

# Destabilizing Disaster Mechanism of Stope & Its Advanced Governance Control

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**Abstract.** In order to study the problem of surrounding rock control excavation caused by complex environmental conditions under the stop instability mechanism and its scope of influence. Based on the real rupture process numerical analysis software, the collapse mechanism of the collapse zone and its dynamic catastrophe process were revealed and its impact of the collapse of the instability was identified, the study of grouting pre-reinforcement and its effective monitoring in the unstable collapse area was carried out. The results show that the hidden area formed after the collapse of the stop is type V, the slip surface of the collapse is determined, grouting pre-reinforcement of the program and steps are presented, and the three-dimensional visualization model of the grouting hole is drawn. The results show that the integrity of the ore body and the filling body is better after grouting. While the water pressure test showed a significant reduction in the value of Live, That is, the slurry is filled and compacted between the ore body and the filling body between the holes and cracks. According to the research results of the mining environment ahead of governance, the safety problems faced by the mining hazards in the mine are effectively solved.

**Key words.** Instability of stop; Mechanism of Catastrophe; Advance Governance; Grouting.

## 1. Introduction

Mineral resources were one of the most basic sources of human production and living materials. It was an important material basis for economic development and the vast majority of mineral resources were non-renewable [1]. Reasonable and effective use of mineral resources was the responsibility of the whole society should bear. With the rapid development of China's social economy, the increasing consumption of mineral resources, high grade and easy mining of mineral resources were increasingly depleted [2~3]. The full recovery of mining resources hidden in the process of hidden resources was imperative [4 ~ 5]. The collapse of the goaf had caused a series of complex engineering problems such as the subsidence of the surrounding rock, the destruction of the rock mass and the chamber instability, which will bring great hidden danger to the subsequent exploitation [6]. The boundary of the collapse zone and its influences range were determined [7 ~ 8], and the technical solution of the surrounding rock reinforcement was within the influence range of the collapse area [9 ~ 10]. It will affect the entire collapse of hidden resources recovery program selection and optimization.

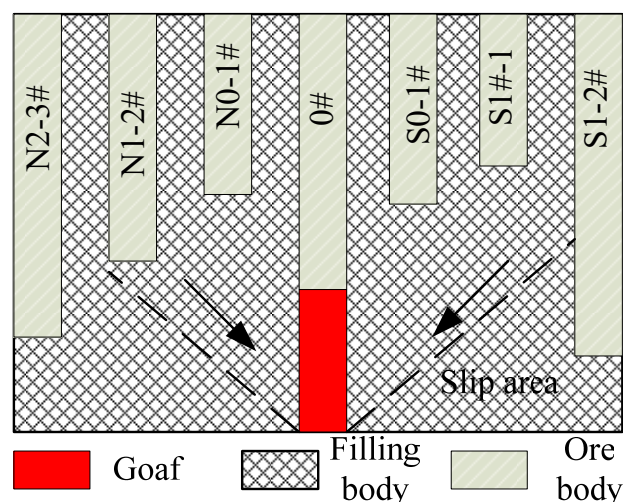


Due to the collapse of the ore body after the collapse of the mining situation and geological conditions become very complex, and the instability mechanism is not a fixed pattern to follow. At present, China's metal mine on the collapse of the adjacent ore body after the successful mining project examples are rare, in some key technologies, it still lacks a theoretical basis and practice verification, but also did not form a safe and reliable, high quality and efficient technical system. Therefore, the combination of theoretical research and engineering practice, it was necessary to further study the impact of the collapse area within the pre-reinforcement of the key technology.

Based on this, the collapse mechanism of the mining system and the reinforcement of the mining collapse area were carried out under the complicated environmental conditions, and the safe exploitation of the hidden resources in the collapse area was one of the frontier issues facing the sustainable development of the mine.

## 2. The status quo of the unstable collapse area

The range of vertical collapse of a metal mine was from the elevation of -298.3m to -232.0m, north-south coordinates from 290.5 to 420.0 which was 80 Xi'an coordinates- see Figure 1, the width of each stop were 6.5 ~ 8m , The mine had been finished and filled and the remaining stop were pillar stop, Some of the stop with cementing filling, and some stop with non-cement filling, and some stop in the vertical direction at a certain distance there were back to the slag, In the figure, the part of the slant filling is the ore body and the rest is the filling body, The second half of the stop was about 22.5m high after the end of the mining, the gob collapse caused by the collapse of the two groups into the mined area and the upper ore body as a whole sink.



