Study on the influence of backfill soil layer to bridge piers liners

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Abstract

Liners construction actual situation, the bridge according to the orchard soil for the backfilling effect on bridge safety evaluation, the geotechnical general finite element program MIDAS /GTS, mainly analyzes the layered filling compaction, to protect the cylinder liners are compared. in the local maximum deformation, stress.

Keywords

Bridge pier; Piers liners; Backfill soil; Safety assessment

1. Introduction

Orchard bridge located on the bridge to post the reroute village of highway K16 + 867 ~ K17 + 057 section. The bridge area for shallow hilly topography, the bridge area geological surface of 0 ~ 3.7 meters thick silty clay, the bedrock of mudstone and sandstone. The bridge area no bad geological phenomenon. The bridge span arrangement for 11 x 30 m prestressed simply supported T beam, the total length of 350 m. The bridge is located in i1 = 1.223% and i2 = 2% of the vertical curve. Bridge design load: car super - 20, trailer - 120, 1/100 of design flood frequency.

Bridge bridge around two Settings, all 31 m wide, bridge deck layout of 0.25 m (lateral anticollision railing) + 14.25 m (roadway) + 2 m (separator) (roadway) + 14.25 m + 14.25 m (lateral anticollision railing) = 31 m, protective railing with linear bending. Upper structure half range from 7 piece with a horseshoe T girder by transverse diaphragm, wet juncture of 0.56 m. T girder height 2.0 m. Girder diaphragm plate with holes, transverse diaphragm connection USES the steel plate welding. Bearings with rectangular four fluorine rubber bearing and skateboard bearings, set up six of the whole bridge expansion joints. Bridge deck pavement with 13 cm thick waterproof C40 concrete. Infrastructure with belt pile pier capping beam, pier diameter 1.8 m, 2.0 m diameter pile. Setting system between pier beam, beam size 1.2 m * 1.5 m, cap set collar beam at the same time, the size of 1.2 m by 2.0 m. Bridge pile foundation for the artificial dig-hole pile, pile foundation embedded weakly weathered rock layer depth is greater than 2.5 times the pile diameter. Related drawings as shown in the figure 1 ~ 2.

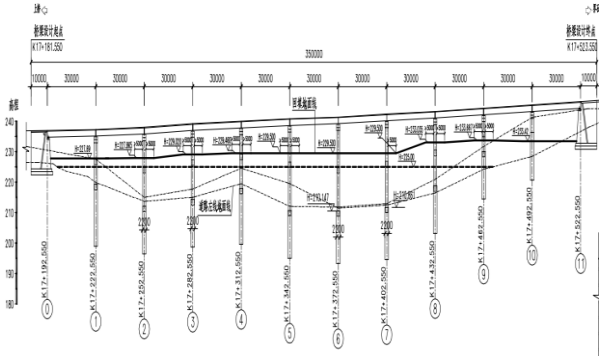

Figure 1. Orchard bridge elevation

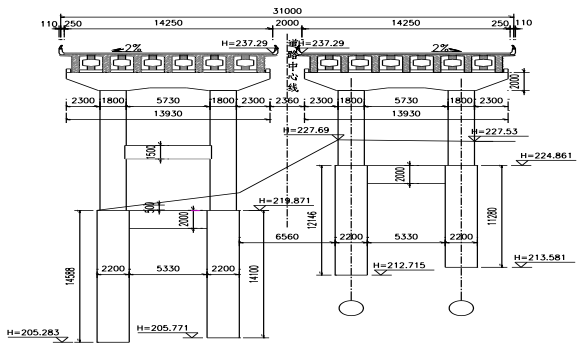

Figure 2. Orchard bridge cross section structure

Jiadao, sierra leone garden landscape engineering projects on the west side highway greening belt is located in the upper high-speed K17 + 359 orchards around the bridge. The project in both the orchard bridge location should be flat field and the elevation of 225 m. Part due to the status quo of the ground

elevation below 225 m, after implementation, the project 1 ~ 8 orchards bridge piers are filling. According to the measurement, pier no. 6, fill depth, the biggest is 17.8 m. In order to ensure the bridge pier in the process of the backfill construction safety, will reduce to minimum the influence of backfill soil of bridge pier, adopted the following measures for bridge pier protection:

Set around the ring liners, the reinforced concrete piers liners and the pier is 80 cm between separated by a space. The liners of the design concept is: through protecting tube set, can guarantee that did not happen when protecting tube rupture, dumping or excessive deformation, bridge pier is not affected by backfill soil completely, protecting tube is shown in figure 3.

