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STRESS FIELD SIMULATION ANALYSIS OF COMBINATION DRILLING EXPANSION DOWNHOLE

QING LI[a1], LING NIE[b] AND ZHIQIANG HUANG[c]

[a]Associate Professor and Research Department of Mechanical and Electrical Engineering, Southwest Petroleum University, Chengdu, Sichuan, China
[b]Post Graduate and Research Department of Mechanical and Electrical Engineering, Southwest Petroleum University, Chengdu, Sichuan, China
[c]Professor and Research Department of Mechanical and Electrical Engineering, Southwest Petroleum University, Chengdu, Sichuan, China

ABSTRACT

Speed boost and synergia have became the central task of oil and gas drilling ,and rock breaking is the key to speed boost. So the research about the new methods aboutbreaking rock efficiently is the primary problem which must be solved at current. Conventional downhole model and stair downhole model are established through carrying out stress field simulation analysis of combination drilling expansion downhole,toreasearch the differences about stress field and displacement field between the conventional downhole and the stair downhole. Moreover various mechanical models on stair downhole are set up through adopting computer simulation in order to study the effect rules about the stress field and displacement field caused by different drilling expansion ratios.Researching the effect rules about the stress field and displacement field caused by different relative locations. The results show that,firstly, the stair downhole has better stability than conventional downhole.Secondly,combination drilling expansion has better effect than the direct use of larger size drill.Thirdly,drilling expansion ratios and relative distance between drilling and expanding body have optimal range for the drilling efficiency of combination drilling expansion.

KEYWORDS : Speed Boost and Synergia, Combination Drilling Expansion, Stair Downhole; Stress Field, Displacement Field

Enlarging combined drilling technology is a rising star of new drilling technologies in recent yearswhich principle is using pilot bit and reaming blade work at the same time, Finally it will realize designing hole size, drilling more rapidly, in order to achieve the purpose to improve the quality of well completion (Bai et al., 2013; Wang et al., 2008; Ma and Wang, 2006). As a kind of technology to increase the drilling efficiency, it reduces operation cost, optimizes well bore structure, improves the cementing quality. therefore the application of technologies such as enlarge combination drilling have been more and more widely used (Eaton, 2001; Rodman, 2001; Rodman, 2003; Dou et al., 2011). But enlarging combination way of structure and rock breaking rock tools is different from the conventional drill, also the ladder type bottom which is produced in the process of combination drilling makes it under different in-situ stress produced by the conventional drill, the differences cause the change of weight which pilot bit and reaming cutter wings are bearing, thus to enlarge the combination effect on drilling tendency of broken rock tools(Shi et al., 2006; Guan et al., 2007; Xia et al., 2009; Xia and Guan, 2008). In this paper, by comparing the conventional bottom hole with the difference between the ladder of bottom hole stress field and displacement field, research different enlarge proportion bottom hole and the steps of the pilot section and reaming section relative distance ladder at the bottom of the well which is formed by the different stress and displacement variation law, to enlarge the design of the composite rock tools provide guidance on the basis of, and drilling for oil rapidly increase find new way of rock do early.

METHODS AND PROCEDURES

Conventional Bottom Hole And Ladder Bottom Hole Model Is Established

Basic Assumptions

Under the complex environment of bottomin order to facilitate research and not to affect the results, do the assumptions on the following system :

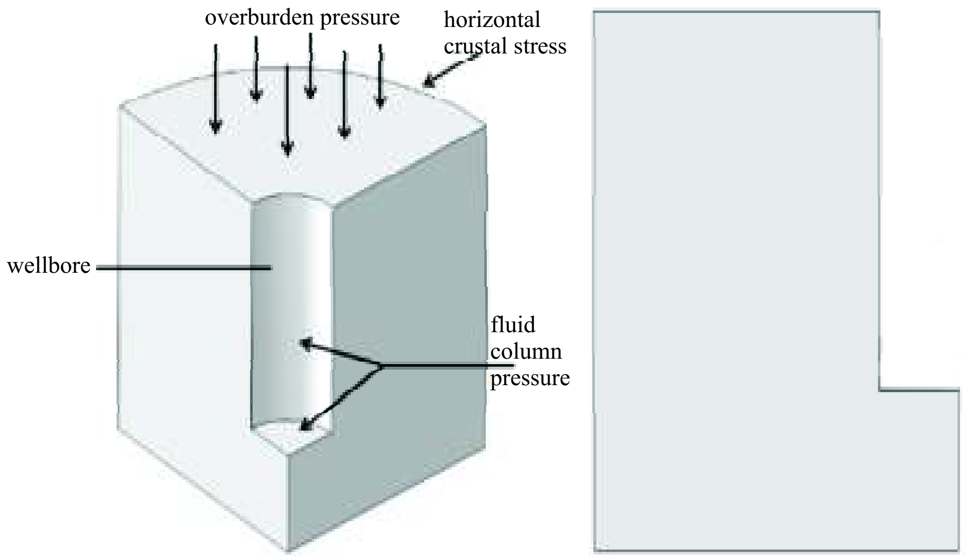
(1) The rock is cylinder, isotropic material, ignoring the original crack and the influence of tectonic stress and rock pressure within gap;

(2) Bottom hole rock is in a borehole far field, simulate the confining pressure influences on rock mechanical by keeping up the pressure on rock boundary.

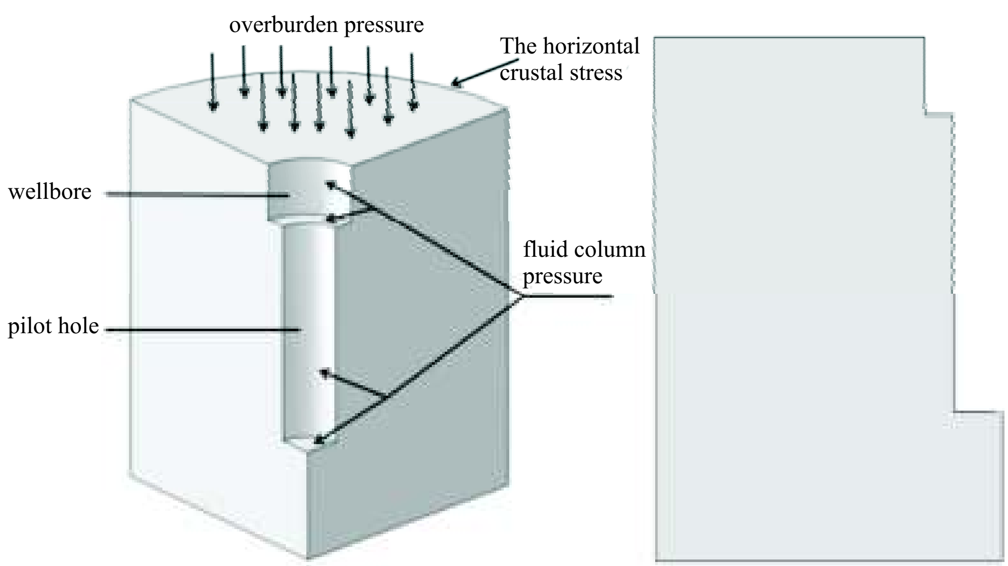
Establishment of the Bottom Hole Model

Convenient to analyze problems, take a quarter wellbore to model, as shown in figure 1.

