# Study on High Pressure Impact Extrusionof the Foundation Curtain Deflection Core Fracture Zone of the Sluicing Dam Section

Liu pan* and Fan kai

*China Three Gorges Corporation, Beijing, China*
**pande72@163.com*

**Abstract**

As the main engineering geological problems of the Xiangjiaba hydropower damfoundation,the deflection core fracture zone which not only affects the damfoundation stress and deformation, but also cause a potential threat to seepage stability. After the Xiangjiaba hydropower dam impounding and generating electricity and running,under the action of high water head for a long time,to ensurethe seepage stability ofthe foundation curtaindeflection core fracture zoneof the sluicing dam section, for solvingtechnical problemof drilling and collapsing hole,segmented closed, pressure grouting, repeat splitting lifting, ineffective perfusion and so on, that using by the process method ,mechanisms, control standards of combined grouting process of "fixed holeand sealing up"and "high pressure impact extrusion" to research and practice, so that the deflection core fracture zone impermeability has been significantly improved, reaching the design impermeable technical requirements, provides technical support and reference to implement seepage controlfor other similar projects.

**Keywords:** Deflection Core Fracture Zone,Fixed Hole and Sealing Up, High Pressure Impact Extrusion, Strengthening Grouting, Impermeability

## 1. Introduction

Xiangjiaba Hydropower Station is the last planning step of the Jinsha River, the dam is located in junction Yibin County in Sichuan Province and ShuifuCounty in Yunnan Province. Engineering hub is mainlywater retaining structure, flood discharge energy dissipation buildings, blunt desilting buildings, diversion and power generation systems after the left bank dam, underground diversion and power generation systemson the right bank , navigation structures and irrigation water intakes and etc. Which weir dam is a concrete gravity dam, the largest dam height is 162m. Hydropower normal water level elevation is 380m, dead water level elevation is 370m, total reservoir capacity is 5.163 billion $m^3$, regulating capacity is 903 million $m^3$, which is incomplete season regulating reservoir. Power plant installed capacity is 6400MW, guaranteed output is 2009MW, annual average generating capacity is 30.747 billion kW·h, irrigated area is 3754800acres. According to distribution range of the foundation curtain deflection core fracture zone of the sluicing dam section of Xiangjiaba dam, determine grouting reinforcement rangeis mainlysluicing section⑤to (13) (right dam 0+095.000m-0+248.000m), treatment range is mainly branch points up and down and its effect of curtain deflection core fracture zone. Seepage grouting reinforcement of sluicing sectionmiddle of ⑧ to (13) is double layout, row spacing is 0.7m, hole spacing is 1.0m, becausesluicing section ⑤to ⑧set cut-off wall, grouting reinforced is a single row layout, hole spacing is 0.8m. Reinforcement grouting usenew technology combination of "fixed hole and sealing up", "high pressure impact extrusion", maximum grouting hole depth hole depth is 165m (curtain bottom elevation is 80m), to ensure the dam operation security, seepage grouting reinforced mustcontrol by zero lift motion, water permeability q<0.5Lu, Seepage failure grade >100, Drilling hole angle control precisionis not more than 1% hole depth, while solvingthe grouting drilling "confined to vomit pulp" and other problems.

## 2. Experiments

### *2.1 Grouting material*

#### *2.1.1 Grouting cement*

Grouting reinforcement used high sulfate-resisting portlandcementwhose strength rating not less than 42.5Mpa as design requirements, cement slurry used a stable slurry ratio, according to laboratory ratio test, selectingthree groups stabilized slurryratioand proportion testingof clotting time and consolidation mechanics index (Table 1).

Table1. Proportion testing of clotting time and consolidation mechanics index

| Test number | Water cement ratio | Dosage of water reducing agent | Inspection item | | Inspection result |
|---|---|---|---|---|---|
| GS24-132366 | 0.65:1 | 0.50% | Setting time | Initial set（h） | 28 |
| | | | | Final set（h） | 30 |
| | | | Compressive strength （MPa） | 3d | 11.8 |
| | | | | 28d | 43.1 |
| GS24-132367 | 0.7:1 | 0.40% | Setting time | Initial set（h） | 23.6 |
| | | | | Final set（h） | 28.1 |
| | | | Compressive strength （MPa） | 3d | 9.5 |
| | | | | 28d | 40 |
| GS24-132368 | 0.8:1 | 0.30% | Setting time | Initial set（h） | 28.2 |
| | | | | Final set（h） | 31.7 |
| | | | Compressive strength （MPa） | 3d | 9.3 |
| | | | | 28d | 36.9 |

*2.1.2 Grouting water*

Using the water supply pipe network within the main project corridor.