**Figure 1.** Status of instability collapse area

## 3. Mechanism Analysis of Unstable Collapse

### 3.1. Numerical Analysis

From Figure 2, the collapse of the instability of the dynamic catastrophe process available. 1) 0 # stop - 280m sub-section following the excavation, the stop two holes increase the stress concentration phenomenon, which induced the stop two gangs gradually collapse. The shear failure of surrounding rock in the goaf was increasing, especially in the upper ore body of the mined-out area and the shear failure area of the two-body filling body. There were obvious shear damage in the upper ore body and adjacent stop of the mined-out area. The filling body on both sides of the goaf was the main carrier, and it also appears a large range of shear yield failure. 2) With the collapse of the two strands of 0 # stop, the energy gradually gathers from both sides to the 0 # stop, and when the energy gathers to a certain extent, it will induce the adjacent intercropping and the filling Body contact surface slip,

dislocation.3) When the interface between the adjacent stop and the contact surface between the filling body and the ore body reaches a certain degree, the failure state will change abruptly, which changes from the original slow slip to the large-scale collapse of the stop. Leading to overall instability collapse.

### 3.2. Analysis of collapse process

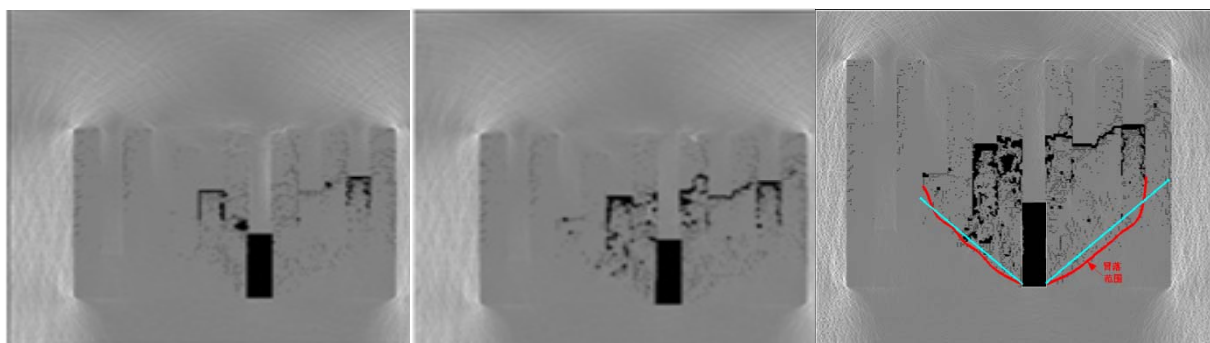
Based on the above analysis of the instability of the upper ore body and the two fillers, the instability process was analyzed as follows:

0 # stop -280m sub-section of the following mined excavation, the mined-out area was not immediately collapsed, according to the scene staff observation, in the ministries of the upper two places on the location of the first sliding, bending dumping damage and block stone collapse (as shown in Figure 3 (a)), that was, in the two gangs on the location of the existence of backfill mud collapse. As the backfill distance from the edge of the mined-out area was only about 1.5m and when the two fillers collapsed after the backfill carrying capacity was basically no, so part of the backfill will be with the filling body into the mined area together, At the same time, the two buckets of the filling body will be due to weakened support and partly to the gob collapse. The energy in the filling body was released by deformation, and the filling around the mined-out area had local damage and extends to the depth, it's providing a prerequisite for the instability of the goof.

