International Geotechnics Symposium
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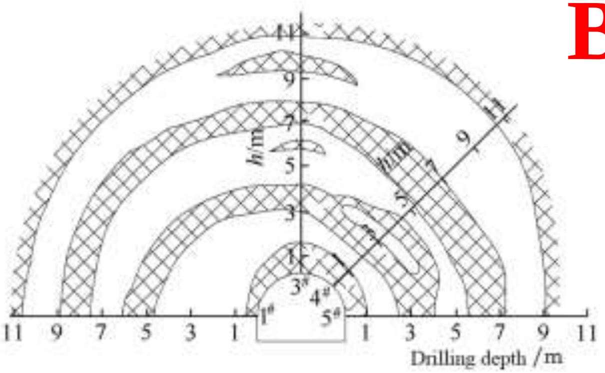
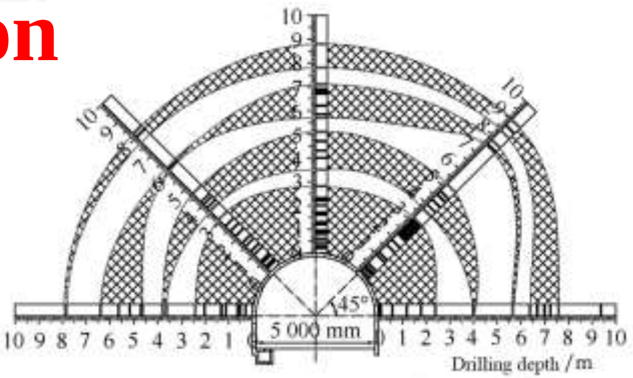
14th Biennial National Congress

Experimental Study on Zonal Disintegration Phenomenon in Deep Rock Mass under Blasting Excavation





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Contents

1 Introduction

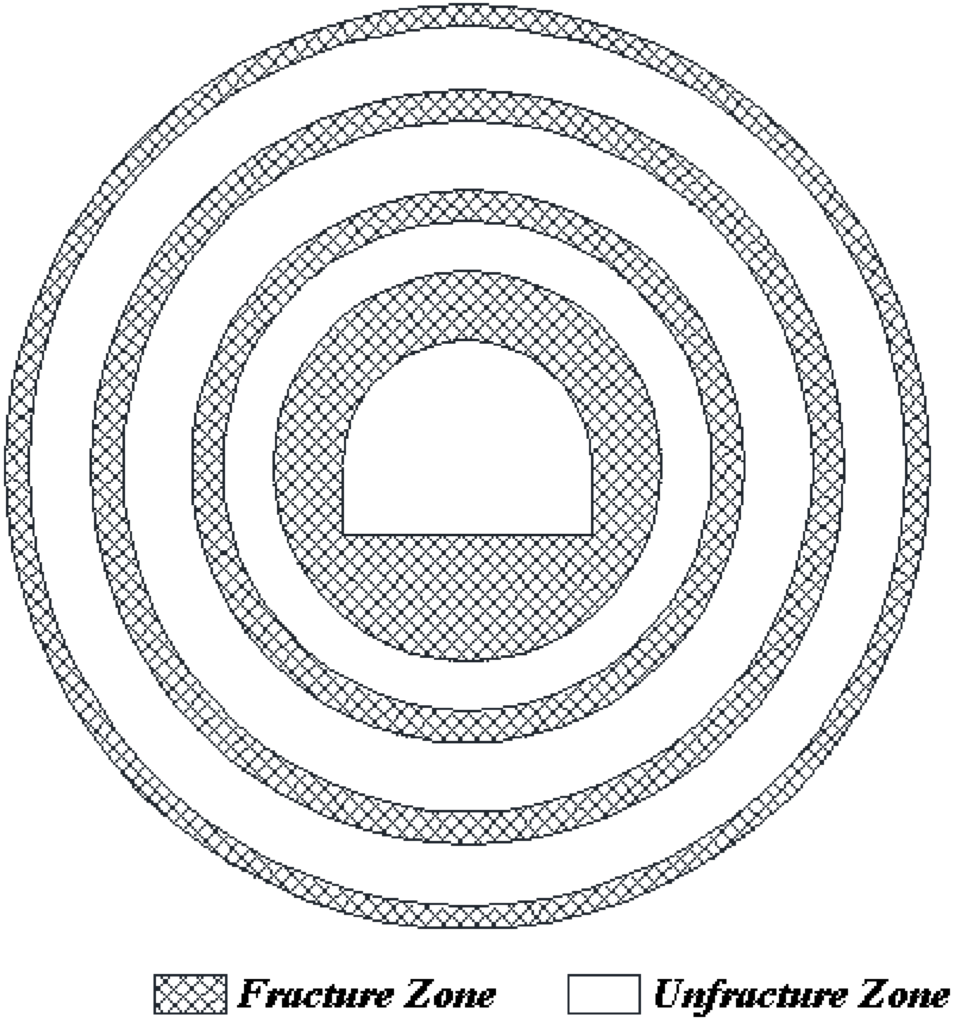
1 Introduction

Nowdays, deep exploitation is becoming a common practice in China. Deep rock masses are in the complex and special engineering environment, such as high geostress, high geothermal temperature, high seepage pressure and blasting disturbance.

Then, a series of unique and new geological hazards are presented. Zonal disintegration phenomenon is such a unique geological hazards in high axial geostress condition.

It was defined as “alternated regions of fractured and relatively intact rock mass appearing around or in front of the working stope”.