[1]Corresponding author



(a) Conventional Downhole and Longitudinal Section Schematic Diagram



(b) Stair Downhole and Longitudinal Section Schematic diagram

Figure 1: Model Construction Diagram

This paper set up a general model of bottom hole, hole size for ф220 tostudy the changes of stressfield of drilling ladders at the bottom formed by different , and the relative position of different drillings, expanding body on the ladder of bottom hole stress field and displacement field, this paper established six step bottom hole models, which divided into two groups, each group has three models.

first group, different drill expansion ratio.

Model 1: (the proportion 4:10);

Model 2: (the proportion 6:10);

Model 3: (the proportion 8:10).

The second group, drilling, expanding body position is different.

Model 4: drilling, expanding body relative distance H = 250 mm;

Model 5: drilling, expanding body relative distance H = 400 mm;

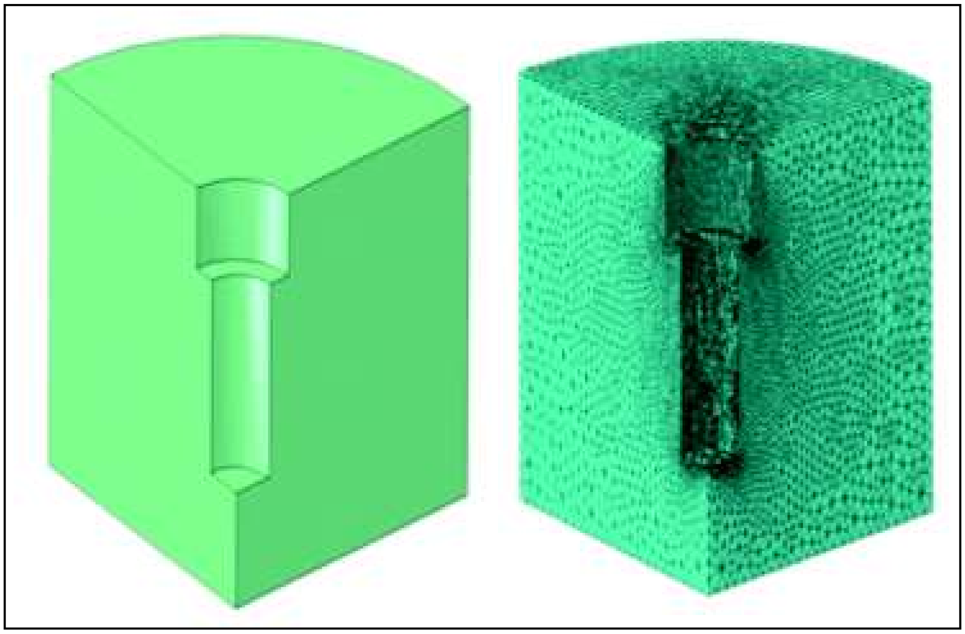


Figure2 : ϕ132×ϕ220The Model Structureand Meshing

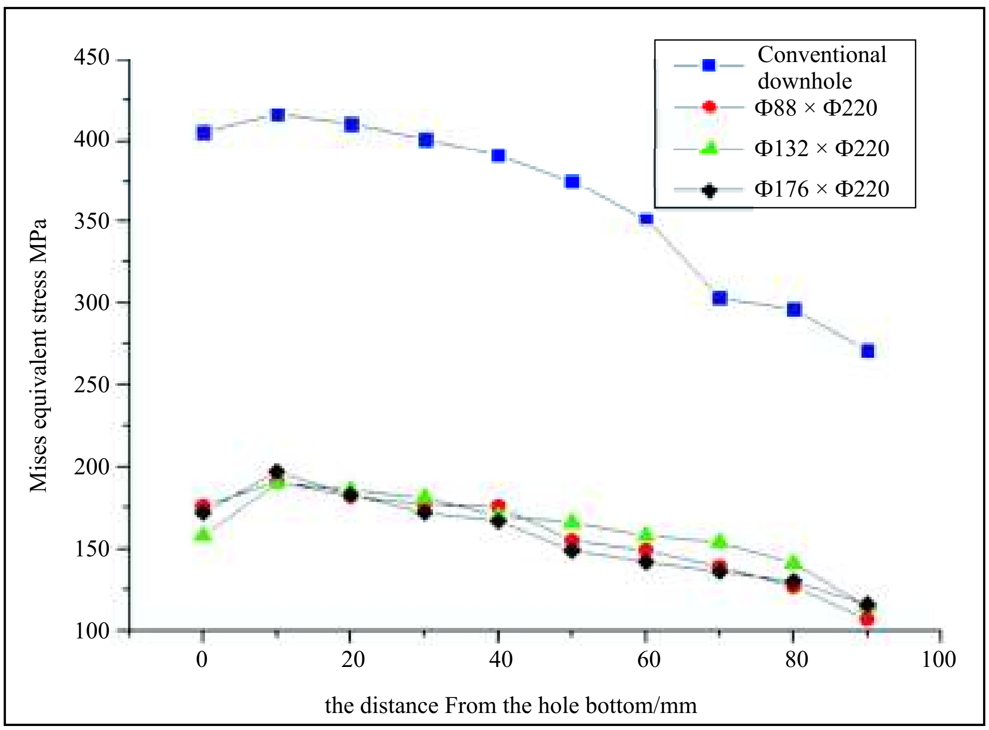


Figure 3 : The Equivalent Stress Curve of Borehole Wall

Model 6: drilling, expanding body relative distance H = 750 mm;

In bottom hole, for example, the model and the grid are shown in figure 2.