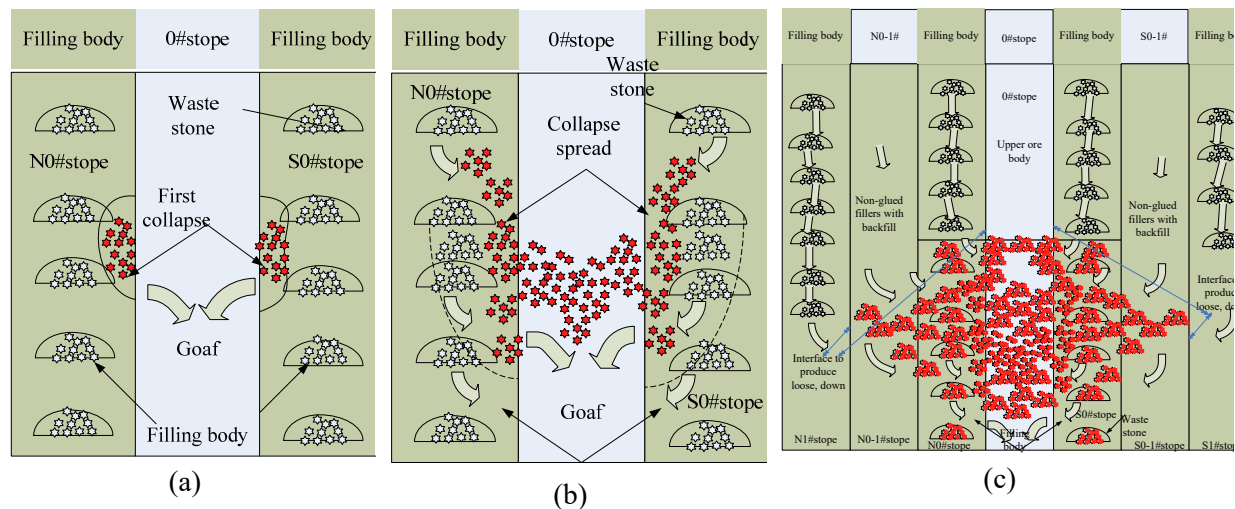
As the two fillers continue to squeeze in the airspace under the action of gravity and lateral pressure (as shown in Figure 3 (b)), the two fillers completely lose the bearing capacity to form unstable rock blocks, resulting in The scope of damage between the two continue to expand, back to the slag as a loose structure, mixed with the filling body in the mined area, until the N0 # stop and S0 # stowage of the filling body to lose support, and further the formation of collapse.

The fissures in the filling body were further expanded as the collapse proceeds (as shown in Fig. 3 (c)). When the N0 # stop and the filling of the S0 # stop exceed the critical force of instability, Completely unstable, and N0-1 # stop and S0-1 # pay field were non-cemented filling and the existence of backfill, resulting in its low strength, N0-1 # stop and S0-1 # filling the stowage of the filling body to produce shear damage and will go towards the mined area squeeze, collapse, at the same time, N0-1 # stop and N1 # stop, S0- 1 # stowage and S1 # stowage at the interface will also produce loose and decline. That was: in the filling body of the loose or extrusion deformation cannot be effectively controlled, the filling body will continue to burst out of the free surface, the formation of an instant collapse damage.

After 0 # stop mining, the goaf in a short period of time from inside to outside the deformation → broken → collapse → overall instability → large-scale slip of the process.



**Figure 2.** Collapse dynamic destabilization of Catastrophe



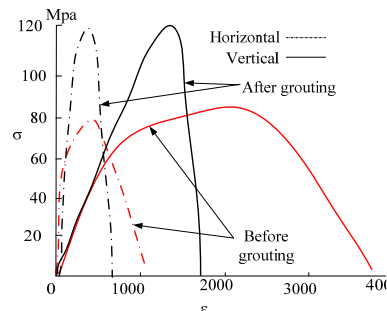
**Figure 3.** Collapse dynamic destabilization of Catastrophe

#### 4. Pre - grouting reinforcement & its effect detection

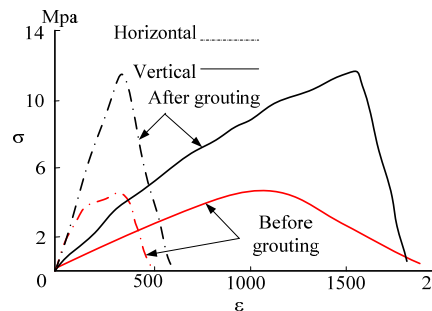
Due to the mine before the collapse of the project had no practical experience in the practice of similar mines have not found the relevant treatment methods, it makes full use of existing or designed excavation works, from outside to inside, the drilling process found holes and cracks must be taken to strengthen the measures until the completion of the collapse of the center 0 # stop safe mining.

##### 4.1. Mechanical Characteristics of Rock Core before and after Grouting Reinforcement

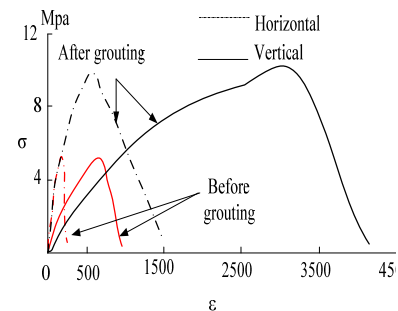
The change of the mechanical properties of the core through the ore body and the filling body was compared, which can indirectly reflect the effect of ore body and filling grouting reinforcement to a certain extent.



