

Michigan Department of Transportation - M•DOT

Mates



Issue No. 75

March 1994

Concrete Testing and Strand Detensioning

Concrete beams must meet specific test requirements before being accepted for use. The wet concrete is checked for air content, slump, temperature, and the cured concrete for strength.

Once all concrete has been placed and finished, the concrete is cured. Test cylinders cast during concrete placement are cured along with the beams and are broken 12 to 24 hours after all casting is complete. Once the cylinders are broken and have met the compressive strength required by design for detensioning strands, the strands are cut or released (detensioned), forms removed from beds, and beams removed and stored. Once beams achieve the specified 28-day strength, they can be shipped to the project. Most concrete mixtures for prestressed beams meet or exceed the 28-day strength requirement in 4 to 5 days.

Measurement of all prestressed concrete products must conform to dimensional tolerances as specified in the standard specifications. One of the most difficult dimensions to control is beam camber (vertical curvature), which can be very unpredictable and unstable if beams remain in storage for a long period of time. Beam camber will continue to increase during storage if dead load (bridge deck) is not applied to the beam, and thus, it is important to schedule beam fabrication sequencing with construction demands.

Handling and Storage

Beams are moved from casting beds by lifting devices cast into the top of the beam at each end. Prestressed beams must be picked up at each end, since the dead weight of the beam is required to balance the prestressing forces in the bottom flange. Beams must be kept in their upright position at all times and never placed on their sides, or they will self-destruct due to the prestressing forces. Beams typically are handled with large fork lifts, straddle truck carriers, overhead indoor cranes, or self-propelled cranes for outdoor handling. One beam can weigh as much as 70 tons, so cranes and carriers must be quite large just to carry and move one beam end.

Special trucks are used for transporting beams long distances. Flat-bed trucks are used, with one beam end positioned just behind the truck cab. The other beam end is positioned at the rear on a detachable flat bed trailer that is tied directly to the beam. This detachable trailer may be steerable from the leading cab and always has independent brakes. After the beam is removed from the flat-bed truck, the detachable trailer is attached to the cab for its return trip to the fabrication facility.

Erection

Erection procedures can be very difficult at the job, depending on site conditions. Many times, contractors have to straddle rivers or swamps, or contend with heavy traffic volumes. Once the contractor has placed the cranes to lift the beams, erection sequencing commences. Each beam has its own identification for specific placement on the bridge substructure seats.

Dowels cast into the concrete bridge abutment and pier cap seats, position the I-beam. Neoprene bearing pads provide a cushion between the concrete bridge seats and the beam-bearing plate cast into

the beam at each end. Once all I-beams are in place for a given span, diaphragms are cast between beams to tie them together and deck formwork is then placed to prepare for the concrete deck placement.

Box beams are placed in much the same way as I-beams. However, box beams are placed 1-1/2 inches apart on neoprene pads, and position dowel holes are field drilled into the bridge seat through holes provided at the end of each box beam. The position dowel is then placed, and the dowel hole is filled with hot-poured rubber-asphalt type filler. After the box beams are in their final position for a given span, the 1-1/2 inch gap (longitudinal joints) between each beam is cleaned with water and grouted. The grout is placed the full depth and length of each longitudinal joint between the beams, then cured for 48 hours. After all longitudinal joints for a given span have fully cured, the entire span is post-tensioned transversely to make the beams work together. Strands are pulled through ducts cast into the box beam during fabrication. Then, the strands are anchored at one end, while a jack provides tension load at the other end. Once jacking is complete and the strand anchored, the post-tensioning hole is filled with grout and deck placement commences.

Conclusion

Inspection and testing occurs at every phase of the fabrication process for prestressed concrete beams. By March 1994, fabricators will be required to certify their fabrication facilities under the Prestressed Concrete Institute's Certification Program, forcing them to establish a formal quality control program. In addition, plant certification provides uniform standards of quality among different prestressed concrete plants. Plant Certification does not alleviate the Department of responsibility for providing quality assurance inspection of the fabricator's quality control. See MATES article, Issue No. 69, November 1992, for specific certification requirements of the Department's quality assurance inspectors.

If you have any questions concerning the fabrication of prestressed concrete bridge beams, contact our Structural Services Unit personnel at (517) 322-5709.

-Steve Cook

R S L REMAINING SERVICE LIFE Reexamining Specialized Language

Remaining - To be a part not destroyed, taken away, or used up. (Webster's Third New International Dictionary)

Service - Useful. (The American Heritage Dictionary of The English Language)

Life - The period of time during which a material object is fit for use or the efficient performance of its functions. (Webster's Third New International Dictionary)

That part of a pavement's life which has not been used up is what remains. Modern Pavement Management Systems use the time in years from a specified time to the year when the service drops below a specified level as the remaining life. The date of the last survey defines the most accurate remaining time period since the surveyors record condition rather than the computer projecting it. A direct comparison of two sections of road is not possible unless the surveys

Materials and Technology Engineering and Science

MATES is a news bulletin authorized by the transportation director to disseminate technical information to MDOT personnel, and is published by the Materials & Technology Division. The cost of publishing 800 issues at \$0.05 per issue is \$40.00 and it is printed in accordance with Executive Directive 1991-6.

are completed simultaneously. The user of MDOT's PMS can select any date since the last survey, such as today or January 1, 1994. The software will project the survey data forward to represent the condition at the selected time.