1 Introduction



Interval distribution of fractured and relatively intact rock mass around deep tunnel

Fig.1 Schematic diagram of Zonal disintegration phenomenon

2 3D Geomechanical Model Experiments

1 Introduction

2 3D Geomechanical Model Experiments

3 Blasting Load Effect Analyses

4 Anchorage support effect analyses

5 Conclusions

2 3D Geomechanical Model Experiments

At present, Deep underground engineering are mainly constructured by drilling and blasting method.

To investigate the effect of blasting load on zonal disintegration phenomenon in deep rock mass, 3D geomechanical model experiments in high axial geostress and blasting excavation are carried out by "capacity of deep rock breakage mechanics and supporting technique model test" in State Key Laboratory of Deep Coal Mining and Environment Protection.

2 3D Geomechanical Model Experiments

Fig.2 Capacity of deep rock breakage mechanics and supporting technique model test

2 3D Geomechanical Model Experiments

Dingji Coalmine in Huainan mine area, where zonal disintegration phenomenon has been observed, is taking as engineering prototype.

According to similarity theory, the geometric similar coefficient is 1:25, the stress similar coefficient is 1:36.

Cemented sand similar maertial is used to simulate the deep rock mass. The compressive strength of intact rock is chosen as 88.55 MPa. Therefore, the compressive strength of cemented sand similar material is 2.48 MPa.

2 3D Geomechanical Model Experiments

Fig.3 Cemented sand model
(Size: 1000×1000×400 mm)

2 3D Geomechanical Model Experiments

Strain measuring **Fracture monitoring**

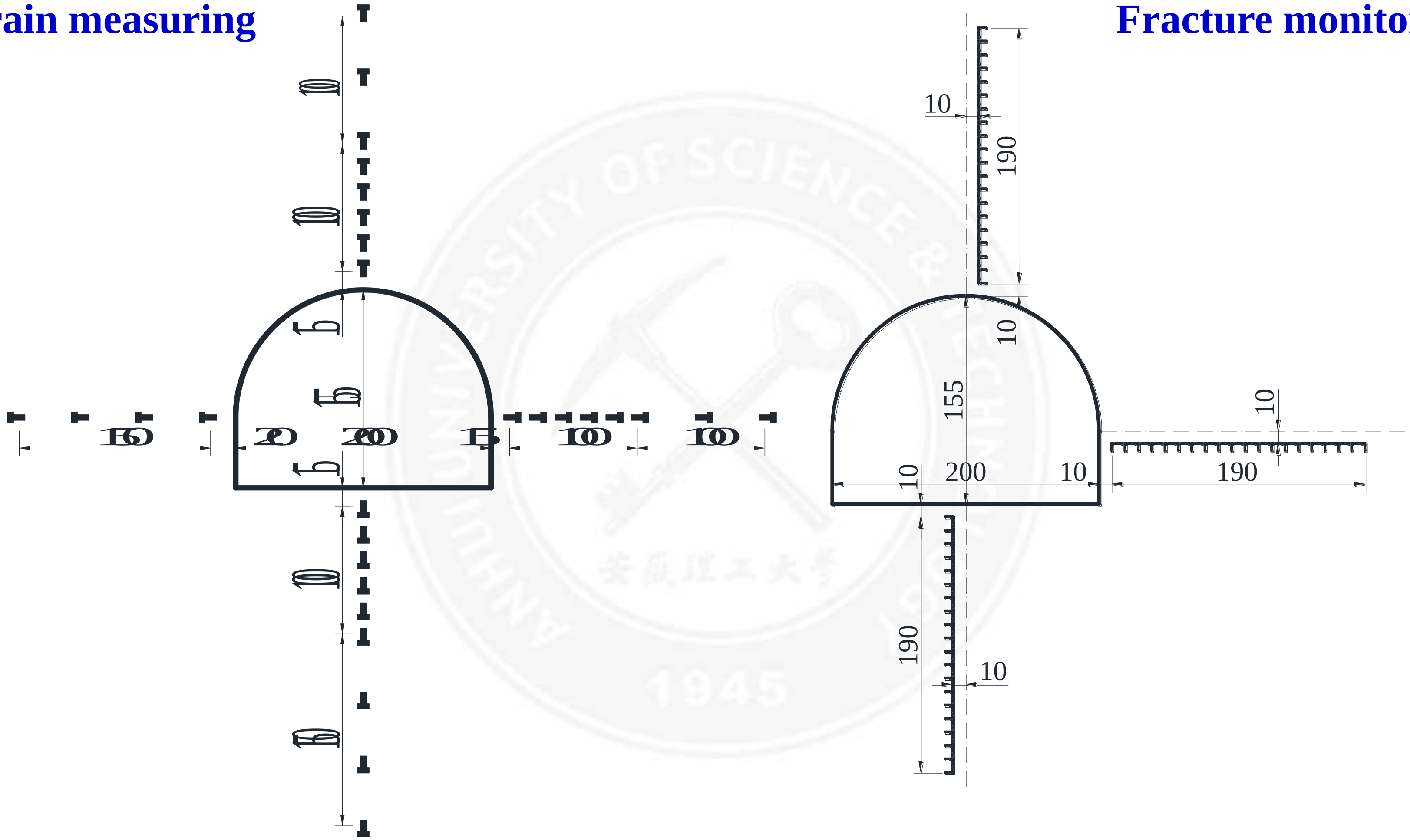


Fig.4 Measuring points arrangement in cemented sand model

(Unit: mm)

