Bridge Abutment / Approach Backfill

Interstate 90, Wasta, SD
South Dakota Department of Transportation
1997
Density: 30 pcf - 40 pcf
Volume: 8,000 cy

Two narrow bridges were replaced with a Contech Super Span arch bridge to eliminate icing conditions on Interstate 90 near Wasta, South Dakota. Initially, the eastbound lanes' arch structure was backfilled with a granular material, but the soft underlying soils began to compress under the new load, and settlement of the arch bridge footing beam began to occur. Over a four-year period of monitoring, the underlying soils finally consolidated. The granular material was removed to springline of the eastbound arch structure and replaced with PROVOTON foam concrete to provide a lightweight backfill to eliminate future settling of the structure. Once the eastbound lanes were completed, the west-bound bridge was removed and replaced with the steel arch structure and backfilled with PROVOTON foam concrete.

The advantages of the lightweight backfill will be:

a) Less overburden on the structure and underlying soils.
b) When set, the foam concrete is 100% compacted, and provide a solid support for the structure.
c) Foam concrete is free standing when set, causing no lateral pressures on the structure and the end walls.

The project involved replacement of a narrow divided steel girder I - beam bridge structure on the Interstate 90, about 10 miles west of Wall, South Dakota. This section of highway travels down in elevation through the Cheyenne River Valley. The bridge structures spans a single rail-road track that runs through the low point of the valley. The location of the west end of the bridge along the stationing of the westbound lanes was at the point of tangency of the curve, or the end of the curve.

The narrow bridge combined with a slight bank that faced a southern exposure and with the location of the bridge structure, was the site of numerous accidents. Due to the harsh winters with large snow falls and extreme low temperatures, the SDDOT had difficulty keeping ice off the bridge structure. The bridge being narrow and with no shoulders, prevented the snow plows from throwing the snow over the outside guard rail. The snow that was piled up along the guard rail would begin to melt slightly and the moisture would flow across the west bound lanes and become icy and dangerous.

PROVOTON
Foam Concrete

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Their solution was to replace the bridge structure with a Contech Super Span steel plate bridge culvert and backfilling the structure with a soil cover. The new bridge structure would be much wider and allow for the addition of shoulders, also with the thick soil cover the road surface would not be susceptible to freezing as much as the old bridge structure. The approximate size of the Contech Super Span structure was 35' wide by 27' tall and covered 320' of the railway.

The project was to be constructed in two stages. First stage was to switch the eastbound traffic to the westbound lanes and to demo and replace the eastbound bridge structure. Once the bridge was removed, the concrete footings that the new steel structure would be connected to were placed. Backfilling of the steel structure was with a granular material with a soil cover to construct the road structure upon.

Soon after the construction of the eastbound roadway, SDDOT Engineers noticed that settlement of the concrete footings supporting the new steel liner plate structure was beginning to occur.

Due to the settlement which was occurring at the footings of the eastbound lanes, the westbound lanes bridge reconstruction was put on hold. SDDOT Engineers began monitoring the settlement to determine how much settlement would occur and what period of time it would take for the settlement of the footings to stop.

Monitoring of the settlement was performed over a four year period after the construction of the eastbound lanes, at which time the settlement had stopped. Due to the additional weight of the granular backfill adjacent the steel plate structure it was compressing the underlying weak soils, and causing the 3' wide by 6' deep concrete footings to bow and settle into the ground differentially up to 19" from the original top elevation of the footings when they were constructed.

Corrective measures for the eastbound lane structure was to remove the select granular backfill material from the top and both sides of the structure down to springline of the Contech super span arch. Then backfill the excavated area with a engineered lightweight foam concrete.

A 30 pcf PROVOTON foam concrete was used for backfilling from springline up to 2'- 4' above the crown of the structure, the width of the foam concrete backfill was at a 12' radius from the sides of the super span structure. A 40 pcf PROVOTON foam concrete was placed 2'-3'deep on top of the 30 pcf material, and then a 1.75' road structure built upon the engineered fill.

Advantages of the PROVOTON foam concrete were primarily it's mass, being 25% the weight of the granular material reducing possible settlement. The minimum compressive strength of the 30 pcf and 40 pcf foam concrete was specified at 80psi and 120psi respectively, actual breaks of the 30 pcf were 80psi at 7 days and 160psi at 28 days, the 40 pcf material averaged over 300 psi at 28 days. Secondly, when the foam concrete sets after placement (approx. 4-6 hours) it becomes a free standing mass which will not place lateral loading on the steel structure.

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The PROVOTON foam concrete was placed in two foot lifts, one lift per each side of the structure per day which insured that the backfill would not deform the steel structure during the backfill.

Outside 2' high forms were relocated 4'' in towards the steel structure on top of the previous days pour for the next lift that day. Once completed with the foam concrete backfill the road structure was constructed and the two way traffic switched from the west bound lanes to the east bound lanes.

Demolition began on the original west bound lanes bridge structure and the construction of the west side Contech super span arch was started. Once the arch was constructed, select granular backfill was placed up to springline on both sides of the arch, (approximately 10') . The foam concrete backfill was placed in the same manner as the east bound structure. Along with backfilling the arch, bin walls which help stabilize the northwest slope of the project were backfilled with foam concrete to reduce the overburden.

Over 7000 cy of the 30 pcf, and 1400 cy of the 40 pcf PROVOTON foam concrete was placed during the two stage project. The 30 pcf material contained 25% flyash , and the 40 pcf contained 50% flyash with respect to the cement.