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TechNote

Shotcrete Preconstruction Mockup—TechNote

Keywords: cores; cross section; demonstration; encasement; inspection; mockup; nozzleman; nozzler; preconstruction; saw cutting; shotcrete; stripping forms; test panels.

Question

Why is a shotcrete preconstruction mockup performed and how is it designed and evaluated?

Discussion

The phrase "shotcrete test panels" has been used in the industry to cover a variety of uses in the preconstruction and production evaluation of concrete placed by the shotcrete method. The purpose of this TechNote is to help the architects/engineers (A/E) to refine their documents with current use of the terms "mockup" and "test panel" to better define their specific requirements for the project. The majority of this TechNote will focus on the use of shotcrete preconstruction mockup.

Test panels

The traditional test panels that are often used for obtaining samples for quality control testing purposes during construction can also be used during the preconstruction phase for acquisition of samples that are used to confirm acceptable performance of the shotcrete properties in relation to the specified requirements during the approval process. As these panels are generally intended to test the compressive strength of the concrete material, they should not include any reinforcing bars or mesh. Guidance for preparation and testing of specimens extracted from these test panels are presented in ACI 506R, ACI 506.4R, ASTM C1140/C1140M, and ASTM C1604/C1604M.

Mockups

Mockups are recognized construction industry tools that are often used to demonstrate satisfactory performance prior to the commencement of construction. Mockups are full-size structural elements or architectural models built to scale for evaluation. For shotcrete preconstruction testing, they are normally intended to verify satisfactory constructability by simulating project conditions as well as many of the more difficult features. The cost and effort to build mockups can be sizable. When mockups are specified, the A/E should consider that the size and complexity of the panels are commensurate with the project needs.

Mockups are generally project-specific, performed during the preconstruction phase, and are used to determine an acceptable level of encasement of reinforcement and other embedments. In some cases, mockups can also be used to evaluate formwork or the desired appearance of the finish. Criteria should be specified in the construction documents developed by the A/E.

Designing mockups

The first step in designing a mockup is determining the configuration of the steel reinforcement. The industry standard is to replicate the worst-case scenario in difficulty for the shotcrete encapsulation of the reinforcing bars. If the nozzleman can, to the satisfaction of the construction documents, properly encase the reinforcing bar that represents the highest degree of difficulty, it is generally assumed that the nozzleman will be able to encase less congested areas. It is essential that only the worst-case reinforcement scenario is represented in the mockup. Two worst-case conditions cannot be morphed together to make a condition that is never experienced on the project. When choosing the worst-case scenario, it is important to evaluate not only the reinforcement but also the wall thickness, formwork, site conditions, and other elements.

There is usually a detail shown on the structural drawings of the reinforcing bar presenting the highest degree of difficulty that can be incorporated into a mockup. If not, the A/E can list the bar size, cover, and spacing as a separate detail. The orientation of the shotcrete application may be part of the difficulty and needs to be incorporated into the mockup. Additionally, forming materials and other components critical to the project (application methods, waterproofing, embedments, and other obstructions) can be incorporated into the mockup to allow for demonstration that the shotcrete can be successfully applied to the satisfaction of the construction documents. It is allowable that a larger mockup be constructed to allow more than one nozzleman to be qualified on the larger mockup, such that each nozzleman is placing shotcrete in the same condition while satisfying the minimum area required to shotcrete a successful mockup.