*2.1.3 Slurry additive*

In order to improve the stability and groutabilityof the slurry, slurry was added neutral superplasticizer (retarding). Additive amount in accordance with the formula provided by the manufacturer and confirmed by laboratory ratio tests, adding themafter dissolved in water in construction site.

***2.2 Grouting for Pulp and used for pulp***

Which is in the secondary slurry storage barrels ineach dam section pulp barrels, the stable slurry main control parameters in Table 2. When using the "top-down, one drill irrigation, interval grouting" process, slurry orifice recycled to use post-precipitation treatment. Drill irrigation construction process controlled strictly slurry density, and make adjustmentstimely, and controlledstrictly slurry final setting time, discard slurry time less than 5h.

Table2"High pressure impact extrusion" cement slurry stable performance

| Ratio of slurry（weight ratio） | | | | slurry property | | |
|---|---|---|---|---|---|---|
| Grouping | Water | Cement | Water reducer | Funnel viscosity （S） | 2hwater loss | Density（g/cm³） |
| Common | 0.7～0.8 | 1 | 0.005 | 25-35 | ＜5% | 1.60±0.05 |

***2.3 Grouting carry dynamic monitoring system***

*2.3.1 Lift observation hole layout*

Grouting carry dynamic deformation control is mainly with the aid of carrying dynamic observation hole, each reinforcing grouting dam arrangement 1-2 carried observation hole. The anchoring section at the borehole bottom through the branch or lower branches, depth not less than 80m, and into the relatively complete bedrock section. Carried observation borehole grout treatment forfixed hole and sealing up, ensure that carried observation device down to reach the designated position, the anchoring grouting is effective.

2.3.2 Carry dynamic observation device structure

A new sliding sleeve structure is used to carry dynamic observation device (Fig.1). The bottom sealed sliding sleeve is the key components, preventing high pressure slurry into the protecting tube. Down to hole was carried out aftersealing experiment, seal test pressure is not less than 6MPa. In order to ensure outer tube sealing, outer tube adopts the φ 50 steel tube, between fittingsmust be sealing fastening strictlywhen down to hole. The installation and debugging of lifting gear should be complete before reinforcing grouting.

2.3.3 Carry dynamic observation device installation

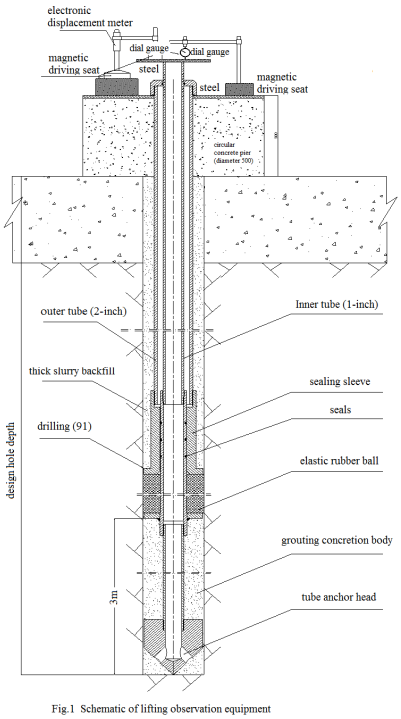


Fig.1 Schematic of lifting observation equipment

To confirm carry dynamic observation hole depth and hole wall stability. According to the holedepth and anchor headdepthto configurethe inside and outside tube length. In order to ensure the internal and external tube sealed sliding sleeve with reliable, which should be used inside and outside pipe to down at the same time. When the anchor head is installed, the inside tube connectgrouting pipe, use 0.5:1 or 0.6:1 thick slurry to drain in the hole bottom and the hole, after being orifice returns thick slurry, down the outside tube tothe rubber ball of the upper anchorage segmentexpansion, tobegin pressure grouting, grouting pressure is not less than 2MPa, perfusion time is not less than 1h, then removed thegrouting pipe, pour orifice meter abutment, installed the dial indicator and carried electronic shift automatic alarm.

