established moduli. This resulted in the prestressing strand being moved laterally off center to compensate for the transformed section. The units were then produced, up to 60 ft (18.3 m) in length, without sweep.

A brick control joint was used at the centerline point to avoid cracking of the bricks which will occur at this location if large unit lengths are cast on a heated, steel casting table. This is due to the table expanding as heat is applied and without the joint, the bricks crack. The manufacturer now has a policy of introducing a control joint in the brick veneer any time the panel length exceeds 30 ft (9.1 m).

Other concerns and production problems, along with solutions, are listed below:

1. Concrete laitance sticking to the brick face — Solution: Wet bricks in stock prior to dipping in retarder.

2. Laitance on brick edges — Solution: Adjust brick penetration into retarder bath (see Figs. 18 to 20). Note, this laitance will not be seen on finished erected panels.

3. Retarded concrete in joints — Solution: Adjust brick penetration in retarder bath. Leave rubber formers in joints during washdown.

4. Unfilled joints between bricks — Solution: Check minimum size of aggregate and adjust. Increase slump and decrease the speed of pouring and vibration.

5. Wavy joints between bricks — Solution: Check alignment before pouring concrete and adjust. Check brick widths and reject if necessary.

6. Black color transferred from rubber joint former to face of joint — Solution: Renew the joint former.

7. Efflorescence — Solution: Washdown panel with a 10 percent muriatic solution. Once surface is dry (less than 14 percent surface moisture), apply surface sealer if specified.

8. Chips, cracks, spalls in bricks — Solution: Check culling inspection methods, handling methods, and vibration and stripping methods and adjust.

9. Vertical alignment of joints, especially with stack bond — Solution: Measure each brick and be prepared to cut all bricks to the same length.

CONCLUSION

As this paper serves to illustrate, brick veneer panels can be produced successfully and to the satisfaction of the architect, especially if the problem areas are fully considered (Fig. 21). The producer need only remember that effective communication is the necessary ingredient in all successful projects.

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NOTE: Discussion of this paper is invited. Please submit your comments to PCI Headquarters by January 1, 1987.