**Figure 4.** Mine rock mass stress - strain curve



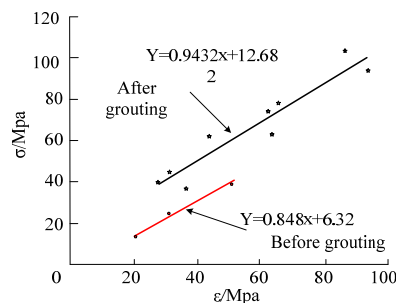
**Figure 5.** Filling the stress - strain curve(a)



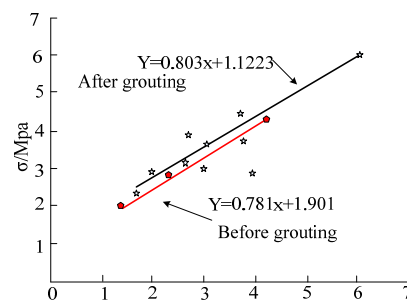
**Figure 6.** Filling the stress - strain curve(b)

According to the statistical data of uniaxial compressive strength before and after grouting, the average compressive strength of grouting was 119MPa and the average reinforcement coefficient was 2.56. The average compressive strength of filling body was 10.2MPa and the average reinforcement coefficient was 2.31. Therefore, the comparison of the absolute value of the uniaxial compressive strength and the grouting reinforcement coefficient shows that the higher the degree of loosening of the grouting ore body, the worse the internal structure. Showing a significant effect of grouting reinforcement effect. The stress-strain curves of the uniaxial compressive test before and after grouting were analyzed, and the resistance to deformation of the ore body and the filling body after grouting was significantly improved, and the uniaxial compression test curve Stress and strain were quite different. After the grouting was strengthened, the resistance to deformation of the ore body and the

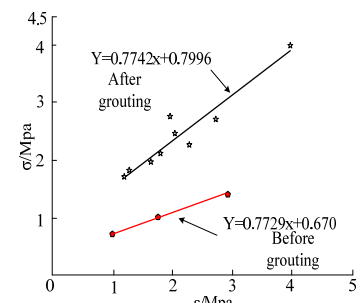
filling body was increased, but the failure mode does not change. After the stress peak was reached, the stress will decrease gradually. With the continuous increase in strain near the peak stress, it shows strong plasticity and resistance to deformation.



**Figure 7.** Mine rock mass stress - strain curve



**Figure 8.** Filling the stress - strain curve(a)



**Figure 9.** Filling the stress - strain curve(b)

Compared with the non-grouting reinforcement, the shear strength parameters were improved obviously, and the cohesion and internal friction angle of the ore body were increased by 101% and 7.4% respectively. The cohesion and the friction angle increase by 52.2% and 2.4% respectively. That was to say, the mechanical properties of ore rock and filling body were improved after grouting reinforcement, and the cohesion is mainly improved.

#### 4.2. Analysis of water pressure test

Aiming at the surrounding rock grouting project in the collapsed area, the test of water pressure test was one of the most direct and the easiest methods to evaluate the grouting effect. Using a simple water pressure test, the pressure time was about 30 minutes, the applied pressure of 80% of the design pressure, and  $\leq 1\text{MPa}$ . The stability of the pressure in the standard: the orifice when the water can end the test, the final flow value for the final calculation was selected, the test section of the water permeability can be drawn. The results of the test of the water pressure after grouting were analyzed, and the grouting effect was verified by the drilling method. The results show that grouting has a good effect on improving the stability of surrounding rock.

**Table 1.** Water pressure test before grouting Summary

Serial number	Position	Test pressure	Test section	Lu Rung value/ before grouting	Lu Rung value/ After grouting
	Hole numb	(Map)	(m)	(Lu)	(Lu)
1	Zk1	0.4	20	>150	3.1
2	Zk2	0.6	20	57	4.6
3	Zk3	0.5	18	>200	9.5
4	Zk4	0.6	16	69.5	4.5
5	Zk5	0.5	17	92	9.2
6	Zk6	0.4	21	118	7.3

## 5. Conclusion

The failure mechanism of the collapse zone and its dynamic catastrophe process are revealed. The influence range of the collapse area is determined, and the influence range of the collapse area is "V subtype", and the fracture surface as a reference, the final slip surface position is acquired.



Based on the position of the slip surface, the study of grouting pre-reinforcement in the collapsed area is carried out. The scheme and step of grouting pre-reinforcement are proposed. The three-dimensional visualization model of grouting hole is drawn.

Grouting reinforcement effect detection analysis is carried out. The results of the grouting reinforcement analysis are analyzed. The results show that the integrity of the ore body and the filling body is better after grouting. The mechanical experiment of the ore body and the filling core before and after grouting reinforcement mechanical properties are obtained. The results of the water pressure test show that the Luring value is greatly reduced, the voids of the ore body and the filling body are filled and compacted by the slurry.

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