Results of Simulation Analysis

To easy the calculation and the analysis, take the bidirectional horizontal in-situ stress equal, meanwhile the model takes into account the overburden pressure, horizontal in-situ stress and drilling fluid column pressure,

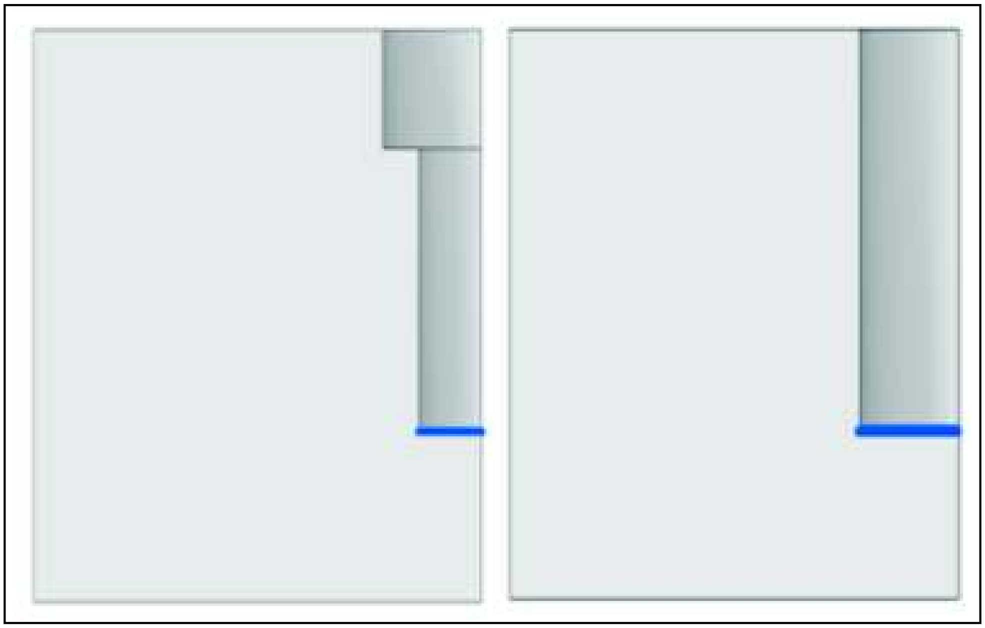


Figure 4 : The Equivalent Displacement Path

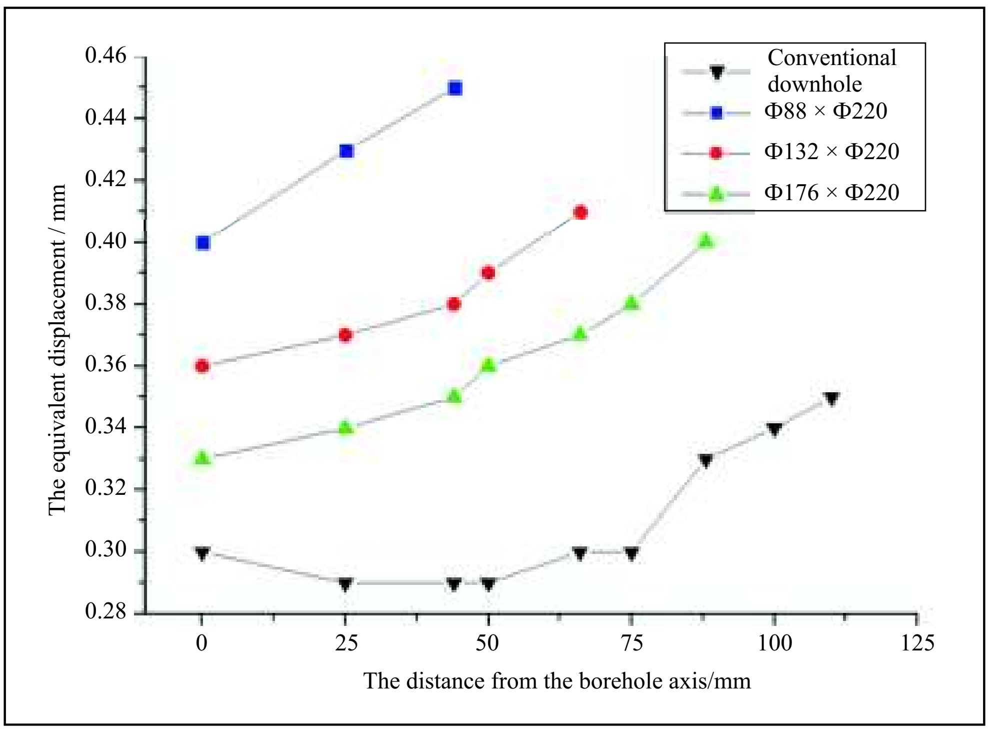


Figure 5 : The Equivalent Displacement Curve

porosity and porepressure. Boundary conditions for the model based on all constraints, two sidesare defined as a symmetric boundary, outer circumferential surface horizontal ground stress, overburden pressure, the top face of the surface in the wellbore drilling fluid column pressure.

Conventional Bottom Hole and Ladder Bottom (First Group) Contrast Analysis

1. Wall Stress Analysis

It Can be seen from the figure 3 that the stress of conventional bottom hole of shaft wall is much greater than the ladder at the bottom of the well borehole wall , the greater the stress is , the greater the object close to the yield limit and the easier it is damaged, the ladder at the bottom of the well borehole stability is better.

2. Bottom Displacement Analysis

As is shown in figure 4 and 5, the conventional equivalent displacement is less than the ladder at the bottom of the well bottom at the bottom of the well bottom equivalent displacement. The bigger the displacement and deformation are , the closer the rock gets to the damage condition, and the more easily be broken. So the bottom ladder of the well is more easily broken and broken faster than conventional well bottom.

Stair Bottom Hole Stress Field Analysis

ϕ132×ϕ220ladder bottom hole,for example.

1. Bottom Hole Stress Nephogram

On free surface borehole wall, rocks under the action of stress and fluid column pressure produce stress concentration, it can make objects to produce fatigue crack, easily lead to brittle material static load crack.And rock belongs to the typical brittle material, so the reaming steps to pilot borehole wall rock stress concentration will help the reaming blade broken rock.

