

## Study of the Treatment of Bridge Bored Pile in the Karst Terrain

Hao Wu<sup>1, a</sup>, Jinghui Liu<sup>2, b\*</sup>, Qida Zheng<sup>3, c</sup>, Wenku Wang<sup>4, d</sup>, Yong Ya<sup>5, e</sup>,

<sup>1, 2, 3, 4, 5</sup>, College of Civil Engineering and architecture, China Three Gorges University, P.R.China

<sup>a</sup>1031637727@qq.com, <sup>b</sup>yangjianxue33@126.com (corresponding author), <sup>c</sup>531833929@qq.com, <sup>d</sup>503669928@qq.com, <sup>e</sup>1390440240@qq.com,

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**Abstract.**the broken pile is one of the serious accidents due to quality in bored pile of bridge, and different treatments have been put forward toward the pile breaking problem discovered in pile checking; and we expound emphatically the problem of the deep broken pile under the bridge bored pile through the integration of grouting consolidation and tendon.<sup>1</sup>

### Preface / foreword

With the rapid growth of the national economy and large-scale engineering construction in China, the constructions of pile foundation in karst terrain are increasing day by day. Due to the complexity of karst development and improper construction, the problems such as drill pipe sticking, mud leakage, bury drill, hole collapse, broken pile will occur in the process of the pile foundation construction, of which the broken pile is the most difficult problem to deal ztested.

### Common methods of dealing with broken piles [3-9]:

#### PILE INSTALLMENT IN SITU

It is a constructive method that alluvia cone is used to strike the concrete of the broken pile till the bottom; after the foundation is cleared completely, a new pile will be perfused in situ. It zsts. It is a better choice for those regions where there are important piles, required strict function, or intensive broken files.

#### PILE EXTENSION IN SITU

The method of pile extension can be used when the distance of the broken pile is not far from the ground. Generally we resort to the way of Manual dig-hole. First of all, the sound test of pile should be adopted to locate the position of the broken pile, according to the analysis of soil layer condition below the pile top with geological data, and determining the plan of wall protection. Then chipping laitance at the top of pile and the loose concrete ; cleaning the rebar and continue to pour the concrete for pile extension.

#### RECONSTRUCTION OF A NEW PILE IN A BROKEN PILE

Izeconomic loss if the drainage is not well treated and water level cannot drop.

#### POLE PILE METHOD

Pole pile method is also known as the method of two cows to wrangle in construction. It scraps the original pile and raw pile position, in waste pile side elevation of pile top elevation design, symmetrical each pile 1 root, connected to a small pier, to replace the original waste pile. This

approach is widely used, and broken pile treatment of the conventional method. This method from effect is more reliable of and deficiencies need to spare working face, the high cost of construction, 1 root pile into three piles, workload put too much, probably because of site conditions and other special constraints can not be used.

#### GROUTING CONSOLIDATION METHOD

This method is economical, simple, and effective, requiring simple equipments. It can construct by using existing core drill mud pump and hydraulic mixer, slurry storage tank and other equipments. The principle is in the broken pile of the pile body center drill a small hole, the aperture according to the pile diameter and heart pumping requirements. A small hole was drilled to broken pile under the site, used for punching drill down to the broken pile with water injection to remove broken pile parts of the filling, then remove the tool in sealed, and then the high-pressure pump high strength cement slurry is pressed into the hole in the pump liquid in the filling pile breaking air gap to the inner wall of the extrusion, not only enhanced the pile and the wall between the contact. It can make the broken pile site filling connection firmly, to ensure the quality and integrity of the foundation pile.

#### THE PRESSURE GROUTING METHOD

Into the deep regional center to draw lessons from the method of drilling pile method and grouting consolidation method two methods to deal with the broken pile, finger along the broken pile drilling 5-7 holes ranging from pore diameter of 110mm, drilled to the broken pile position specified depth, usually need to drill wear at the bottom of pile in the rock about 2m, then rinse off the broken pile position of debris, then filled with fine stone concrete, so that the defect location hole fill and compaction, and then under reinforced beam (usually consists of 5 root diameter 25 rebar welding) and pressure grouting. The method is suitable for treatment of broken pile position from the ground broken pile, the cost is low, construction is simple, the effect is better. This paper mainly analyzes this method, verifying its feasibility.