***2.4 Grouting lifting observation***

Grouting lifting observation used a dial gauge and electronic displacement meter, while manual observation and electronic displacement meter alarm monitoring. Grouting strictly accordance with the zero lift motion control. Arrange to carry out lifting the dial gauge observations and recordsin the construction process, to set the alarm of electronic displacement meter detection system is 3μm. If there is a slight lifting indicator (<2μm) or electronic displacement meter alarm system alarm, immediately relief to stop grouting, to identify the reason and eliminate the lifting factors and then zero lift grouting. Make anti-collision and anti-vibrationmeasures to observation device in scene, to ensure the authenticity of the test results.

***2.5 Grouting***

*2.5.1 Grouting process*

The first stage "fixed hole and sealing up" use "top-down, one drill irrigation,interval grouting" process, that is drilling and grouting into one, using high-pressure grouting drilling pipe consisting of a long roundtube use stable slurry as a drilling fluid. In the drilling process, through the reciprocating pulsation high-pressure grouting pumped to pressed slurryinto the hole bottom,in the small gap blocking effect, and instantly produce a certain pulse grouting pressure, drilling with irrigation, irrigation guard binding (Fig.2). Sodrilling and groutingafter every drilling interval 0.5~1.5m from top to bottom, tucked the high-pressure grouting drilling pipe to a spacing segment,makeopening closed and recycle slurry pressure control, further in accordance with the grout control standards to implement effective high-pressure grouting to spacing segment. The second stage "high pressure impact extrusion"use "bottom-up, down plugto section, high pressure impact extrusion " grouting technology, based on grouting holes was fixed and sealing upeffectivelyin the first stage, the grouting hole wall havebasically safety plug segments and closed conditions, the special pressure embolism downintothe hole, bottom-up, segmented closed, high pressure crowded rush grouting, in order to achieve long subparagraph (0.5-1.5m), small pulses (0.2L/times), high pressure (>6MPa) splitting wedge compacted and injection pressure irrigation.

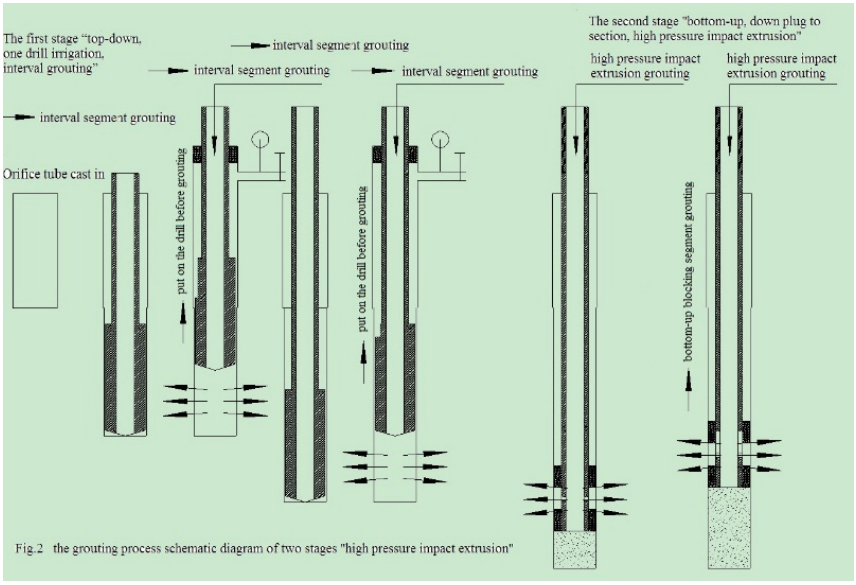

Fig.2 the grouting process schematic diagram of two stages "high pressure impact extrusion"

2.5.2 Grouting point sequence

Seepage grouting "fixed hole and sealing up " and "high pressure impact extrusion " were implemented in two stages, each stage of the drilling irrigation construction are to follow the principle of row and sequence encryption, due to the strengthening grouting close original dam seepage curtain, to prevent "bottom-up, down plug to section, high pressure impact extrusion " to produce for the formation curtain, double rowsgroutreinforcementto construct the first rowprimarily, and then the second row; each rowdivide intoⅢsequence, firstⅠsequence, thenⅡsequence, and Ⅲsequence. To prevent the grouping lifting effect of all holes, while the drilling irrigation hole spacing is not less

than 8m; under special circumstances, when the grouting hole bottom height of the two-hole is greater than 50m, the drilling irrigation hole spacing can be relaxed to 4m.