2 3D Geomechanical Model Experiments

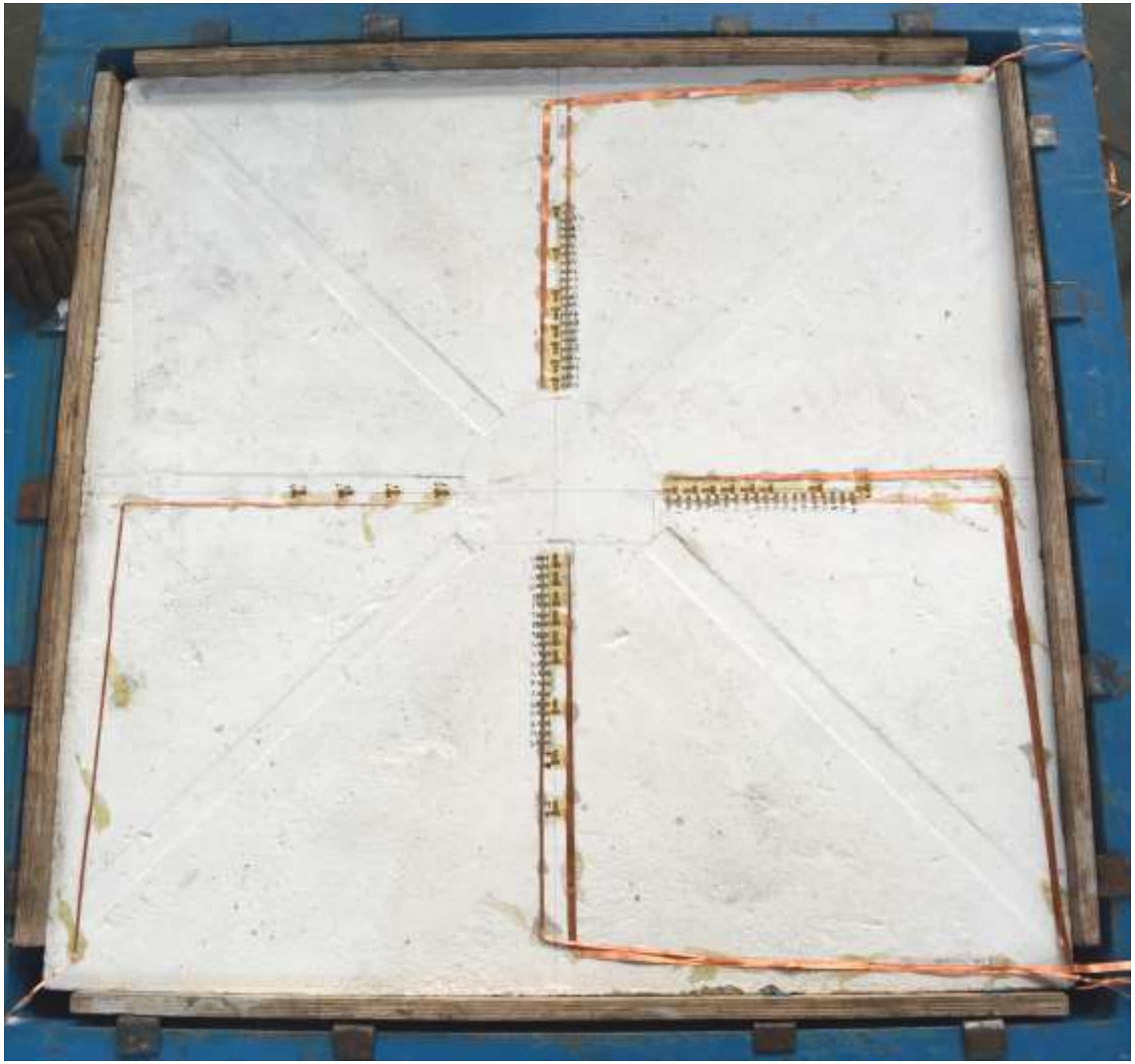


Fig.4 Measuring points arrangement in cemented sand model

3 Blasting Load Efffect Analyses

Table 1 Test Scheme of 3D geomechanical model experiments

Number	Excavation method	Support condition
ZD-1	Static	No
ZD-2	Blasting	No
ZD-3	Blasting	anchor bolt + anchor cable

The experiment procedure is " first loading, then excavation, last overloading".

The cemented sand model is firstly loaded at the initial geostress condition.

During experiements, only axial direction is overloaded.

