

# Analysis of the Application of Micro Steel Pipe Pile Technology in Emergency Maintenance of Ordinary National and Provincial Trunk Highway Subgrade

Xinchang Wang

China Three Gorges University, Yichang, Hubei, China

**Abstract:** *A provincial road in Guizhou Province experienced cracking and bursting of retaining walls, roadbed subsidence, and road surface cracking, with a rapid trend of disease development. After multiple on-site inspections, it was decided to implement emergency maintenance of the roadbed. For sudden disaster sections that affect traffic safety, emergency plans should be initiated and emergency maintenance and repair work should be carried out in a timely manner. The treatment plan adopts micro steel pipe piles to reinforce the roadbed, demolish and rebuild the original retaining wall, and finally restore the road surface, drainage, and traffic safety facilities.*

**Keywords:** filling roadbed; Settlement treatment; Micro steel pipe pile.

## 1. INTRODUCTION

Due to the lack of construction technology and the impact of the external natural environment, the roadbed often suffers from diseases after road engineering is put into use, such as uneven settlement, which greatly affects the comfort of driving and even endangers driving safety. Therefore, maintenance units need to analyze the causes of settlement for different roadbed settlement issues, and adopt targeted construction techniques based on the causes in order to fundamentally solve the hazards caused by road settlement. Based on a provincial highway K77+200 in Guizhou Province as an example, this paper analyzes the root causes of uneven settlement, and briefly describes the application effect of micro steel pipe piles in second-class highway. War has always been the inevitable activity and topic of mankind. War is not only the “touchstone” used to test the national quality, but also the focus of the whole cultural connotation. Spengler once said that the essence of war is not the triumph but the unfolding of cultural destiny [1]. The 6th century BC was a period when human history entered an epoch of rapid development. The ancient cultures of several nations, such as Greece, China, India and Hebrew, have gradually separated themselves from the primitive cultural model and entered a new historical process. Homer’s epic and The Book of Songs, compiled under this historical background, profoundly reflect the spiritual state of each nation in the important period of human development, and have a great influence on the later historical and cultural development of each nation. The two works are precious treasures of the ancient eastern and western poetry art, all of which are created by the people collectively, collected and sorted out by later generation. There are war poems in both works, which can reflect the understanding and attitude of the nations towards the war. It is an effective way to study the war poems in these two works if we want to know the cultural characteristics of ancient war through time and space.

## 2. MAIN FACTORS AFFECTING ROADBED SETTLEMENT

At present, the rapid development of information technology in vocational colleges has become a trend, and the rapid promotion and impact of information technology on vocational colleges are more obvious. At this time, the senior leaders of the school should strengthen the overall situation, improve and optimize the top-level building design of teaching information management services, integrate cutting-edge technologies such as big data and artificial intelligence, integrate physical education teaching, scientific management and implement system construction, one of the more important links is to implement the relevant systems of the CIO as soon as possible. The CIO is mainly responsible for the key trend development of the informatization construction of vocational colleges. For its overall informatization development strategy, planning the digital campus plan and adopted standards, promoting and implementing the organizational reform of the informatization school leadership system, and constantly strengthening the strategic orientation and consensus of the overall informatization core

competitiveness of vocational colleges, The informatization leadership of its Information Supervisor plays an important and irreplaceable role in the informatization development of vocational colleges.

Research in recent years also supports the broad application of LSTM in financial forecasting. G. Huang et al[23]proposed an integrated learning method combining LSTM, CNN, and random forest algorithms to improve the effectiveness of stock price prediction. J. Hu et al[24]used the LSTM network and attention mechanism to predict foreign exchange prices and proved that the attention mechanism could help the model to focus on more important input information. The current study shows that LSTM can learn the long-term dependence and nonlinear changes of time series, which shows great advantages and application prospects in financial market forecasting.

Quantum economics reveals the uncertainty and volatility of economic variables by studying the quantization law of economic activities. We can apply quantum game theory and quantum probability theory to build a quantum model to describe the crude oil market and analyze the quantum fluctuation characteristics of crude oil prices. On the other hand, LSTM networks are excellent in dealing with financial time series forecasting by learning the long-term dependence of time series. Therefore, this study proposes to build a hybrid quantum finance-LSTM prediction model:

- 1) A quantum model describing the crude oil market is constructed based on the principles of quantum economics to reveal the quantum laws of the crude oil price.
- 2) An LSTM network is used to learn the time series of crude oil price output from the quantum model, and LSTM networks are trained to capture the long-term dependence of the time series.
- 3) A hybrid model that integrates the principles of quantum economics and deep learning is built up.

This research proposes an integration of quantum econometrics and long short-term memory deep learning for enhanced predictive modeling of crude oil price dynamics. By synthesizing the theoretical underpinnings of quantum economics with the pattern recognition capacities of recurrent neural networks, this novel framework aims to advance the efficacy of forecasting for this complex financial time series. The fusion of these multidisciplinary techniques offers new perspectives and endeavors to improve petroleum price prediction through a hybrid quantitative approach. Overall, this study contributes novel concepts and methodologies for amalgamating quantum economic theory with machine learning algorithms to better comprehend and anticipate the behavior of global commodity markets.