PMS's use the year as a time period for several reasons. The most obvious is that the year is convenient. We schedule rehabilitation for specific construction seasons and describe them by the year in which they will occur. We base funding and budgets on years. In addition a shorter time period would suggest a level of precision that does not exist.

Service level or usefulness, as a concept, dates back to the test road in Ottawa, Illinois in the 1950's. MDOT's Ed Finney was a mover behind that national test road, and he co-authored a paper that developed the idea of serviceability of a roadway. Thirty plus years of research have refined the serviceability idea, making it less subjective, but have not overturned it. Ed Finney's serviceability is a scale of one to five, with five being the best possible. New concrete pavements usually have a serviceability of 4.5.

While the idea is valid, the serviceability scale is not sufficient for modern pavement management systems. The needs to project future condition, budgets, and rehabilitation projects require a scale with more increments. Many systems today involve a condition scale of zero to 100, with either the zero or 100 as the best. Local preference will choose whether zero or 100 is best, since analysis software can work with either. Michigan and other states use zero to infinity as their scale with zero being best. These zero to infinity scales allow a description of condition that does not have an upper limit.

The developers of the PMS will define the condition scale but management must decide what level of service they wish to provide the public. Ed Finney and his compatriots at the Ottawa test road chose 2.5 as their minimum desired level of serviceability. Knowing the variability of budget allocations and the shifting of priorities, perhaps, we should not call this a desired level of service, but simply a trigger value or threshold level. Whatever it is called, a numerical figure will be placed in the computer program for analysis.

MDOT's PMS leaves the threshold value as a user input. Our PMS development group programmed a default value of 50 distress points. We found that 50 distress points described most of the projects selected by the districts in the annual call for projects over several years. It is essential that we know what threshold value a condition analysis used. The choice of a higher threshold than previously used will indicate an improvement in condition without any expenditure of effort.

We usually think of life as having a beginning and an ending. The ending is final or termination of life; however, that is not a useful idea in PMS, as we have already discussed. This is precisely the reason that "life" in PMS discussions requires adjectives like "service" or "design". Webster's definition of life, quoted earlier, seems to include the idea of service level with the phrase fit for use.

Taking the most useful concepts from each of these definitions, we can define remaining service life. The number of years from a fixed time, now or when last surveyed, until the pavement reaches the end of its usefulness is our definition. Weighting the RSL by the number of miles and computing the average RSL extends this definition to a network.

Applying the idea of remaining service life to a feature as variable as a road network allows some interesting things to happen. Some segments of the network will fall below whatever level of acceptable service we select before we can rehabilitate them. Pavements below the selected level of service have negative service lives. We might find

negative service lives during times of budget shortfalls. As a practical matter when the level of service falls below the agency's acceptable goals, no years remain in the pavement's service life. It makes little sense to say that the pavement has a negative service life. When computers do our calculations, as they must in a PMS, we may see this result. Negative service life will have some meaning since what we are observing is that the roadway exceeded the threshold level of service a specific number of years ago.

Some have asked "Why are we using a concept like this anyway? What is wrong with measuring condition and using that? Everyone can compare what they see." We asked this question of ourselves here in M&T several years ago when we were beginning to develop MDOT's PMS. We decided that MDOT managers needed a system which provided the ability to project ahead in time to effectively manage the roadway network. Condition measurements provide a look at the present. To project we have linked the present condition with the rate of deterioration by defining RSL.

Let us show the idea of RSL with a simple analogy. Al is an employee of the DOT, in his mid 30's, tall, and thin with a pale complexion. Just looking at him (present condition), you might think that he is not going to be around to collect his 30 year service plaque. What you don't know is that his doctor has just informed him that he has only a simple stomach disorder easily controlled with over-the-counter treatments. Al will likely be working for 25 to 30 more years, according to his doctor's report. Bill, on the other hand, is also in his mid 30's, but with a ruddy complexion and a well-filled frame. This employee, you conclude, is good for the long run. What you don't know is that Bill, too, has just returned for his doctor. The news is that the minor cold which has been hanging on for several weeks is the first symptom of the AIDS virus. Bill's doctor has told him that in six to 10 months he will be too weak to continue working.

Al has a remaining service life of 30 years, while Bill has only 10 months. These employees are not dead at the end of their work (service) lives, just as our pavements are still driveable at the end of their service lives. The rate of deterioration of these employees' condition is just as important as their present health when deciding their remaining service lives. (Author's Note: Al and Bill are names chosen to represent unknowns like A and B. Please don't look around at your fellow employees with these names.)

Michigan's PMS uses the Remaining Service Life idea to connect pavement condition with the rate of deterioration of pavements. MDOT will not realize the power of RSL as long as confusion continues about the level of service concept.

Larry K. Heinig