It is seen from the figure 6that the position of stress concentration is mainly in the pilot shaft wall .however, in the pilot bottom hole and reaming compared stress on casing collar is smaller than the eye wall.So on one hand,the pilot shaft wall rock bottom hole rock is more easily broken, pilot shaft need smaller cutting force and fracture work than the pilot bottom, reaming blade reamer willnot slow down the whole drilling.On the other hand, at the time of exerting wob, more weight on bit will be assigned to the pilot, smaller size of pilot bit can obtain enough mechanical energy, therefore, under the same bottom hole area, the reaming while drilling technology is better than the direct use effect of the larger size of the bit drilling.

2. Bottom Hole Stress Field Stress Curve

Bottom hole stress diagram can reflect the change trend of stress from the perspective of quantity and features.For a comprehensive analysis and a reflectionof the characteristics of the ladder of bottom hole stress field, the model of a radial plane defines five stress path, as shown in figure 7.

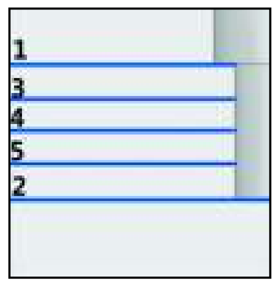


Figure 7 : The Stress Curve Path

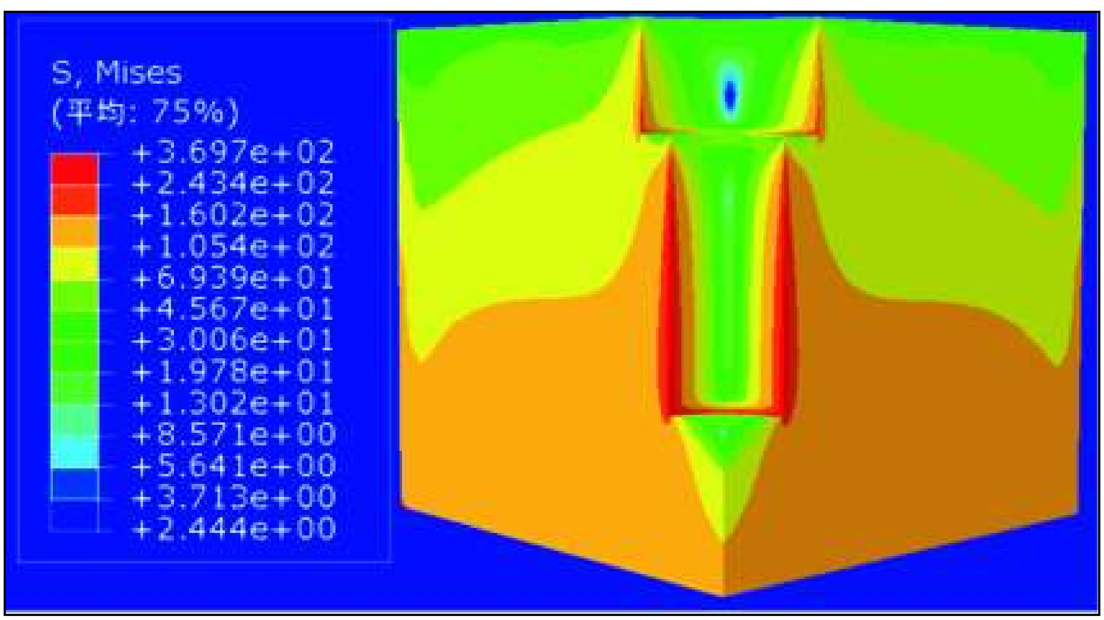


Figure 6 : ϕ132×ϕ220 Equivalent Stress Nephogram of Stair Downhole

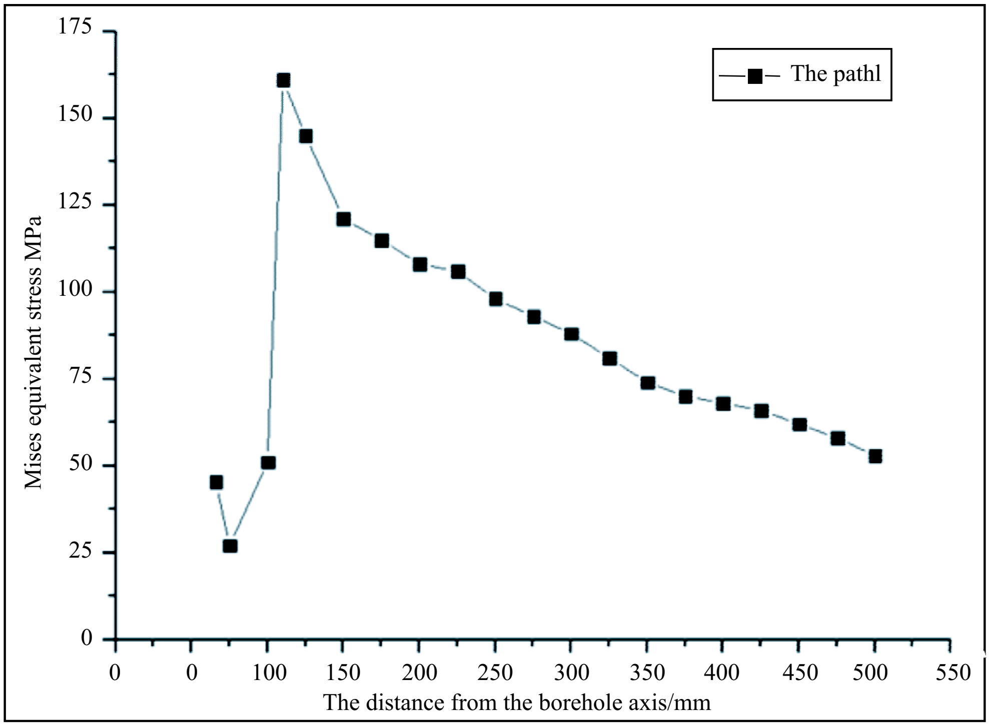


Figure 8 : The Equivalent Stress Curve of the Path 1