### **2.1 The quality of roadbed filling material is unqualified**

The filling subgrade accounts for a large proportion of second-class highway in mountainous areas. The mountainous areas are densely populated with trees, flowers and grass, and there are many impurities in the soil. If the road bottom cannot be thoroughly cleaned, it is inevitable that impurities such as tree roots will remain, affecting the construction quality of the filling subgrade. In addition, the geological environment in mountainous areas is relatively complex, and the rainy and humid climate conditions cause weathering of rocks or soil, which also seriously affects the uneven settlement of the roadbed.

### **2.2 The construction process of the roadbed is not standardized**

The roadbed conditions of ordinary national and provincial trunk highways in mountainous areas are complex and varied, and different regional environments will have different roadbed forms. During the construction process, due to certain factors, the filling roadbed was not compacted in layers according to the specifications, or the thickness of the layered filling was not determined through testing, or the data of the test section could not match the environmental factors of a certain region, resulting in the construction process not being in accordance with the site, resulting in settlement of the highway roadbed in the later stage.

### **2.3 Incomplete subgrade drainage facilities**

The water resistance of the roadbed has a certain limit. If the waterproof and drainage problems of springs, groundwater, lakes, ponds, rice fields, and other parts are not properly solved during the construction stage, if they

exceed the water resistance range of the roadbed, it will have adverse effects on the roadbed.

#### **2.4 Poor quality of filling roadbed retaining walls**

The construction of ordinary national and provincial trunk highways is often limited by the investment amount, and the retaining wall materials under the filled embankment roadbed and half filled and half excavated roadbed are mostly made of mortar rubble. If management is not good during the construction process, poor quality of rubble masonry, low mortar strength, and uneven and full mortar filling often occur. This leads to the deformation, cracking, and collapse of retaining walls caused by vehicle loads and long-term rainwater after many years of highway operation, resulting in roadbed settlement and pavement crack deformation.

### **3. INTRODUCTION TO ROADBED SETTLEMENT TREATMENT PROJECT**

At K77+200, a provincial road in Guizhou Province, there is a cutting type roadbed. The retaining walls on both sides of the road are made of mortar rubble, with a balance weight retaining wall. The settlement occurs on the left side of the road, with a length of about 32 meters. The deformed and cracked retaining wall is 8 meters high. The agricultural irrigation ditch in front of the roadbed is blocked, and the water flows out for a long time along the road surface (there is no side ditch in this section of the roadbed), washing the retaining wall and road surface, soaking the retaining wall filler, and forming a soft foundation. The left retaining wall burst due to heavy vehicle rolling, and there was no sliding phenomenon at the bottom of the retaining wall foundation.

After the adjustment of the national road network, the provincial road has become a part of the national road. If the retaining wall collapses, it will affect residents' safety and traffic safety. After multiple on-site inspections, it has been decided to adopt emergency maintenance measures for the roadbed. That is, for sudden disaster sections that affect traffic safety, emergency plans should be launched and emergency maintenance and repair work should be carried out in a timely manner.

### **4. CONSTRUCTION PROCESS OF MICRO STEEL PIPE PILES**

#### **4.1 Process Introduction**

According to the design requirements, the prestressed anchor cable adopts the action of anhydrous dry drilling to ensure that the construction of the anchor cable does not deteriorate the engineering geological conditions of the slope rock mass and ensure the bonding performance of the hole wall. The construction steps for treating roadbed settlement with prestressed anchor cables in this project include: roadbed drilling - production and installation of micro steel pipe piles - roadbed grouting reinforcement - pouring of reinforced concrete ground beams - adding concrete guardrails - restoring the road surface, security facilities, and drainage engineering.

#### **4.2 Process flow**

##### **(1) Preparation before construction**

The project adopts a semi enclosed road construction method. Before construction, it is necessary to prepare a construction organization design and a safety and smooth plan, and provide pre job training and disclosure to workers. A isolation strip is set up in the center of the road to seal the left side of the road, and mechanical equipment and materials enter the site after calibration and inspection. Move the machine into position and correct the hole position and angle based on the measurement results. Before drilling each hole, the drilling angle value needs to be checked to ensure that the designed drilling angle is  $0^\circ$ , in order to prevent small and uneven spacing from weakening the anchoring force of the pile group.

##### **(2) Micro steel pipe pile hole drilling and chiseling**

Effective and high-speed drilling of pile holes that meet the requirements is a key process for controlling the construction period and quality. Firstly, select generator sets and tracked drilling vehicles based on the type of strata, select a drill bit with a diameter of 130mm, and prepare casing in advance to prevent collapse in the hole. Secondly, the anchor hole drilling adopts anhydrous dry drilling to ensure that the drilling construction does not pollute the surrounding environment and ensure the bonding performance of the hole wall. Thirdly, the drilling process should address the changes in the formation and drilling status of each hole. Make on-site records of

drilling pressure, drilling speed, groundwater, and some special situations. Due to the use of clay in the backfill of the roadbed, hole collapse often occurs during drilling, and in this case, the method of drilling with a pipe should be adopted.