3 Blasting Load Efffect Analyses

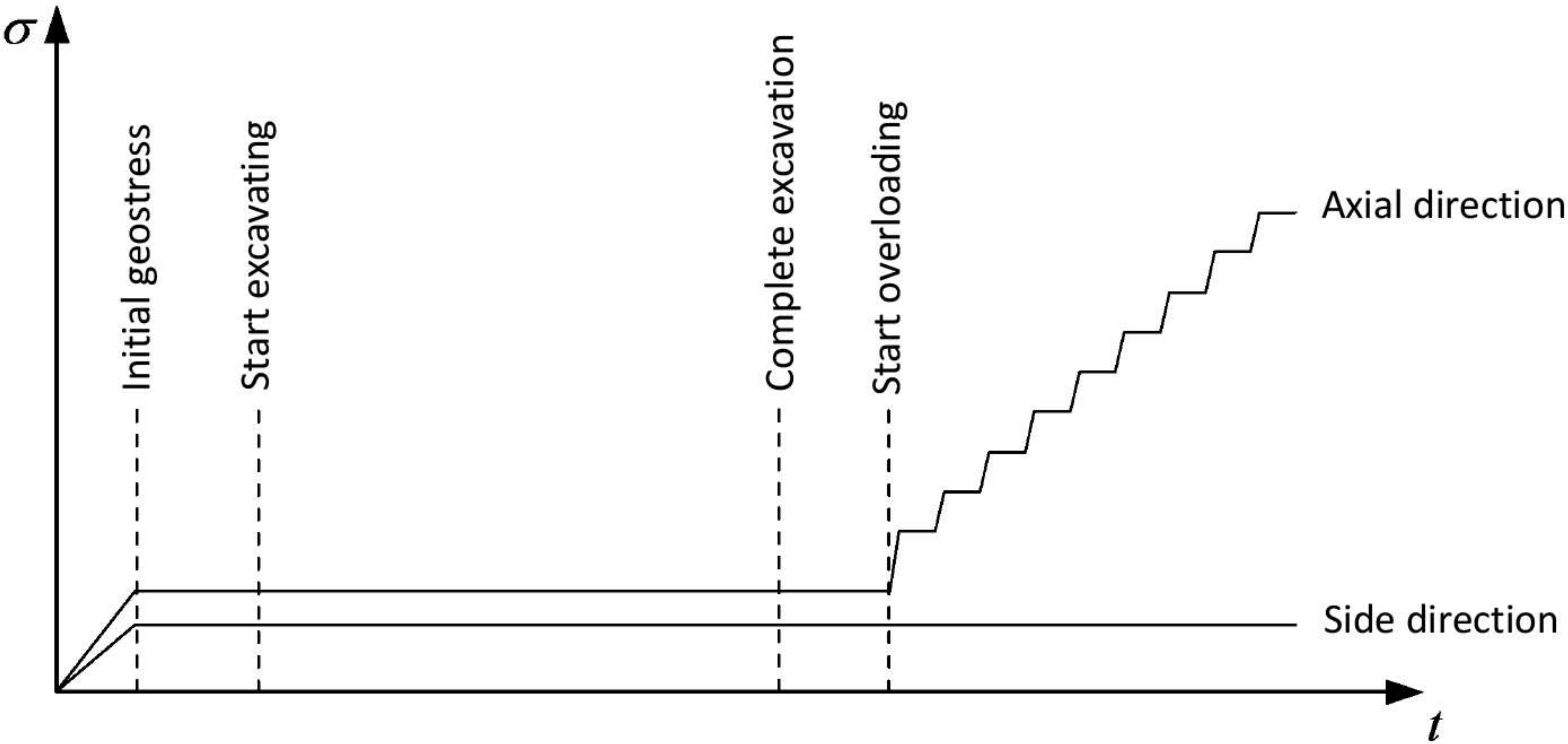


Fig.5 Schematic diagram of design loading curve for model test

3 Blasting Load Efffect Analyses

1 Introduction

2 3D Geomechanical Model Experiments

3 Blasting Load Efffect Analyses

4 Anchorage support effect analyses

5 Conclusions

3 Blasting Load Efffect Analyses

Fig.6 Blasting excavation in 3D geomechanical model experiments

3 Blasting Load Efffect Analyses