***2.6 Drilling***

*2.6.1 Drilling structure*

Reinforcing grouting carried observation holes (and the guide holes,geophysical explorationholes), grouting hole, quality inspection hole structure shown in Table 3. All hole number, hole depth, hole sequence, long segment division are performed according to the design requirements.

Table3 Drilling structure characteristics

| Dam section | Project | Bore diameter（mm） | | Hole direction | Hole depth |
|---|---|---|---|---|---|
| | | Orifice tube | Drilling and grouting hole | | |
| Sluicing section middle of ⑧ to (13) | Carried observation hole | φ110 | φ91 | Vertical | ＞80m，Enter the complete bedrock |
| | Groutig hole | φ91 | φ75 | | hole bottom elevation80m |
| | Access hole | φ110 | φ95 | | Grouting hole deep-2.0m |
| Sluicing section ⑤to middle of⑧ | Carried observation hole | φ110 | φ91 | | ＞80m，Enter the complete bedrock |
| | Groutig hole | φ110/φ91（isolation pipe） | φ75 | | hole bottom elevation 80m |
| | Access hole | φ110 | φ91 | | Grouting hole deep -2.0m |

2.6.2Drilling accuracy

Drilling hole location and design hole location deviation is not more than 5cm, hole depth error is not more than 0.5% of design hole deep. Drillingirrigationhole bottom deviation was controlaccord to the provision standard in Table 4.

Table4 the allowable maximum deviation of drilling irrigation hole bottom (m)

| Hole depth | 20 | 30 | 40 | 50 | 60 | ＞60 |
|---|---|---|---|---|---|---|
| Allow the deviation | 0.15 | 0.25 | 0.35 | 0.45 | 0.55 | ＜1% hole depth |

*2.6.3 Orifice tube cast in*

To facilitate the opening of the first stage to collect and return back to the pulp slurry seal pressure control, to install orifice tubebefore drilling and grouting, orifice tube used seamless steel pipe, installation depth into the bedrock 2.0m; adoption 0.5:1 were cast in the thick slurry. To ensure that the lower bedrock drilling vertical accuracy, to controlverticalityof the orifice tube cast in strictly, to be used as drilling vertical guide tubeof the lower bedrock, the orifice tube cast in until 3d days after solidification.

2.6.4 Isolation pipe installation

Consideringsluicing section ⑤ to middle of ⑧ provided with a cut-off wall, in order to avoid"high pressure impact extrusion"to influence the cut-off wall structure, a second phase of "high impact extrusion filling" before taking a full wall segment down into the steel casing quarantine measures. After isolation of seamless steel tubes to use design, installation depth control in strict accordance with the design requirements, the spacer tube down into the design depth, using 0.5: 1 were thick paste filling cast after cast until condensate pipe irrigation isolated 3d.

2.6.5Drilling

Lifting Observations holes, quality inspection hole, reinforcing grout holes are drilled by geological rotary drilling rig and diamond drilling. All reinforcing grout holes usedstable slurry to drill, other lifting observation holes and quality inspection hole are used water to drill. Thenon-irrigation segment below orifice tube drilling used long over 5mdrill to guide drilling. Upper 20m hole sections drilled inclinometer and hole bottom of oblique hole deviation is not more than 0.15m,then conducting inclinometerafter finished the following to 50m non-irrigation segment drilling, and the deviation of hole bottom of oblique hole is not greater than 0.55m, otherwise to closure and straightening hole to drilling. Lifting observations holes drilled into the fracture zones, stop pump to carry out pressure inflow, water pressure, water quality and other observationseach drilling 2.0m, when pressure water inflow greater than 20L/min, and the water quality was broken obviously with debris structure, immediately closed orifice, for regular blow section waterproofing., To observestrictlycircumstances of recycle slurry density and injection rate changein all reinforcement

grouting process, when there is recycle slurrydilution obvious, injection rate turned negative, time to stop drilling irrigation, orifice closed and interval grouting treatment.