### (3) Manufacturing and installation of micro steel pipe piles

The material of the steel pipe pile is 108mm steel pipe, with a single length of 10m and a wall thickness 3mm, 10mm Quincunx grouting holes are set 1.5m below the steel pipe pile top, with spacing 40cm, with a diameter of 15mm for the discharge hole; 3 micro piles are used  $\phi$  32mm hot-rolled ribbed steel bars, arranged in a regular triangular pattern, with a spacing of 2m spot welded into bundles. Before micro pile bundling, the steel bars are screened to remove dead bends, mechanical damage, and rust pits. Then, the steel bars are arranged in a straight and uniform manner according to the design length, and mechanical cutting of the steel bars and steel pipe is used.

When installing micro piles, it is advisable to first lift the steel pipe. After the steel pipe enters the hole to the bottom, measure its verticality with a lifting rope to ensure that it is vertical and free from tilting. Then, fix the steel pipe and lift the steel tendon. When transporting the steel tendon vertically, except for the main lifting point, other lifting points should be able to quickly and safely unhook the anchor cable; During transportation and lifting, careful operation should be carried out to avoid damaging the steel pipe pile and its protective coating. After the tendon is placed into the steel pipe pile, its perpendicularity is adjusted, and then the rebar is fixed on the steel pipe wall in the form of "+".

### (4) Grouting for micro steel pipe pile holes

Pressure grouting plays a decisive role in connecting steel pipe piles and roadbed as a whole. In this project, P.O32.5 ordinary Portland cement paste is used for low-pressure grouting. The grouting pressure is 0.5Mpa, and the Water–cement ratio is controlled between 0.45 and 0.5 to allow the slurry to flow evenly to the subgrade gap, fill the cavities between the subgrade, enhance the overall strength of the subgrade, and prevent uneven settlement of the subgrade. The frictional force between the anchor body and the soil layer increases the anti sliding force of the micro pile. After the completion of the first grouting, when the mortar body reaches its initial setting value, a high-pressure pump is used for secondary grouting. Splitting grouting mainly uses pressure to split the grouting body like a sharp axe, and then enters the weak rock and soil layer and cracks; During the process of splitting into the soil layer, the slurry produces several reinforcement effects on the rock and soil, such as filling, squeezing, diffusion, skeleton, and ion exchange. After the grouting of 66 anchor holes is completed, check the grouting situation one by one to ensure that the secondary high-pressure grouting effect meets the expectations.

### (5) Reconstruction of retaining walls and pouring of ground beams

The damaged wall body 6.5 meters below the road surface needs to be removed. After removing the old retaining wall, the C25 rubble concrete retaining wall will be poured in three sections using formwork. Drainage pipes and Expansion joint shall be set for the extension of the retaining wall according to the design and specifications, and the wall back shall be backfilled after the wall concrete reaches 75% of the design strength. The overall pouring of the concrete ground beam involves placing three adjacent micropiles using  $\phi$  The 18mm stirrup is connected into a Equilateral triangle, every 10m is a whole, and a Expansion joint is set. After the self inspection is qualified, concrete pouring will be carried out. 50cm behind the whole concrete ground beam, one-time vibrating pouring molding and curing will be carried out.

### (6) Add drainage system, restore road surface and security facilities

After the completion of the main construction of steel pipe piles, cover plate side ditches, drop wells, and steel corrugated pipe culverts will be implemented to introduce rainwater into the township drainage network, and reinforced concrete guardrails will be restored as required. Finally, after the concrete ground beam reaches a certain strength, the construction of the water stabilized base and asphalt concrete surface layer begins. The asphalt concrete surface layer uses 6cm thick dense graded medium grained asphalt concrete, which is leveled and consistent with the road surface on both sides after rolling.

## 5. SUMMARY ANALYSIS

Uneven settlement of roadbed is one of the common diseases in highway maintenance engineering. Prevention

should be the main principle, and different treatment measures should be taken according to different situations, such as adding retaining walls, replacing fillers, prestressed anchor rods (cables), frame beams, anti-skid piles, etc. In practical management and maintenance, micro steel pipe piles can achieve rapid response, effective rescue, timely treatment, and safety protection without interrupting traffic. They are an effective treatment method similar to roadbed diseases and are worth promoting in emergency maintenance of roadbed. Cultural defaults pose significant challenges in the translation of publicity texts due to the differences in cognitive assumptions and cultural backgrounds between the source language authors and the target language readers. Relevance Translation Theory provides valuable insights and strategies for addressing these challenges. By analyzing the patterns of cultural defaults and implementing ostensive stimulus, appropriate reconstruction, and acculturation strategies, translators can reconstruct the cultural nuances and bridge the cultural gaps, enabling target language readers to better grasp the cultural connotations conveyed in the source text. This not only facilitates effective communication but also contributes to the success of international cultural exchange and mutual understanding among nations.

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