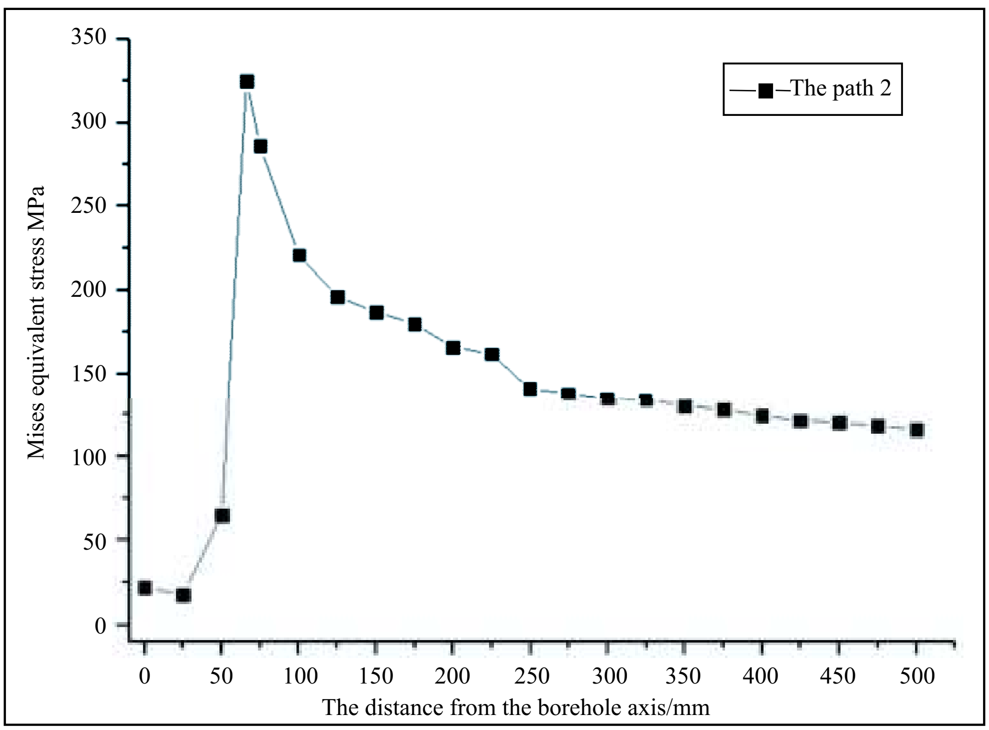


Figure 9 : The Equivalent Stress Curve of the Path 2

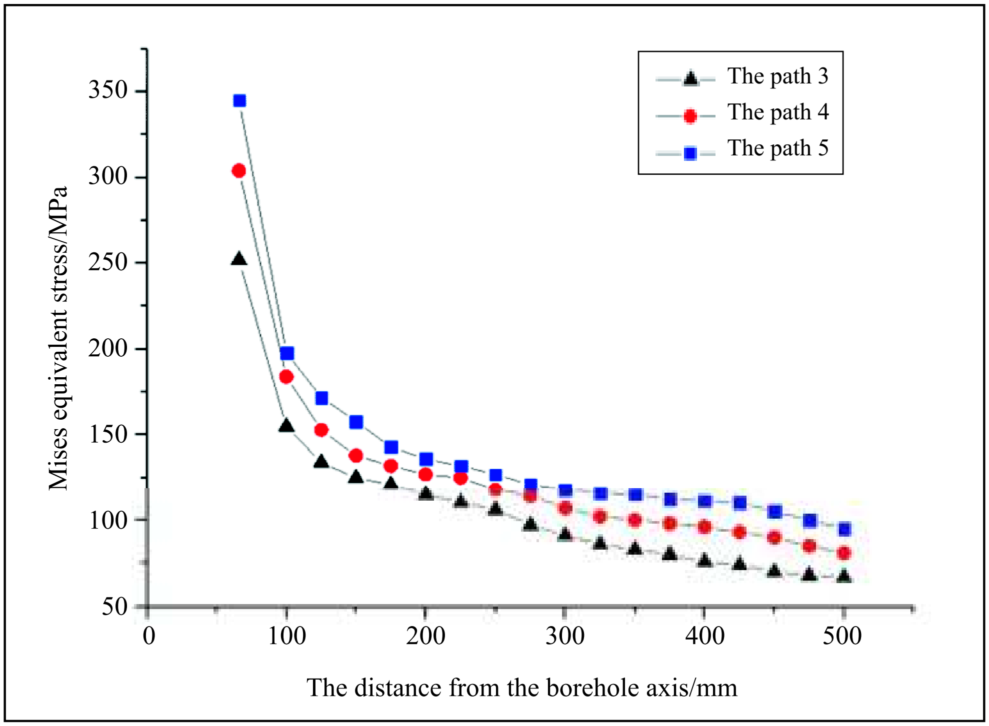


Figure10 : The Equivalent Stress Curve of The Path 3、4、5

d. The Equivalent Stress Curve of Guide- Enlarge Downhole

As is shown in figure 11 & 12, brought the eye bottom center area has low stress area.In the pilot on the borehole wall, the bottom stress is much larger than the top, showing that the closer the pilot shaft wall led eye bottom hole, more obvious the stress concentration is.

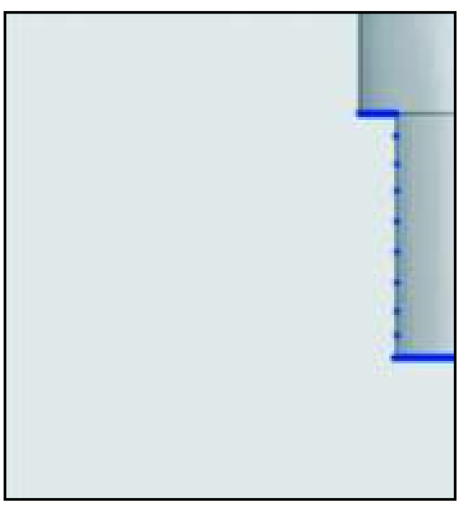


Figure11: The Equivalent Stress Curve Path of Guide- Enlarge Downhole

Different Drill Than the Bottom of the Steps of the Comparative Analysis

1. Bottom Displacement Field Comparative Analysis

Take the pilot on the wall from the pilot bottom hole along the axial direction to the reaming at the bottom of the well as a path,which is for the displacement model ϕ88 xϕ220, ϕ132 xϕ220, ϕ176 xϕ220 at the same displacement path.

According to figure 14, it can be seen that from the reaming well bottom to the pilot ladder at the bottom of the well wall equivalent displacement decreases, the equivalent displacement of the reaming steps is maximum. Pilot displacement of wall rock and pointing down shaft center, so the eye wall rock has a tendency to to the center of wellbore collapse.