### **Engineering survey and broken piles**

Using the pseudo Liang Ganggou, small, there are lots of extremely common, but there are lots of strong via a Hubei Enlai en Qian highway bridge in Western Hubei mountain area, karst development, bored pile construction is difficult. The bridge site belonged to structure and Corrosion Erosion of low peak cluster landform. The overlying soil layer is thin, the distribution of relatively sparse. Bedrock weathering karst is developed for solution groove, solution groove, local cave, and part of the interconnected signs. In the bedrock weathering layer a few Cave Erosion phenomenon, joint fissure development, broken rock, part of the dissolved pores. The bridge deck width 2-12.25m upper structure of prestressed concrete box prestressed concrete T beam and cast-in-place box girder, pier pier / double Column pier, pile foundation and abutment intends to use u to Taiwan to expand base. Test pile for the bridge pile foundation found that two broken pile quality problems. The construction unit take timely measures to deal with, and achieved satisfactory results.

(1) No. 11 Pier 1 piles, pile diameter 1.8m, pile length 20.2m, pile foundation detection found that the concrete strength of the 2.5m is significantly lower, after the drill core to confirm that there is too much mud, for defective piles.

(2) No. 13 pile, pile diameter 1.8m, length 28m, pile testing found that the concrete strength of the 23m is significantly reduced, and the 23.2m~23.9m is confirmed by the drilling core.

## Broken pile treatment program

(1) 11 pier No. 1 broken pile, from the ground near, the underground water level low of the disconnected pile position. On the surface, about 1m gravel soil cover layer. After discussing the design units and the construction units consistently identified by in situ pile splicing scheme. The commonly used artificial dig hole, pneumatic pick broken upper pile has concrete pouring, with concrete wall will be broken pile bottom concrete cutting hair, re perfusion concrete pile, forming the integrity of the pile. Construction period of about 10 days, at a cost of about 3 million yuan. Re testing of pile foundation, test results for class II pile.

Applied with a pole covered with thick about 0.8m, (2) 13 pier No. 2, broken pile, broken pile position from the ground very deep, about 23.2m~23.9m surface of gravel soil layer. The broken pile scheme, design units and the construction units to controversy. A kind of opinion is the pile method, quality reliable, but the cost is high, long construction period, and the venue is limited; the other is by in situ composite pile method, the original broken pile concrete impact crushing, clean up after in situ to cast new pile, but clean concrete and steel is difficult, time is long, the cost is high; there is a kind of opinion is the pile sinking method, the original pile bit to drill a small diameter pile, but by It is very difficult to deal with the high water level, the construction is difficult, and the cost is high. It has been suggested that the use of grouting consolidation method, which is very difficult to guarantee the quality of the pile. After the treatment, it is very difficult to guarantee the quality of the pile.

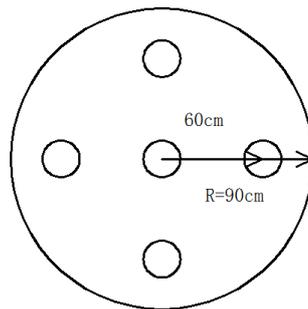


Fig. 1 boring plan

## Concrete construction process

drill; bore ; perforate ; drill hole ; broach

The 100 type drill rig is used to complete the 5 diameter of the 110mm, as shown in Figure 1, as a grouting hole and the insertion hole of the reinforcement.

Hole cleaning

High pressure water on the 5 hole of the loose section of the implementation of high pressure jet grouting, in addition to the part of the broken piles of mud, concrete debris, etc., so that the sand and mud back to the ground, until the back of the water, washing the hole.