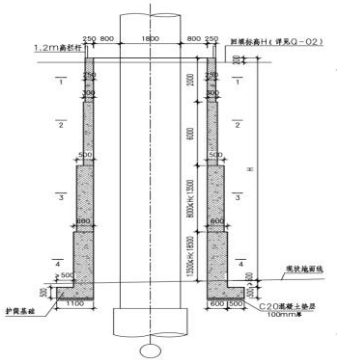

Figure 3. Cross-sectional schematic pier protection scheme

The soil around the piers (scope of protection: the bridge and bridge touchline 30 m around each range), the homogeneous stratified backfill pressure (ram), layered thickness should not be more than 30 cm, backfill soil compactness is not less than 90%, protecting tube basal bearing capacity not less than 200 kpa.

Before backfill soil around the bridge pier layered set liners. Liners using reinforced concrete, the bridge pier protection schematic diagram as shown in the 3-2, 3 to 3. Liners with variable cross-section form, the height under 2 m tube diameter 1.7 m, diameter 1.95 m, thickness of 25 cm; Height between 2 m to 8 m, liners inside diameter of 1.7 m, the outer diameter of 2.0 m, thickness of 30 cm; Height between 8 m and 13.5 m, liners inside diameter of 1.7 m, the outer diameter of 2.2 m, thickness of 50 cm; Liners inside diameter of 1.7 m, the height more than 13.5 m diameter, 2.3 m, thickness of 60 cm.

Liners using stratified pouring, the pouring height should be higher than each backfill height 50 cm;

Liners outside the bagged sand pebble stratified backfill protection;

Tube at the top of the set of crash barrier;

Between pier transverse beam reinforced concrete protection should be set structure, prevent backfill soil direct effect on the collar beam spacing is 20 cm, specific as shown in figure 4 ~ 5:

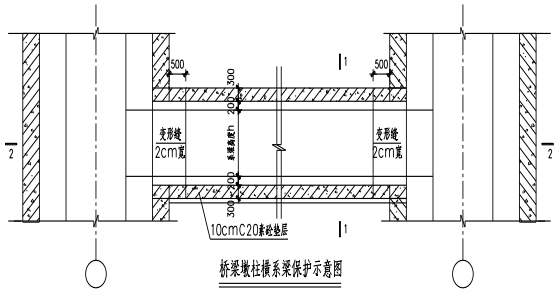

Figure 4. Bridge pier beam protection structure elevation

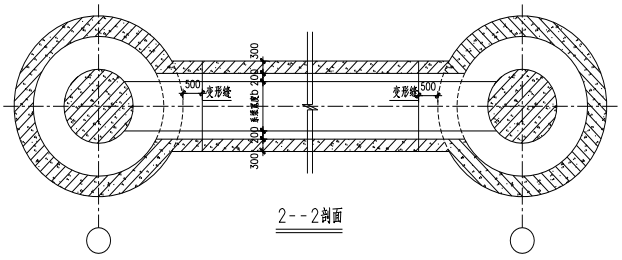

Figure 5. Piers collar beam profile protection structure

2. The Analysis Model

2.1 Model Overview

The calculation according to the uniform backfill and according to the foregoing, to simulate the protection scheme selected according to the height of backfill liners as analysis object, the bridge pier no. 6, and in the model considering liners for the double row space with elastic-plastic finite element tool to analyze it, and evaluation of flat field construction scheme of protecting tube structure of security risks. Space elastoplastic numerical analysis using general finite element program MIDAS/GTS.

Model length x width is 90 m by 60 m, according to the actual surface to model the initial stress state after the basis of the original surface water chestnuts simulation, control the original ground base at the bottom of 21.2 m. Liners for the simulation of two rows of liners in each row 4, a single tube length is 19.0 m, protect the bottom from the bottom of the model of 21.7 m, and buried in the ground below 0.5 m. Bottom model boundary conditions for the vertical displacement constraint, and constraints for the horizontal method before and after, on both sides at the top of the model for the free surface. Flat field per 2 meters a backfill layer considering (the top layer, in accordance with 1.8 m height). Most Gao Tiantu liners on both sides of the consider 0.5 m height of embankment, compaction machinery in liners damaged the arris body (scope) consider small static within 20 t type ramming machine.