According to figure 14, the greater the pilot diameter is, the larger the pilot shaft wall displacement is.From the perspective of internal energy, displacement and volume change means the external force on rock work, the closer the displacement is , the bigger the volume change of rock damage state. So model pilot shaft wall rock is more easily broken. That is to say, the pilot shaft wall rock gets

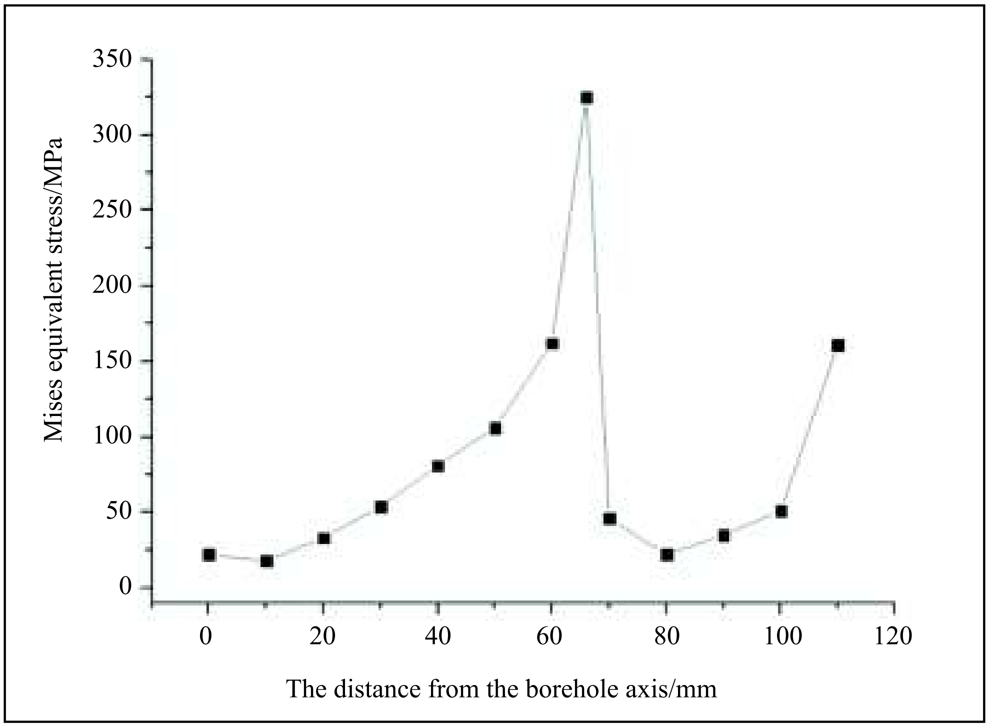


Figure12: The Equivalent Stress Curve of Guide- Enlarge Downhole

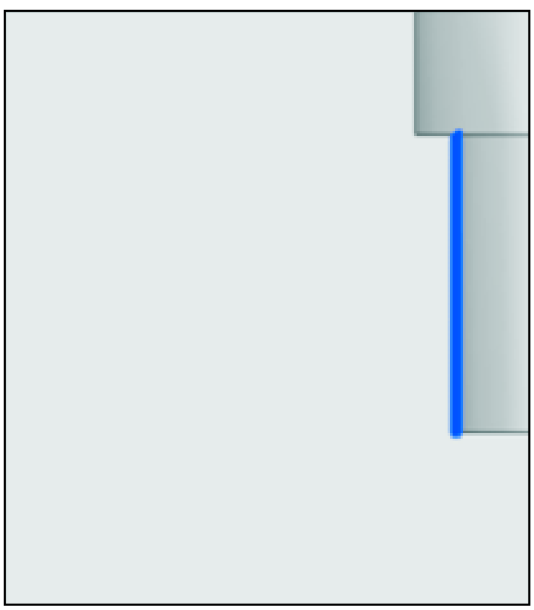


Figure 13 : The Path of Equivalent Displacement and Equivalent Stress

more and more easily to be broken along with the enlarge of the diameter of the pilot bit. Stress path is shown in figure 13.

2. Bottom Hole Stress Field Analysis

Figure 15 reflects the different pilots of the diameter of the pilot shaft wall, the equivalent stress changes along with the stress path, it can be seen from the diagram that the equivalent stress from pilot shaft wall to the bottom increases gradually, the pilot near bottom reaches the maximum equivalent stress value,showing that the release of the stress of the reaming steps , is more fully than other parts.conclusion can also be made from the table that the larger the pilot diameter is, the greater the equivalent stress of the pilot shaft wall is .

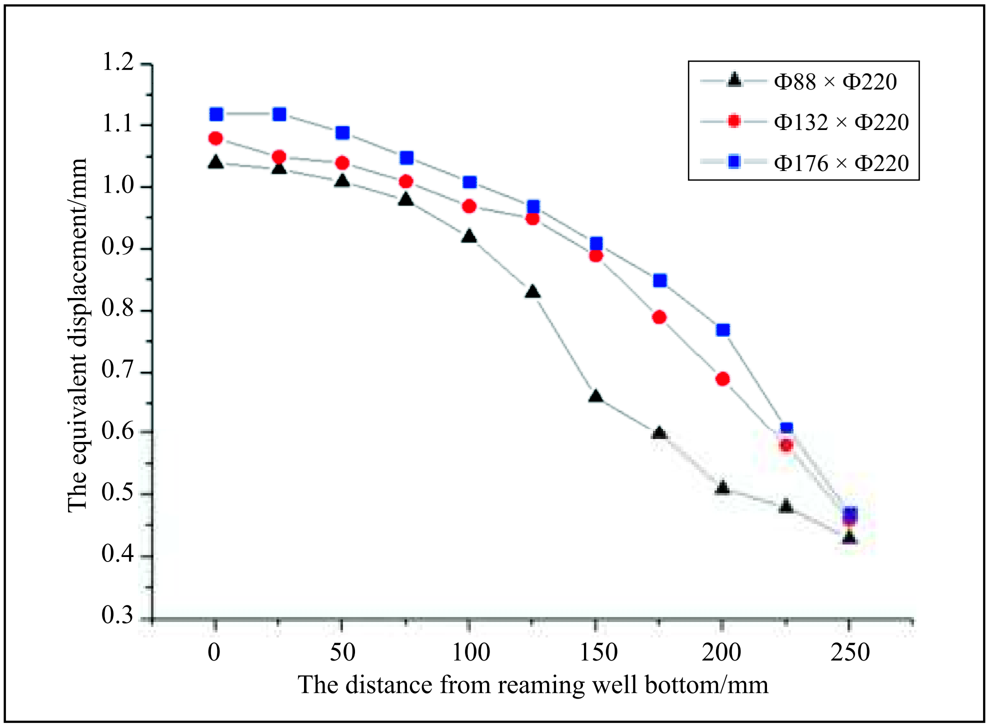


Figure14 : The Equivalent Displacement Curve of Different Diameter's Pilot Wallofawell

