

TEST PREPARATION AND DATA ANALYSIS FOR VIBRATIONAL TESTING OF MID BAY BRIDGE TENDONS

PROBLEM STATEMENT

In 2000, the Mid Bay Bridge (MBB, FDOT Bridge No. 570091) experienced corrosion failure of external post tensioning tendons, which led to extensive examination of all accessible tendons in the bridge. As part of the condition assessment, a vibration survey of all external tendons was conducted during October of the same year. The vibration test method consists of lightly impacting an external tendon segment, measuring the resulting vibration spectrum, and, from that information, obtaining a numeric estimate of the force acting on the tendon segment. Low tension, or significant differences between the tension at each end of the same tendon, is a potential indicator of mechanical distress that could be the result of corrosion damage. Vibration tests offer an independent opportunity to detect corrosion damage that may escape observation by other assessment techniques.

OBJECTIVE

A survey was conducted to supplement the other evaluation procedures in detecting corrosion damage in the bridge. The objectives included the following :

- prepare a vibration test plan for the bridge's external tendons (involving over 2,900 tendon segments)
- prepare test equipment and procedures
- train operators
- process data and interpret the results to flag potentially distressed tendons
- document a baseline vibration record for the bridge, which could be used for comparison with the results of future surveys

FINDINGS AND CONCLUSIONS

It should be noted that the initial findings were obtained using the data analysis methods available at the time of the field survey. Tensions were computed from preliminary data reports as tests were executed and the information was promptly communicated to FDOT. An interim report summarizing all results was delivered in 2001. A further detailed analysis of the data was completed recently using advanced processing methodology that became available in 2003 from another FDOT investigation now in progress (BC353-44). That detailed analysis is included in the present Final Report.

The tests were suitable for calculating estimated tensions for nearly all of the tendon segments in the approach spans of the MBB and for much of the tendon inventory of the main spans. Average estimated tension values of the tendons tested agreed with those expected from design. Regional

variations in estimated tension along the bridge were revealed but appeared to reflect the normal variability expected within construction practice. Unusual disparity between estimated tensions at opposite ends of each tendon was used as an indicator of possible distress in the tendon. In the approach spans, the average disparity was about 2% of the average tension (a value of 6% was chosen as being sufficiently large to merit note). One tendon known to experience corrosion distress (and later removed) showed a difference of 27%. At the time of inspection, only one in the over 800 remaining tendons tested showed estimated forces disparities exceeding 6% (and in that case disparity was still $< 8\%$) after accounting for possible artifacts. In addition, there were four other tendons that showed disparity less than 6% but that had estimated tensions markedly lower than those in nearby spans. These five tendons were flagged for special attention during future inspections.

Analysis of the center spans tendons was subject to greater uncertainty than elsewhere because of complex geometry, shorter tendon lengths, and obstructions to vibration. Nevertheless, the estimated tension values agreed generally with those expected from design. There was no conclusive indication of tendon distress in any of the tendon segments that produced useable data in this group.

BENEFITS

This study generally demonstrated that the subject testing method can successfully detect tension loss where corrosion distress exists and that it can practically and rapidly be applied to a very large tendon inventory in a major bridge. With regard to the Mid Bay Bridge, the study provided prompt evaluation of the tension condition of critical structural components when it was necessary to rapidly implement assessment and control procedures for unexpected corrosion damage. The tasks completed under this project cost only a fraction of the replacement cost of one tendon, but the findings played an important supporting role in technical decision making regarding the plans for future action. Furthermore, the present vibration data have been archived and will provide a baseline that can be contrasted with the results of later vibration surveys, allowing for high sensitivity in revealing tension degradation that may take place in the interim.

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