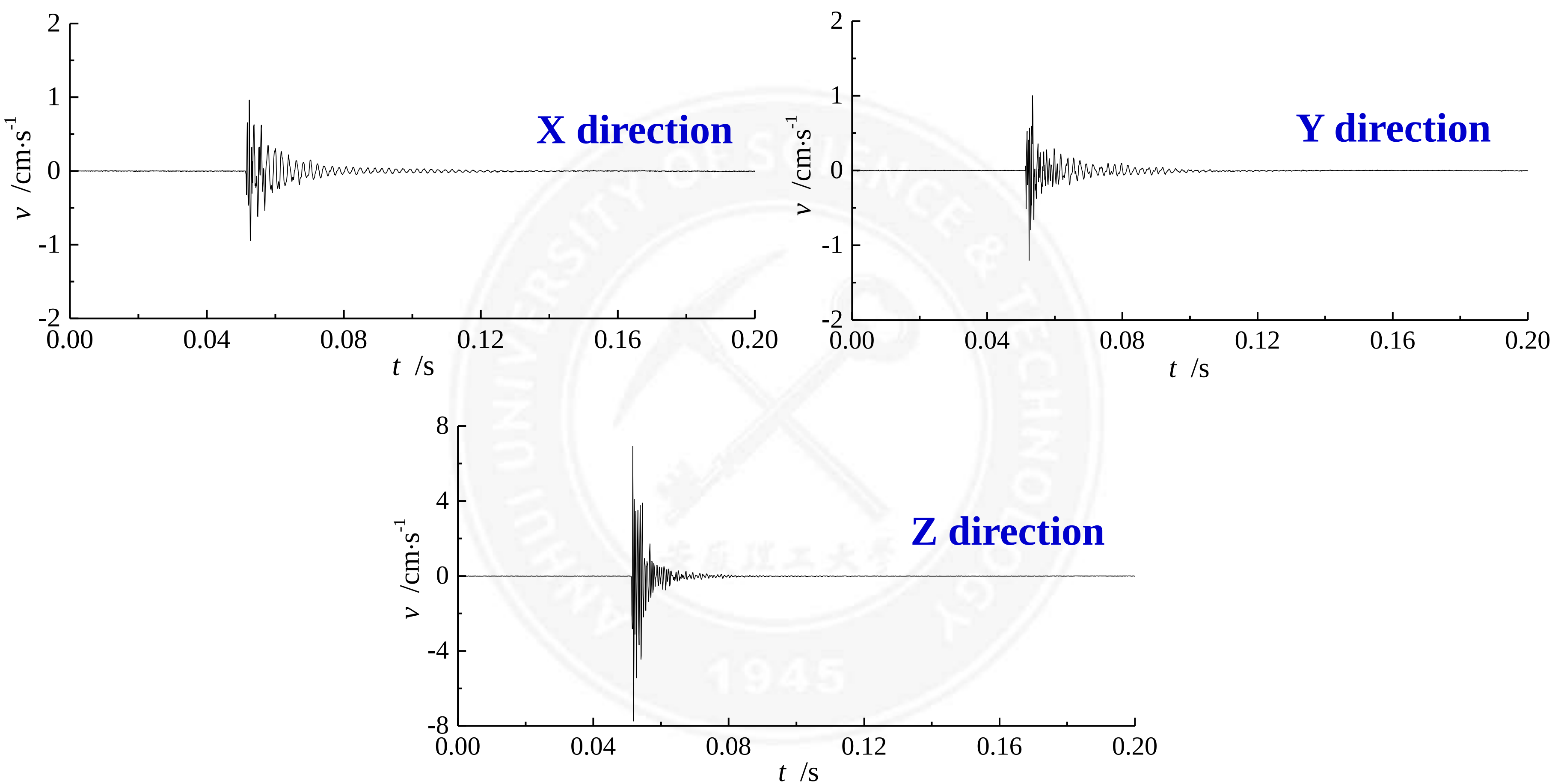


Fig.7 Blasting vibration signals in three directions

3 Blasting Load Efffect Analyses

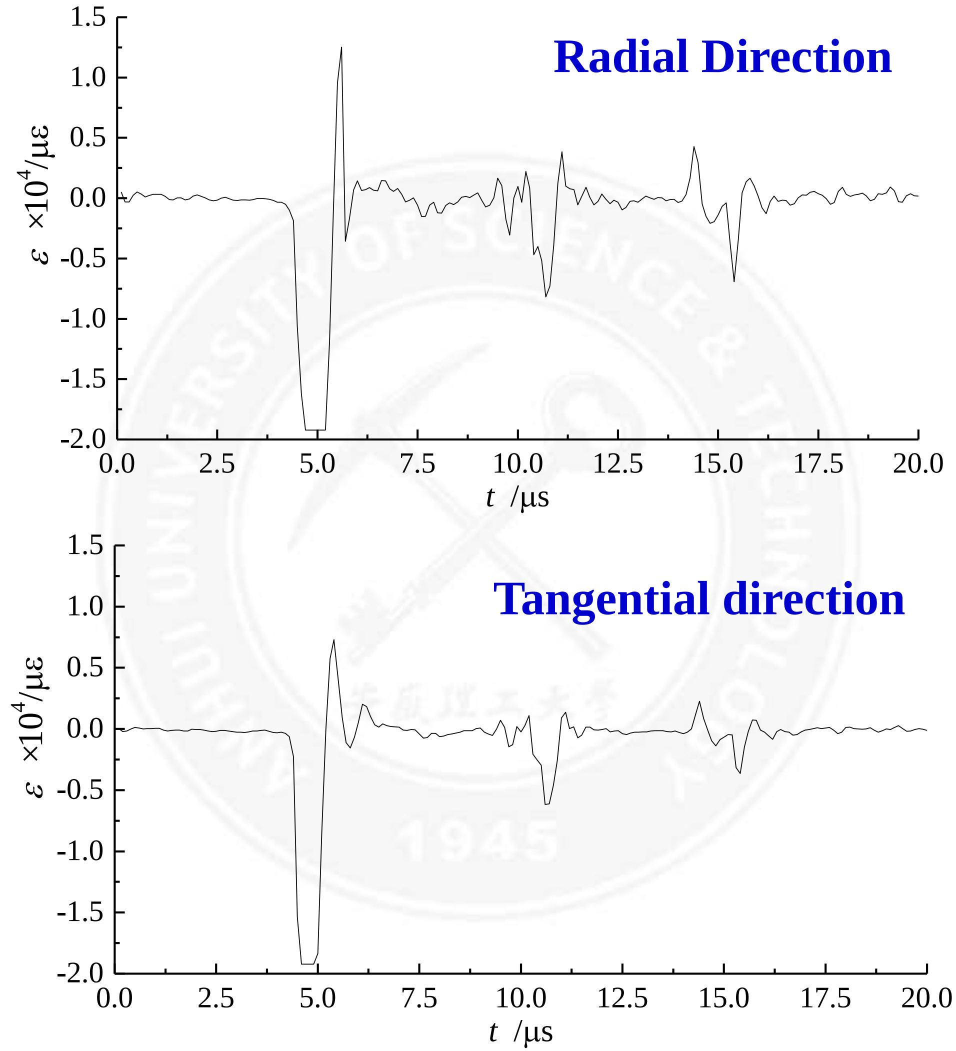


Fig.8 Actual measured explosive strain waves

3 Blasting Load Efffect Analyses

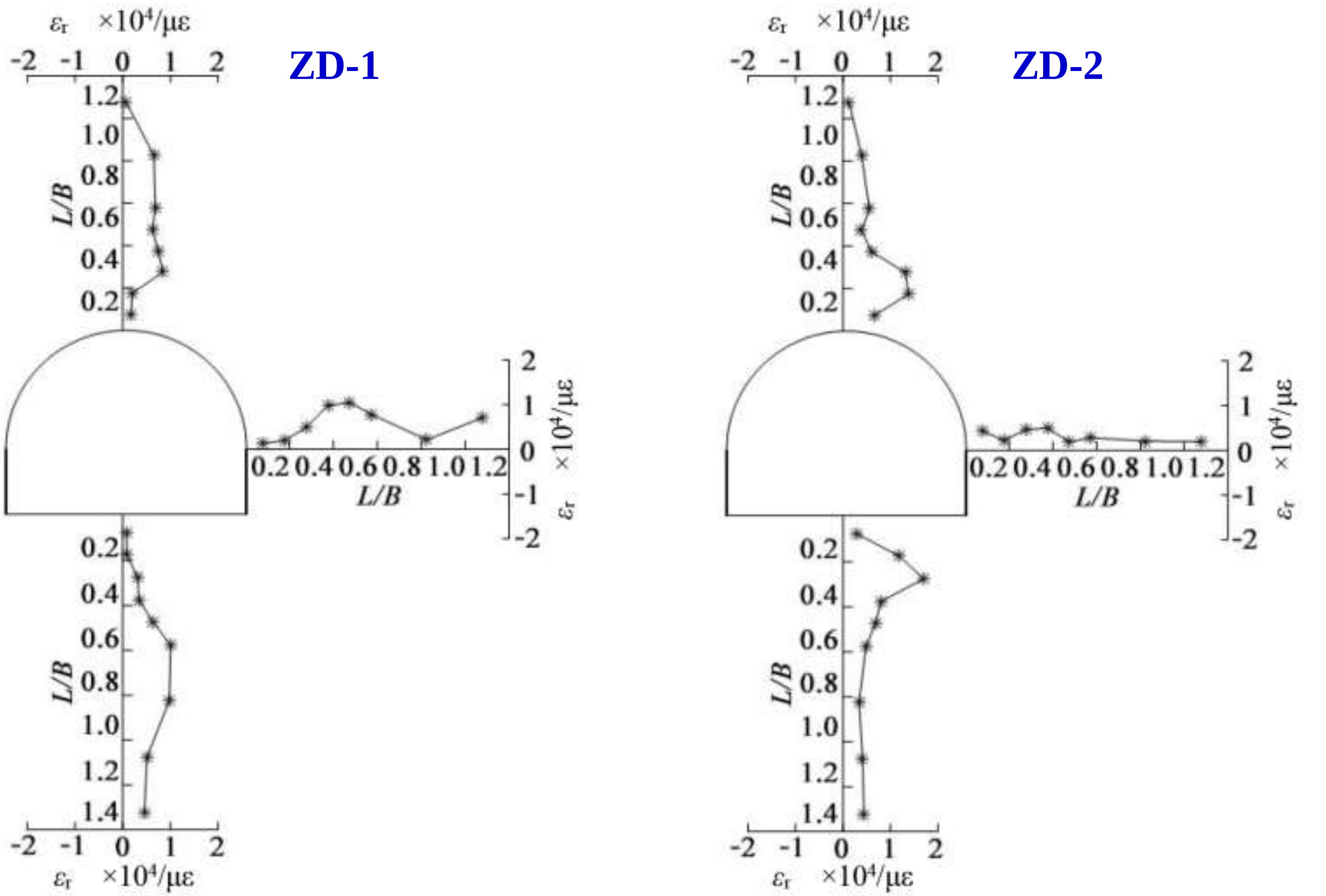


Fig.9 Radial strain distribution around tunnel after overload 1.5σ_c

3 Blasting Load Efffect Analyses

Blasting load produces some micro-cracks on similar materials nearby the boundary of model tunnel with deterioration of its mechanical properties and damage to its integrity.

Under high axial load, micro-cracks caused by blasting load propagate and connect to form a macro fractured zone.

After quantitative analysis of fracture zone distribution under blasting load, the radius of next fracture zone is about 1.28 times bigger than that of former fracture zone.