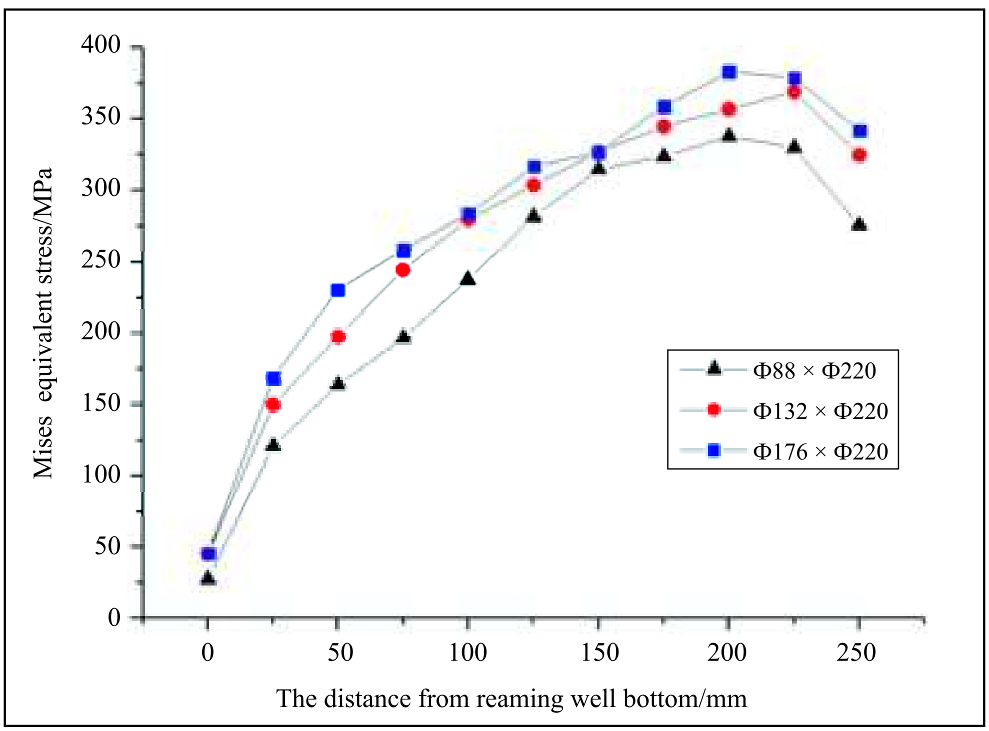


Figure 15 : The Equivalent Stress Curve of Different Diameter's Pilot Wallofawell

According to the stress concentration problem, the more obvious stress concentration is, the more easy to cause the deformation of material damage.so, from the contrastive analysis of the equivalent stress ,it reach the conclusion that the modelф176 x ф220 pilot shaft wall rock is more easily broken.That is to say, in the condition of the constant hole diameter , the larger the pilot bit diameter is, the more easily the pilot shaft wall rock is broken.

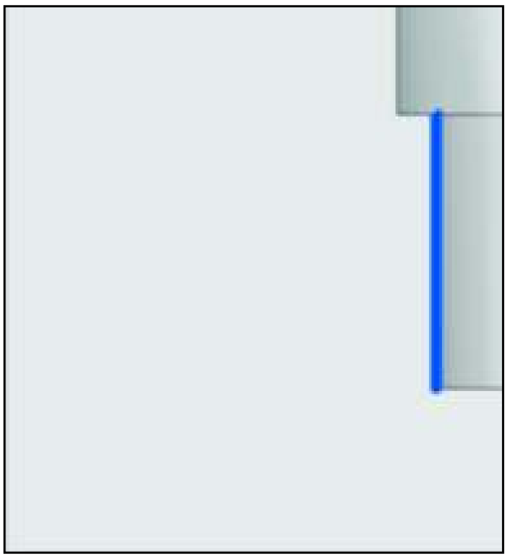


Figure 16 : The Path of Equivalent Displacement and Equivalent Stress

Drilling-Expanding the Relative Position of Different Bottom of the Steps of the Comparative Analysis

1. Bottom Displacement Field Comparative Analysis

The equivalent displacement and equivalent stress path is expressed in figure 16.

As shown in figure 17, pilot shaft equivalent displacement from the reaming well to bottom decreases, the equivalent amount of displacement of the hole bottom ismaximum.A cone-shaped which the pilot shaft is small above and large below, brings down displacement of wall rock and points in the direction of shaft center, pilot shaft wall rock has a tendency to to the center of wellbore collapse. According to figure 17, the pilot shaft, pilot wall displacement is larger. The greater the displacement is which means the larger the deformation of rock is, leads to the closer that it gets to the damage state. So, the model of H = 750 pilot shaft wall rock is more easily broken. That is to