2.2 Analysis Conditions (Filling Method, Mechanical Position and Weight)

Condition 1: protect the undisturbed soil as the initial stress state at the bottom of the barrel

Condition 2: pouring reinforced concrete liners

Condition 3: liners buried deep in the backfill soil

Condition 4 ~ 11: according to each layer 2 m upper layered filling sand

Condition 12: liners filling height of 0.5 on both sides, the liners filling between the two rows of 1.3 m, liners lateral fill the 1.8 m, the liners filling the high side will be in the form of a pressure load applied mechanical load.

2.3 Model Schema

According to the flat field elevation and both the structure of spatial relations, and considering the influence of the terrain and geological condition based on reinforced concrete liners and the surrounding rock and soil as the research object of the three-dimensional elastoplastic finite element model, as shown in figure 6 ~ 7.

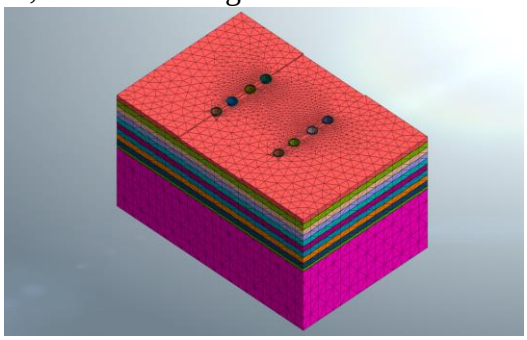

Figure 6. Calculation model

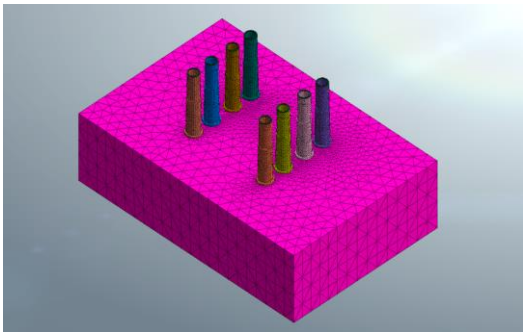

Figure 7. Liners distribution of the model

3. Model Results

3.1 Liners Calculation Results

Liners in the most unfavorable condition after 12 for the whole structure of state, stress state and deformation situation as shown in the figure below.

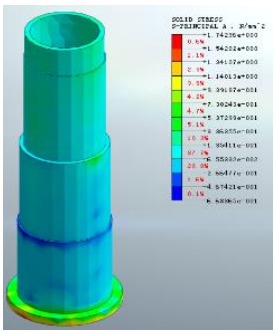

Figure 8. Protecting tube of principal tensile stress (unit: MPa)

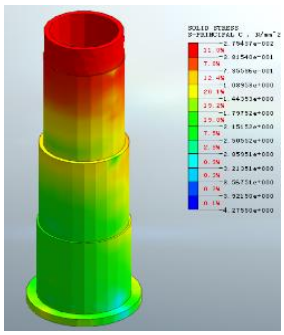

Figure 9. Protecting tube of principal compressive stress (unit: MPa)

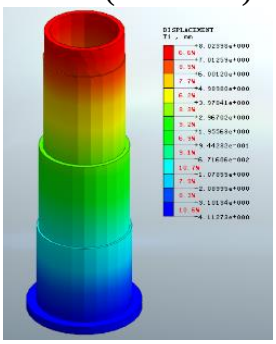

Figure 10. Liners ele vated the displacement (unit: mm)

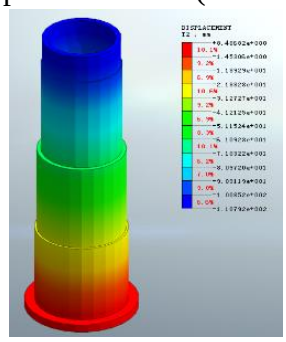

Figure 11. Liners Cross the bridge the displacement (unit: mm)

Conclusion according to the figure 8 ~ 9: filling the last layer of 1.8 m and 0.5 m height of filling, protecting tube of maximum principal compressive stress is 4.28 MPa, located at the base of the liners. Protecting tube tensile stress value is 1.74 Mpa, also in the bottom of the barrel, all does not exceed the allowed strength values. According to the figure 10 ~ 11: finally a layer of 1.8 m filling construction and considering 0.5 m height of fill will lead to liners produce different direction of displacement of the X direction (ele vated to) the maximal displacement of 8.02 mm, Y direction (to) cross the bridge the maximal displacement of 110.79 mm.