3 Blasting Load Efffect Analyses

Fig.10 Macro fracture mode of model ZD-2

4 Anchorage support effect analyses

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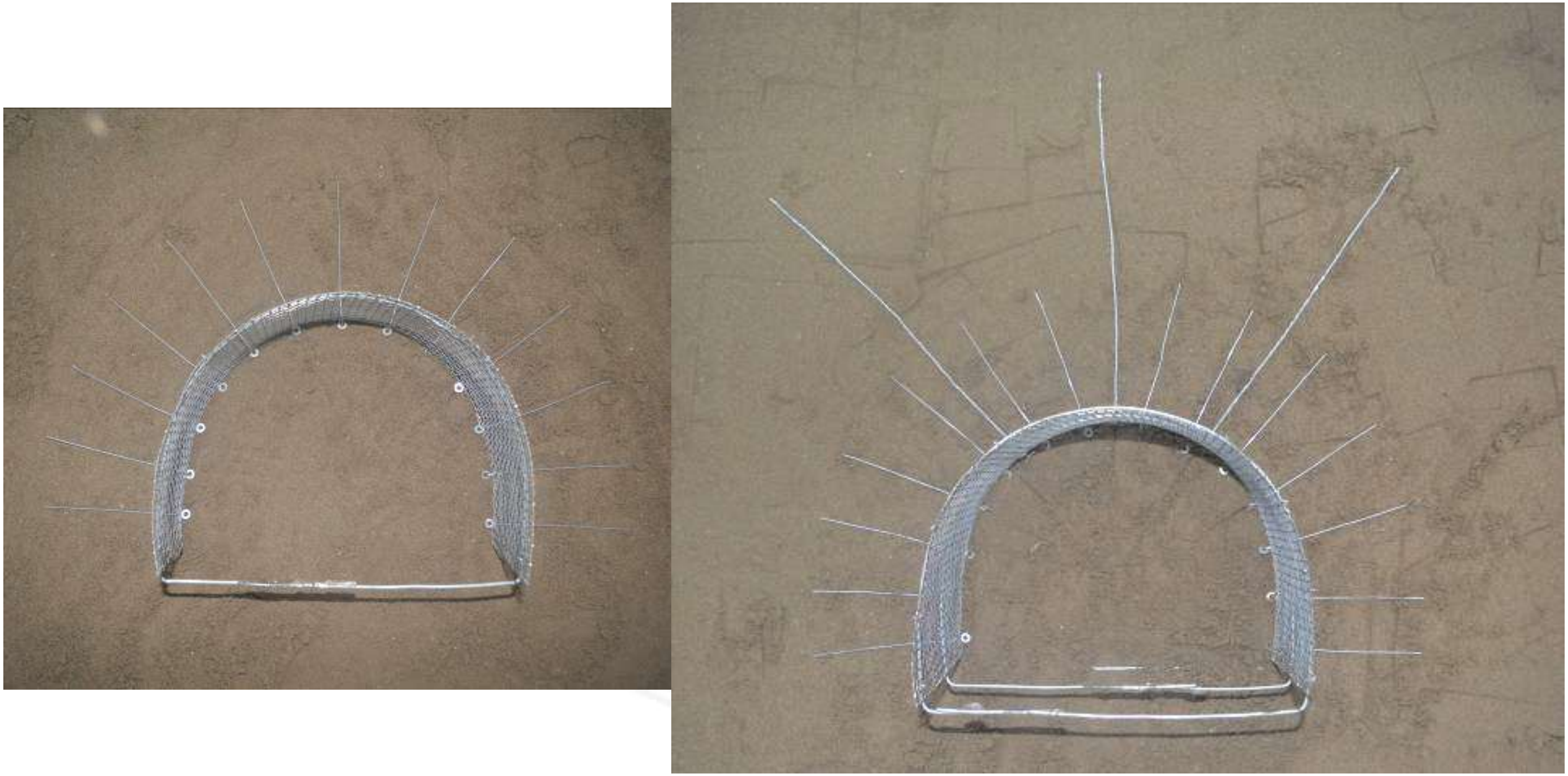


Fig.11 Layout of model support materials
(anchor bolt + anchor cable)

