Controlling Shrinkage in Portland Cement Plaster

New Chicago Office Building Ceiling Shrinks Over Three Inches With No Visible Cracking in Three Years

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Few persons, even those who have been closely associated with the plastering trade for many years, fully realize the extent of the shrinkage factor in portland plaster and stucco. Frequently, when cracking appears in newly plastered portland cement surfaces, structural movement and other causes are blamed, when in fact, it is shrinkage that is the villain in the overwhelming percentage of cases.

Many agencies, both governmental and private, have done much research on this subject, but the information developed has not found wide dissemination. However, few examples have gone further to prove this shrinkage factor than a building that was constructed about three years ago.

The building in question is a one story public structure approximately 210 feet square. The excavated space under the building was to be used for open unheated parking. Ceiling height in the garage area was nine feet. For fire protection, a portland cement plaster ceiling was installed and the garage area was sprinklered.

The exterior walls were laid out in a series of offsets’ for increased daylight. The structure is supported by sixty-four columns, each twenty inches square on thirty foot centers. Exterior walls consist of a precast fascia 4” and 6” wide, and 15” and 36” high respectively, above which is brick. The design called for a suspended metal lath and portland plaster ceiling, which when finished, would be flush with the bottom face of the precast perimeter fascia.

Construction of the ceiling consisted of 1½” channel iron, 4’ on center,
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held in place by 3/16” cadmium coated hangers spaced 3’ apart. Cross furring was ¾” channel iron spaced 12’ apart, to which was tied 3.4 diamond mesh metal lath. Casting beads and control joints were zinc alloy. Unless otherwise noted, all components were galvanized. Plastering was done in a three coat system, consisting of scratch, brown, and finish coats, with the finish coat containing white portland cement, hydrated lime, and silica sand, then floated as a finish.

The architect, cognizant of the need to control expansion and contraction, had specified a design not commonly seen. The ceiling, which contained approximately 45,000 square feet, was divided into nine panels, each of which was to be enclosed and separated from adjacent panels by means of back-to-back casing beads. The ¾” furring channels and metal lath were not to be carried from panel to panel, but rather were to be terminated at the casing beads. In addition, the ceiling was not to be abutted to fixed structural columns or the precast fascia around the perimeter of the structure, but was to be held ¼” away from such members through the use of casing beads. The ¼” margin around these surfaces was to have a rubber gasket installed at the time of lathing. Each of the nine panels was then to be further subdivided through the use of control joints placed at 15’ intervals in each direction. Thus, each such subdivision contained 225 square feet of ceiling area. (See reflected ceiling plan.)

However, one mistake was made. A single carrying grid was used, that is, the carriers spanned from panel to panel, so, while all the furring iron and the metal lath terminated at the junction of each panel, the ceiling was still tied together through the use of these common carrier bars.

The Shrinking Ceiling . . .

This unusual construction allowed the ceiling to move in reaction to the shrinkage of the portland cement plaster—and move it did! ! ! Since the ceiling was totally unrestrained around the perimeter, and the ceiling was still tied together through the use of carrying iron which spanned the panel division, it moved in all directions—that is, from all four perimeter areas toward the center.

Because the ceiling area was quite large, plastering was completed in stages. In order to expedite operations for other trades, the northern half was completed before any of the scratch coat had been applied to the southern half. Within a short period of time, the casing beads along the northern perimeter began to move away from the fascia. Beads which had been installed around each column also shrank away on the two sides towards the center, and on the two faces away from center moved closer to the column. When the ceiling was finally finished and dried, the perimeter casing beads which had been installed ¼” away from the fascia
were now more than 1½" from their original position.

Several meetings were held on the job site with the architect, the contractor, and other interested parties, to attempt to solve this dilemma. When the contractor was informed that the ceiling had shrunk more than 3", he thought the statement was a good joke. He blamed the condition on building movement and structural changes, and pointed out that the casing beads and control joints were butted together, and that no damage had occurred to these. The explanation for this was found in the undulation of the beads. Placing a long straight-edge against the ceiling showed the wave effect and this was the reason that no damage had occurred to these members.

The fact remained, after all discussion, that the unusual construction of the ceiling, with none of the components being secured to adjoining panels, and yet still being tied together through the use of a common carrying iron system, had allowed the ceiling to move uniformly toward the center. Further evidence of the magnitude of the shrinkage problem is found in the fact that there was not one crack to be found in the ceiling. The simple reasoning was that this large area, because it was unrestrained, was allowed to find its own final size, and this resulted in no cracking. Can we imagine what might have happened in the way of cracking due to this shrinkage, if the ceiling had been tightly restrained?

Fire regulations and protection of the structure above demanded that these open areas be corrected. The final solution of this problem was that the contractor was required to remove all casing beads that had shrunk away, place them back where the original design had shown, and then patch all such areas. It was a costly lesson to learn of the shrinkage power of portland cement plaster.

Because of its low installed cost, its adaptability to any size or shape, its variety of finishes, and its permanence, portland cement plaster or stucco is a very desirable product. What then are the steps necessary to insure a lifetime job? Let's take the example of this particular building.

**Preventive Measures . . .**

The design of isolating each section of ceiling from adjacent sections was ideal. However, such isolation steps must be complete, that is no component be tied to adjoining panels, and the perimeter of each such isolated section be encased with back-to-back casing beads. Further, ceiling areas of
4500 square feet are larger than is practical. This author believes that such large unbroken portland cement ceilings should be divided into areas of not more than 1000 square feet, and then subdivided through the use of control joints, into areas of 1000 square feet.

One important fact cannot be repeated too often. Portland cement plaster and stucco can shrink more than one inch per hundred lineal feet. This fact must be taken into consideration always, but is even more important when installing large unbroken areas.

You can minimize shrinkage in other ways also. Proper gradation of sand is quite important. The ratio of cement to sand is even more important. Floating the brown coat, protecting the fresh material from too rapid drying or cold are also critical. And, lastly, curing the newly applied plaster is another very necessary step.

There are hundreds of thousands of beautiful portland cement plaster and stucco installations all over the country. This construction material has withstood the test of time, and is a joy to be proud of, when installed properly. When the physical fact of the shrinkage of portland cement is kept in mind, and follow all of the necessary precautions, the final product will bring untold satisfaction.