Pouring concrete

The C30 fine stone expansion concrete is poured into the 5 hole, which makes the hole filling and compacting, and then each drill hole is made up of a steel beam, which is made of 5 30m diameter 25mm, and a long steel bar.

Grouting consolidation

This pile is made by central hole injection, and the surrounding hole is in the way of grouting, the pressure grouting adopts the first 10MPa (about 5MPa), then the high pressure is used to be the cement slurry.

## Effect detection

The whole construction process is about 17 days, the cost is about 35000 yuan, the process is simple and the cost is lower than other methods. Through the 5 hole drilling and grouting, the 5 diameter is 11cm, and the other parts of the pile are 1 8m concrete.

## Reinforcement principle analysis

Under the action of the upper upper less the proportion occupied by the pile's ultimate bearing capacity of pile side friction resistance, pile tip resistance of two parts, the pile more long pile more coarse, pile side friction resistance in the limit bearing capacity accounted for the proportion of larger, pile end resistance of pile under load, by down the play pile side friction resistance [7-9], a root section of a defect or even disconnect broken pile, is the upper pile first loaded, as the load increases, the pile side friction resistance sequentially from top down play until the upper part of the pile slip. This process can be broken pile is considered as a piece of friction pile. To be broken pile slip to a certain height, and the lower segment of the broken pile contact in the vertical load, the second can be Normal play of very deep, to work together to become a root length longer end bearing friction pile. Pile ultimate bearing capacity and the broken pile defect position has a direct connection. The defect position is by close to the surface, the broken pile limit bearing capacity of the smaller 13th pier No. 2 broken pile location away from the surface, limit bearing capacity loss is small; through the grouting consolidation cement slurry filling defect position, and by grouting, cement grout and surrounding rock and soil combined more closely and improve the pile side friction resistance, the central region of the five small aperture reinforced beam holes formed reinforced concrete pile, depth original pile under 2m, ensure the pile end resistance, and a Further strengthened the defect position, the broken pile on the position of the two parts are connected to form a complete pile.

## Concluding remarks

In this paper, the general scheme of the pile is found out when the road bridge bored pile is bored pile, and the following conclusions are obtained by combining the engineering examples:

(1) for different broken piles, there is no standard treatment plan, specific problem analysis. First of all, we should determine the location of broken piles, analysis of the reasons, and then combined with the actual site conditions, geological conditions, technical equipment, select the appropriate treatment program.

(2) for the problem of ground breaking, the method can be considered to be used in the process of ultrasonic pulse detection and the social benefit. The method can be applied to similar defects in pile foundation treatment.

## References

- 1 Wang Jingqi. Case analysis of broken piles and Its Revelation:67-69,76., bridge construction, 2005, (3) [J]
- 2 Wang Yongxin. Analysis of causes and treatment measures of [J], highway transportation technology, 2007, (4):78~79.
- 3 Li Guozan, Zhong Shihao, Liu An et al. Treatment of defective piles in bridge pier [J], China Political engineering, 2006, (6): 30-31
- 4 Cui Guiguan. Large diameter bored bridge pile broken pile treatment technology of highway

and automotive, [J], 2010,(5): 171-173

- 5 Shen Zhongwu. Treatment method of reinforcement cage deflection and broken pile in construction of bored piles [J], railway engineering Newspaper, 2009, (5):12-15.
- 6 security foundation. Three dimensional finite element analysis of vertical bearing behavior of pile foundation with defective piles [D], Tianjin:Tianjin University, 2006
- 7 Wang Chenghua, an, a three dimensional finite element analysis of vertical bearing behavior of group piles with defect piles [J], four Research on the construction of Sichuan, 2007,33 (6):90~93
- 8 Wang Gan. With fault defect pile perfusion pile vertical bearing character of the model experimental study and numerical analysis [D]. Tianjin: Tianjin University, 2012
- 9 Su Juan. Model test study and numerical analysis of vertical bearing behavior of single pile and group piles with broken [D], Tianjin: Tianjin University, 2012