### *2.7 Grouting control*

*2.7.1 Grouting section and stress*

The First phase "fixed hole and sealing up" interval segmentation and pressure control,the second stage "bottom-up, down plug to section, high pressure impact extrusion " grouting process parameter controlby Tables 5 and 6respectively.

Table5. First stage"fixed hole and sealing up" interval segmentation and pressure control

| Drill grouting stage | Fixed hole and sealing up | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Elevation | EL245m | | | | EL210m | | | | | |
| Sort /grout partition | 1 | | 2 | | GII、GV | | GIV | | GIII | |
| Grouting segmentation | high pressure impact extrusion grouting segmentation:0.5m，Other:1.5m | | | | 0.5m（high pressure impact extrusiongroutingsegmentation）-1.0m | | 2.0-3.0m | | 3.0-5.0m | |
| Injection rate | ＜3 L/min | | ＜5 L/min | | ＜5 L/min | | | | | |
| Control pressure（MPa） | Into slurry | Recycle slurry | Into slurry | Recycle slurry | Into slurry | Recycle slurry | Into slurry | Recycle slurry | Into slurry | Recycle slurry |
| | ＞4.0 | ＜2.5 | ＞5.0 | ＜2.5 | ＞4.0 | ＜2.5 | ＞4.0 | ＜2.5 | ＞5.0 | ＜2.5 |

Table 6. Second stage"bottom-up, down plug to section, high pressure impact extrusion" grouting process parameter control

| Elevation | EL245m | | | | | | | | EL210m | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sort / grout partition | 1 | | | | 2 | | | | GII、GV | | | |
| Grouting segmentation | 0.5m | | | | | | | | 1m | | | |
| Pulse volume (L / times) | ＜0.2 | | | | | | | | ＜0.2 | | | |
| Control parameters | $P_{min}$ | $V_{max}$ | $P_{max}$ | $V_{min}$ | $P_{min}$ | $V_{max}$ | $P_{max}$ | $V_{min}$ | $P_{min}$ | $V_{max}$ | $P_{max}$ | $V_{min}$ |
| | 6 | 200 | 7.5 | 100 | 6.5 | 200 | 8 | 100 | 6 | 200 | 8 | 100 |

*2.7.2 Grouting finishing standard*

For the first stage "fixed hole and sealing up", under the design grouting pressure, injection rate is less than 1.0L/min, continue perfusion 90min, to the end of the interval segment perfusion. For the "bottom-up, down plug to section, high pressure impact extrusion", when theimpact extrusion grouting injection rate reaches the maximum design units amount, and the impact extrusion grouting pressure is greater than the minimum design impact extrusion grouting pressure, or when rushing to 150% of the maximum design units amount, while the grouting pressure is still less than the minimum design units amount, to end the interval segment grouting; when grouting pressure rush to the maximum design the impact extrusion grouting pressure, and the unit amount is greater than the smallest segment design unit groutingamount, or when the pressure exceeds the maximum impact extrusion grouting pressure 10%, while the unit groutingamountis still less thanthe smallest segment design unit groutingamount,to end grouting of thisinterval segment.

*2.7.3 Special case*

If there is backwater larger or recycle slurry dilution in the first stage "fixed hole and sealing up" process, to stop drilling immediately and to measure analysis gushing water inflow and pressure, and judgment gushing circumstances, processed separately according to the size of water inflow, when water inflow is less than 20L/min, to stop drilling grouting immediately and plugging, appropriate to extend the interval segment grout time. After end grouting under normal circumstances, drilling irrigationcan continue. When water inflow occurs more than 20L/min larger and sudden gushing, immediately put on the drill string 10m above the hole, quickly closed the aperture, using 0.5:1 thick slurry to limit pressure (less than 0.5Mpa), a small injection rate (<10L/min), intermittent plugging grouting and based on plugging grouting pressure and injection rate to research to determine the single poured cement plugging totalof the sudden gushing water segment, and re-irrigation time and frequency. orifice closed and relieve pressure every 10~20min in interval grouting process, irrigation drillup and down in the hole, and prevent long-timegroutingto cause the solid tubeaccident. If the

injection rate is greater than 10L/min and can't afford pressure to recycle slurry in intervalgrouting,orifice closed and relieve pressure immediately,to limit the flow (less than 5L/min), to limitthe pressure (recycle slurry pressure is less than 0.5MPa), intermittent infusion; after paragraph spacing If the interval segment groutingamount reach 1000kg, then swept hole and reperfusion after solidification 8-10h.