3.2 Cross Beam Calculation Results

Because Gao Tiantu range including pier transverse beam, therefore, liners will be involved in the protection and the influence of cross tie beam. Figure 12 ~ 13 condition seven and conditions for the liners vertical displacement value of the twelve. Because of the liners in the working condition of each lengthen, therefore in the process of the backfill liners under the working condition of the backfill, the only completely into the pier of backfill soil collar beam for pier no. 6 left collar beam, the top elevation of 223.24 m, collar beam 2 m high, liners elevation in backfill the collar beam elevation to around 217.7 ~ 219.7 casting. Is the working condition of the calculation of the working condition of seven.

Condition of twelve and conditions for seven of the vertical displacement of the difference is the single beam sheath after casting the most unfavorable conditions in the process of construction of the backfill deformation value, the value of 444.296 mm to 244.533 mm = 199.763 mm, namely the liners and the bridge pier beam sheath relative bridge pier is vertical downward displacement of the 199.763 mm.

At the same time considering the largest piers X direction (ele vated to) the maximal displacement of 8.02 mm, Y direction (to) cross the bridge the maximal displacement of 110.79 mm, Z direction (ele vated to) the maximal displacement of 199.763 mm. Calculated collar beam sheath after casting and the maximum space between collar beam displacement.

$$\Delta=\sqrt{x^2+y^2+z^2}=\sqrt{8.02^2+110.79^2+199.763^2}=\sqrt{52244}=228.57mm$$

Greater than 20 cm, jacket and tie beam clearance shows that collar beam sheathed in the process of backfilling construction, along with the protecting tube settlement deformation, the maximum displacement is greater than the sheath and the collar beam, the protection of the clearance between collar beam will suffer because of the adverse stress effects of backfill, so it is necessary to protect the space.

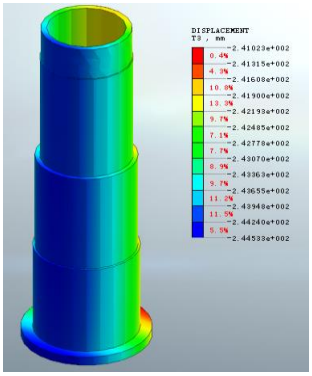

Figure 12. Condition 7 liners vertical displacement (z unit: mm)

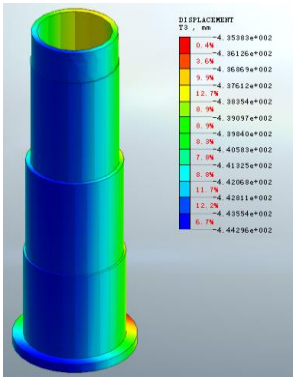

Figure 13. Condition 12 liners vertical displacement (z unit: mm)

4. Layered Filling Construction Process Analysis

Within the scope of orchard bridge piers filling analysis of layered soil filling process, considering its effect on 20 t within small and medium-sized rolling machine, filling liners on both sides of the maximum height difference of 0.5 m, the most unfavorable liners ele vated biggest to the displacement of piers is 8.02 mm, maximum cross the bridge to the deformation of 110.79 mm, liners tensile stress is 1.74 MPa, the biggest liners compressive stress is 4.28 MPa, the biggest analysis showed that the bridge pier liners in the process of layered filling flat field, the reinforced concrete bridge piers liners strength, stiffness and crack etc to meet the specification requirements, under the most unfavorable load, the most unfavorable pier liners too large deformation and structure damage does not occur, as a result, when carried out in accordance with the design requirements for layered filling, layered filling process of flat field safety impact structure of bridge pier no.

Between the pier beam under the aegis of the reinforced concrete sheath, sheathed backfill deformation process is greater than the sheath and the safety of the gaps between the collar beam distance, collar beam are sheathed and filling effect, so it is necessary to protect the space.

Assessment analysis, the project of bridge pier protection scheme can be limited to protect orchard bridge piers, due to the small collar beam structure protection gap between bridge piers, layered filling process of flat field safety influence on collar beam structure between bridge piers, suggested that will protect the gap increased to 30 cm.

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