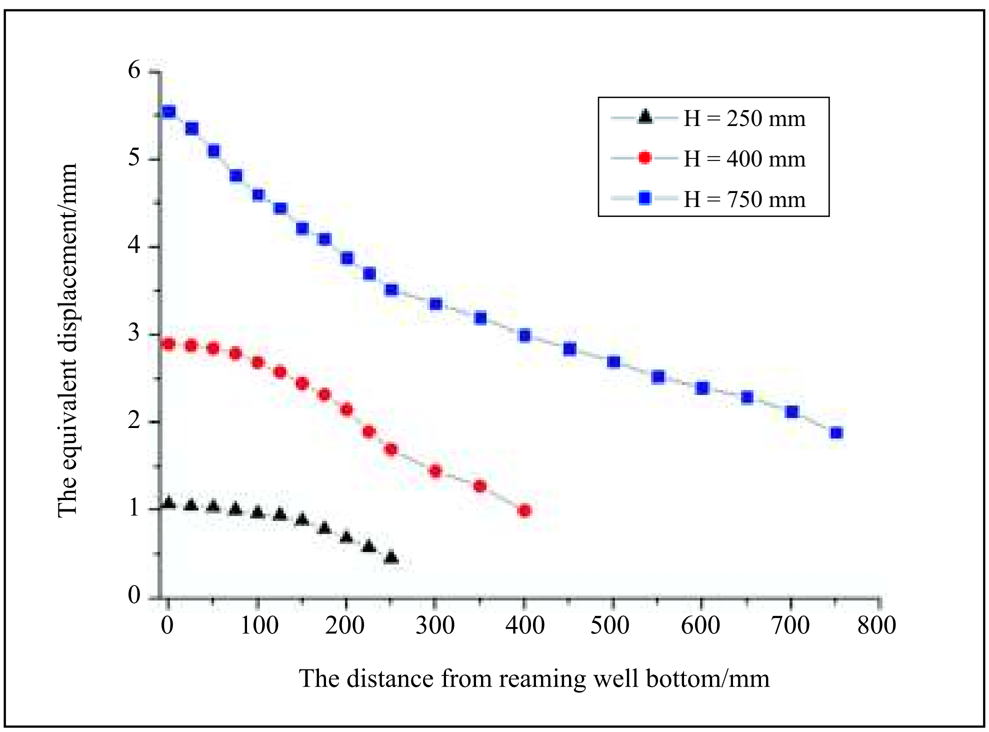


Figure17: The Equivalent Displacement Curve of Pilot Wallof Pilot Wellbore at Various Depths

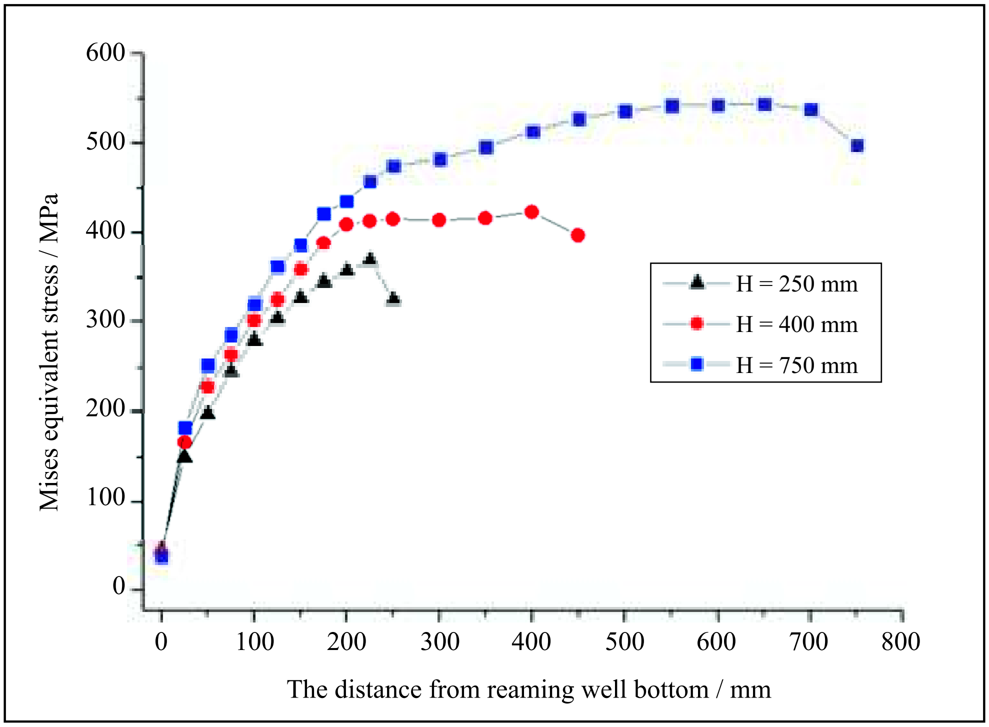


Figure18: The Equivalent Stress Curve of Pilot Wall of Pilot Wellbore at Various Depths

say, the longer the drilling and expanding body relative position distance is, the greater the pilot displacement of wall rock and the greater the deformation are the more easily pilot shaft wall rock is broken.

2. Bottom Hole Stress Field Analysis

Figure 18 reflects that the deeper the wellbore pilot and pilot shaft wall rock equivalent stress is, the more obvious the stress concentration is.Due to the stronger stress concentration, the material is easier to be deformated. So the model of H = 750 pilot borehole wall is more easily broken. That is to say, the eye wall rock get damaged more easily along with the growth of drilling and expanding body relative distance.

RESULTS AND DISCUSSION

The stress of ladder bottom hole are much smaller than conventional downhole wellbores, explain enlarge combination drilling hole has a better stability. Ladder at the bottom of the well led eye bottom displacement is larger than conventional bottom of the well bottom displacement, stated that the eyes of arc ladder at the bottom of the well bottom hole is more easily broken.

The ladder at the bottom of the well led eye wall stress concentration significantly, compared with other parts is more easily broken.

The hole diameter is changeless, pilot, the greater the diameter is pilot ladder bottom wall stress, the greater the displacement is larger, but not change trend.

The distance of drilling-expanding body position is greater,the pilot ladder bottom wall stress is larger, the greater the displacement, the greater the change trend is obvious.

Pilot borehole wall displacement and pointing down shaft center, displacement, the greater the reaming blade work will contact surface is larger.

Enlarging drilling hole which is formed by the combination has better stability than conventional borehole, and the ladder bottom hole rock is more easily broken.

Enlarge pilot on the bottom rung of the ladder which is formed by the combination of drilling borehole wall significant stress concentration, and the pilot displacement of wall rock and pointing down shaft center, sidewall rock had a tendency to collapse to a shaft center, which makes the pilot easily broken wall rock, is advantageous to the reaming blade broken rock.

The pilot ladder bottom of wall rock stress, displacement and drill is inversely proportional expansion ratio, with drilling, expanding body distance was positively relative position.

A cone-shaped pilot shaft, pilot borehole wall displacement is larger, the reaming blade work will contact area is larger, does not favor the reaming blade broken rock.

To increases drill expansion ratio can't improve pilot breakability of shaft wall.Guide the eye section and reaming section relative distance, the greater the pilot shaft crushability significantly higher, but can aggravate the reaming blade broken rock burden.

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