*2.7.4 Grout hole sealing*

Afterthe entire hole is over in the first stage "fixed hole and sealing up", to bebottom-up to improve segmentation screen plasma gradually, segment length 20-30m, screen plasma pressure is controlled by the recycle slurry pressure, with reference to the hole section grouting pressure, each screen plasma 30min, after the plasma screen 60min, to continue by hydrostatic water (1.0MPa) to closeslurry after closing the orifice. The whole hole is overin the second stage "bottom-up, down plug to section, high pressure impact extrusion", removable closure plug filled with 0.5:1 thick slurry into the hole by water pressure, take out the drilling rodtimely, fill up 0.5:1 thick slurryinto empty hole again, then use hydrostatic water (1.0MPa) to close slurry after closing the orifice, to backfill thick slurryagainto void segmentafter close slurry 3 days, until fill orificeand consolidation.

## 3. Grouting result analysis

### *3.1 Unit grouting quantity analysis*

Seepage groutingmainly carried out the first stage "fixed hole and sealing up", which only carried out the second stage grouting in little holes section.The statistical analysis of grouting segmentunit volumein two stagesshowed that the first stageI sequence hole poured average unit volume of 68.27kg/m, II sequence hole poured average unit volume of 37.62kg/m, the average hole injection grouting amount of 60.69kg/m, in line with the law of diminishing sub-sequence encryption; the lower branch sluicing section⑩original test:the first stage I sequenceholepoured average unit volume of 104.52kg/m, II sequence hole poured average unit volume of 85.12kg/m, Ⅲ sequence hole poured average unit volume of 68.28kg/m, the average hole injection grouting amount of 86.12kg/m; the second stage I sequence hole poured average unit volume of 199.05kg/m, Ⅱ sequence hole poured average unit volume of 118.44kg/m, III sequence hole poured average unit volume of 159.81kg/m, the average hole injection grouting amount of 167.21kg/m.The analysisof injection groutingunit volume in two-stage shows:under dual control of partial small gaps blocking of high pressure impact extrusion drilling equipment and the orificerecycle slurrypressure, the interval segment grouting in the first stage coordinateinstant impact extrusion role of reciprocating pulsation high pressure pump, which can be achieved more higher grouting pressure than conventional orifice closed grouting process. Therefore, multiple rows of curtain grouting had been carried outbefore the curtain deflection core fracture zone of the sluicing dam section, but althoughwhich had some grout abilityunder the role ofthe largerimpact extrusiongrouting reinforcement. The second stage used a plug segmented and pure compressionperfusion, theoutlet of grout orifice and grout pump didn't set the recycle slurry control line, thus groutingwas a mandatory high-pressure perfusion, the amount of grout poured was control based on the construction programentirely, whichwas the minimum grouting pressure and the maximum grouting amount or the maximum grouting pressure and the minimum grouting amount. The second stage grouting results analysisshowed that the curtain deflection core fracture zone of the sluicing dam sectioncan meet the design minimum amount poured, which in the range of the minimum and maximum design impact extrusion.

### *3.2 Grouting pressure analysis*

As one of the important grouting parameters, grouting pressure is directly related to the grout ability and the compactibilityand durability of the grout body. The results statistical analysis of construction hole grouting pressure showed that the maximum pressure into slurry is 6.1MPa,and the average pressure into the slurry 5.5MPain the first stage "fixed hole and sealing up", which reached design requirements about a minimum impact extrusion. The maximum impact extrusionpressure is 8.8MPa, and the smallest impact extrusion pressure is 7.1MPa in the stage"high pressure impact extrusion",the average impact extrusion pressure is 7.5MPa, except impact extrusion pressureof the branch sectionholeis smaller, most of the holes reached the minimum design pressure.

