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Memphis Airfield Improvements Related to the Structural Requirements of the Airbus A380

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Enclosed in this report are the findings of the structural evaluation of the Hurricane Creek Box Culvert, Taxiway Yankee Tunnel, and the Winchester Road Tunnel as related to the Airbus A380 design requirements. The loads and landing gear pattern used during this evaluation were outlined in the Airbus A380 airplane characteristics, as attached in Appendix A.

Hurricane Creek Box Culvert

An evaluation was performed on the above mentioned structure. All evaluation and computer output are attached in Appendix B. The loading of the Airbus A380 was applied in the landing gear pattern shown in Appendix A. The loading was distributed in a fashion to represent 0', 3', 6', and 8' of soil/pavement cover by distributing at a 45-degree angle from the gear pattern shown in Appendix A.

It should be noted that for covers greater than and equal to 3', a uniform weight for 18" of pavement was used, in addition to the remaining cover of soil. Also, for covers greater than and equal to 6', the wing gear and body gear act together, resulting in a larger load over a section of the top slab.

It was determined in the calculations that the top slab of the box can handle a maximum moment of 131 kip-ft (as seen on sheet B1A). During the evaluation, if the A380 was to be placed directly on the top slab, the slab would be overstressed by 13%. For covers equal to and greater than 3', the top slab will have a maximum moment of 56 kip-ft (as seen on sheet B22), which is well under the 131 kip-ft allowable.

During the exterior wall check, a concern was raised related to the J-bars. On the cross section supplied to our office the J-bars did not extend far enough into the top slab for the applied forces of 3' of cover. As seen on sheet B53 of the Appendix, the moment equals zero at approximately 5.8' from the wall and the actual lengths of the J-bars are only 4'-9" long. From this, a depth of 6' is required for these bars to be effective. If less than 6' of cover is in place, additional reinforcing will be necessary to account for the shortness in the J-bars. Besides the J-bars, the wall was sufficiently reinforced for covers greater than and equal to 3'.

The evaluation of the interior wall (Appendix B53 B57) was performed with two reinforcing patterns. It was unclear on the cross section what the bar spacing and size was for the interior wall, so an evaluation was performed using both spacing and sizes shown for the exterior walls. The checks were for #8 bars @ 6" on center, and #5 bars @ 12" on center. If the interior wall has #8 bars @ 6" the wall is sufficiently reinforced. If the #5 bar option was used, the wall will not be strong enough.

The exact size and spacing of the interior wall reinforcement should be confirmed and compared with the outlined reinforcement. It is possible to use precision instrumentation for inspection of reinforcing bars in concrete to determine the size and spacing of the existing rebar in the interior wall. An example of this type of equipment is the Data Scan C-4974 Digital Rebar Locator, Rebar Finder. Further information regarding this equipment could be found on the James Instruments Inc. website (www.ndthames.com).

Assuming that the reinforcing is insufficient, a possible remedial program for this would include increasing the interior wall width, and tying additional steel reinforcing to the existing steel. Once this is completed, additional concrete could be added to increase the width of the wall.

It was determined in the calculations (Appendix B110 B111) that the bottom slab of the culvert was sufficiently reinforced to handle the loads applied by the A380. The maximum applied loads were 15.5kip axial load and 245.7 kip-ft bending moment, which is within the allowable limits.

Taxiway Yankee Tunnel

An evaluation was performed on the above mentioned structure. The evaluation and computer output is attached in Appendix C. The loading of the A380 and the landing gear pattern are as shown in Appendix A.

The evaluation included with the slab, Bulb Tee girders, and the exterior and interior walls. It was noted during the slab check that due to the relatively small spacing of the girders, there was little load that the slab had to carry in bending. It was determined that the slab can handle the loads applied by the Airbus A380 and the approximate 3' of soil and 3' of concrete above the centerline of the runway, as shown on the drawings supplied to our office. As seen on sheet C3, the required top transverse steel in the slab is 1.21 in^2 and the bottom required steel is 1.87in^2. The supplied top and bottom steel are 4.42 in^2 and 4.42 in^2, respectively.

The Bulb Tee shapes were evaluated using Conspan, which is a bridge design software. In order to use this program, a "design truck load" had to be created to represent the loads applied by the A380. For the evaluation of the girders, a 20' wide section of the tunnel was used, along with the modified "design truck loads." The evaluation results indicated that the Bulb Tees could handle the loads applied by the A380. The modified loading can be seen on sheet C19 & C35.

The exterior and interior walls of the tunnel were also checked with cover depths of 3', 6', and 8'. The outcome of the exterior wall evaluation was that it was 6% overstressed, which is considered ok (as seen on sheets C38 and C39). The interior wall, however, was overstressed due to the loads. The interior wall required approximately twice the bending steel that is currently in the wall (as seen on sheet C58). A similar remedial program outlined for the Hurricane Creek Box Culvert interior wall would be applicable in this situation as well.

It should be noted that according to the existing structural drawings, the existing tunnel was designed to handle a 1.7 million pound plane with a tricycle "C" landing gear pattern. Original structural calculations were not supplied to our office, thus this applicable load could not be confirmed. It is unclear at this time why the interior wall cannot handle the 1.4 million pound loads applied by the A380. A possible reason for this is the distribution of the load by the particular landing gear types.

The footings for this structure were not evaluated at this time because there was no soil information was provided to our office. Without the soil data, the resistance of the soil cannot be determined.

Winchester Road Tunnel

An evaluation of the Winchester Road Tunnel was performed at the same time as the Taxiway Yankee Tunnel. The design of the tunnel area in question was the same layout as the Taxiway Yankee Tunnel. The results of the slab and Bulb Tee check indicate similar results to the Taxiway Yankee Tunnel.

During the evaluation of the interior and exterior walls, the reinforcing bar size and spacing was not available to our office. If should be confirmed that if the same size and spacing were used as in the Taxiway Yankee Tunnel, the same results will occur with the interior wall not being able to handle the applied loads. It should be confirmed if this is the same case for this tunnel, and if so a similar remedial program should be developed and implemented.

Additional Notes

It should be noted that during the evaluation of these structures, the effects of the pavement type were not taken into consideration. The loads were taken to be similar to a point load, and then distributed through the soil at a 45-degree angle to the structure. If the pavement distributes the loads in another pattern, this may help the structures, but will not likely affect them enough to not require remedial work where necessary.

Executive Summary

The Hurricane Creek Box Culvert evaluation shows that the box can handle the loads of the Airbus A380 as long as the soil/cover depths above the box are at least 3' deep. For depths less than this, the box will be overstressed and should be strengthened to handle the loads. Also, if the soil cover is less than 6', additional reinforcing will be required to account for the short length of the J-bars. In addition, the interior wall reinforcing needs to be confirmed that #8 bars at 6" spacing was used. If less steel was used, the interior walls may need to be reinforced.

The Taxiway Yankee Tunnel evaluation shows that the interior wall of the tunnel needs to be reinforced to handle the loads of the A380 for any soil/cover depth checked. Once this is completed, the footings will need to be evaluated to confirm they are adequate. This will require soil information to be provided to determine the resistance of the soil.

The Winchester Roadway Tunnel evaluation could not be confirmed at this time. The portion of the structure in question appears to be designed the same as the Taxiway Yankee Tunnel. If this is correct, the same results can be expected.

If there are any further questions or concerns regarding this evaluation please feel free to contact our office.

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