### 3.3 Effect analysis of "fixed hole and sealing up"

Xiangjiaba hydropower station has been runin the normal high water level, in the first stagedrill irrigation construction, the largest water inflow reached 170L/min, gushing pressure was about 0.42MPa, and mostly occurs in lower branchesof the curtain deflection core fracture zoneand its impact zone. The first stage offer the down plug security and reliabilityclosed for the subsequent second stage in the reinforcing grout. According to the implementation of the first stage"fixed hole and sealing up", the branches and over hole section of the curtain deflection core fracture zone

complete the first phasegrouting, which can be reach the expected results of "fixed hole and sealing up". However, for the lower branch and hole section, most of the drill holes needed one or more potting and solid holes, in order to achieve the sealing effect whose water inflow is less than 5L/min.

***3.4 Grout lift motion control analysis***

When the interval segmentgroutingin the first stage and high pressure impact extrusion in the second stage had been carried out, two lift motion important parameters of recycle slurry pressure and grout injection rate wascontrol strictly, which didn'toccur move, to reach the technical requirements of zero grout reinforcement of lifting.

***3.5 Drill hole deviation control analysis***

Grouting reinforcement isdeep grouting, drilling hole deviation control precision affects directly the continuity of grout curtain, so the opening holesvertical accuracy must be control strictly, drill irrigationprocess used longer drill which was greater than 5m, the part of drill hole section was taken expansion "eyeful drilling" technology (φ59mm drill / φ75mm expansion), the maximum deviation of reinforcing grout holes which have been completed in the first stage was less than 1% hole depth, to meet the design specifications.

**4. Conclusions**

1. Accordance with the two stages "fixed hole and sealing up" and "high pressure impact extrusion "in seepage grouting, which usedtwo new engineering methods of "top-down, one drill irrigation, interval grouting" and "bottom-up, down plug to section, high pressure impact extrusion", it's better to solvethe hole drilled with hardly and gushing spit pulpand other technical problemsin the curtain deflection core fracture zone.After the first stage "fixed hole and sealing up", the branches and over holes section was satisfied with grouting requirements of the down plug security and reliability closedthe second stage, but there was embolism sealing failure and grout around the plug in the local hole section of the lower branch and impact zone in the second stages, which need sealing and sweeping grouting again.

2. In the deep hole deviation control, It's control strictlyby opening hole vertical accuracy, the length of drill irrigation equipment, drill irrigationspeed of soft hole segment and a series of technical means, and with a handful of timely inclinometer skew value is exceeded hole section plugged with correction, and cooperate with the survey to seal actionin time of a handful of deflection value exceeds hole section, to controlthe drill hole deviation accuracyeffectively, fully meeting the design requirements.

3. There was control strictlyrecycle slurry pressure and grout injection rate in the first phase,by using pulsed high voltage, long subparagraph, small pulses and other new technologyin the second stage, high pressure splitting wedge compacted and injection pressure irrigation, which was better to solve the problem of repeated fracturing of small stress surface of the curtain deflection core fracture zone and invalid perfusion and lifting grouting, to ensure zero grout reinforcement of lifting.

4. As long as grouting process in the second stage can be the implementation of effective byhigh pressure impact extrusion, splitting wedge and pressure infiltration perfusion to the curtain deflection core fracture zone, which was bound to improve impermeabilitysignificantlyto reach the design infiltration technical requirements.

5. In accordance with "fixed hole and sealing up", "backfill sweep irrigation" and "high pressure impact extrusion " in three stages, the lower branch and impact zoneis reinforced grouting, which can ensure the closed reliability and validity of a continuous grouting of high pressure impact extrusion ofdown plug to section in the second stage.

6. Reinforcement grouting pressure should mainly control recycle slurry pressurecombined with the length into slurry pipe, the pressure into slurry, to determine the blocking effect of irrigation equipment in the hole.

7. Under the conditions of groutinglifting didn't appear, by using thick slurry, low pressure (less than 0.5MPa), limitingwater flow, intermittent perfusion and other measures, that should be a one-time infusion to approach or reach the groutingend standard, to avoid disturbance defects sectiondue tomultiple sweep hole and reperfusion.

8. When the second phase "high pressure impact extrusion"was implemented, the branch should be given priority double plugand subparagraph perfusion, but the deep hole of down branch should adopt a single plug for grouting.

9. In order to improve the utilization of slurry material further, saving cement resources and reducing emissions discard pulp, the performance of slurry should be optimizedfurther, to appropriate delay the slurry initial time, to optimizefrequency of the single hole inclinometer,to improve pressure

into slurry and increase unit poured amount, improving irrigation technology to reduce tube buried accidents of deep borehole.

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