4 Anchorage support effect analyses

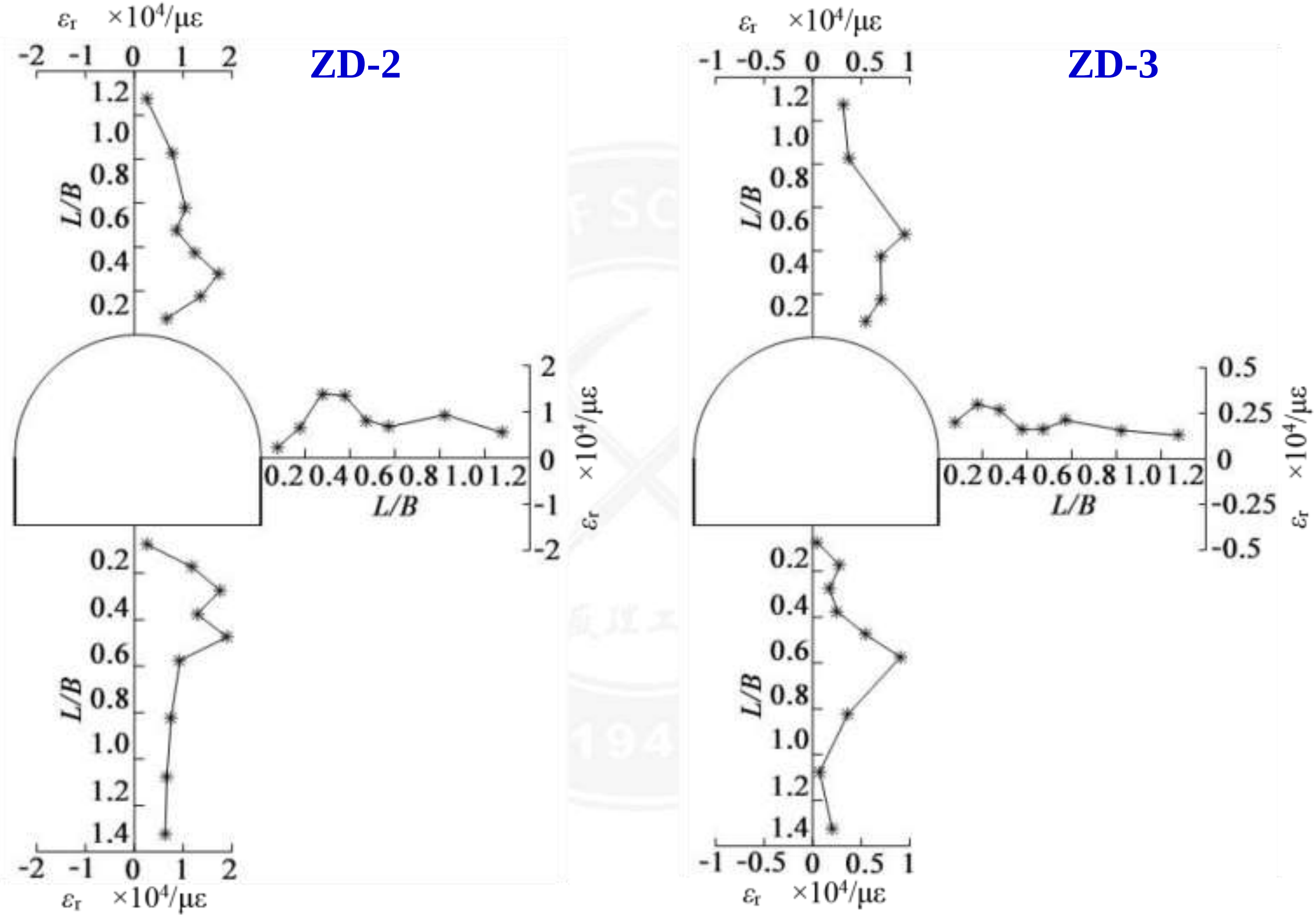
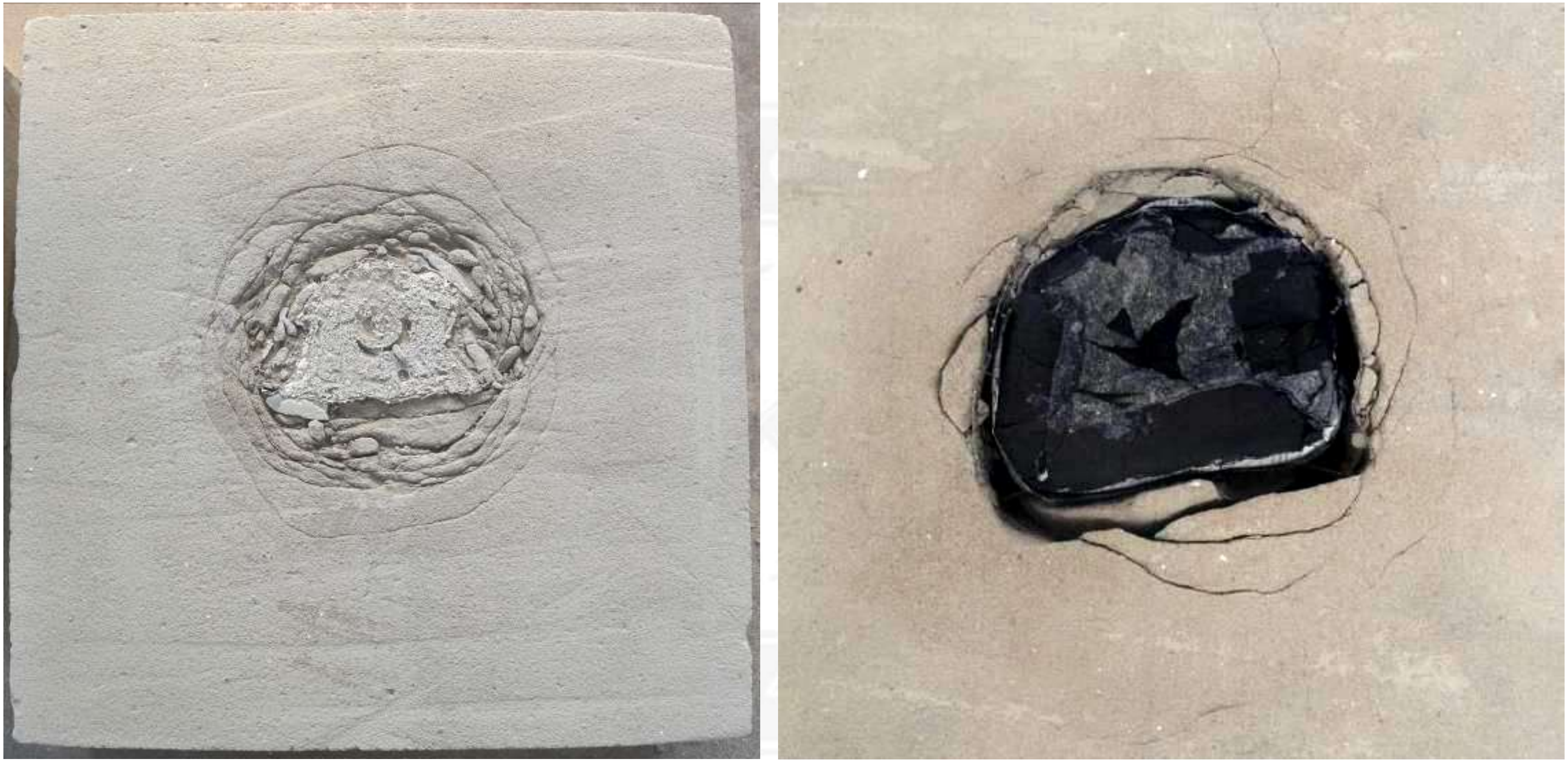


Fig.12 Radial strain distribution around tunnel after overloading

4 Anchorage support effect analyses



ZD-2 ZD-3

Fig.13 Macro fracture mode of model ZD-2 and ZD-3 after overloading

4 Anchorage support effect analyses

Compared the results with no anchorage support, there is no zonal disintegration phenomenon in anchorage positions of model tunnel.

The combination of anchor bolt and anchor cable can transfer and redistribute the stress of surrounding rock.

Therefore, the combination of anchor bolt and anchor cable presents a good inhibition effect of zonal disintegration phenomenon.

5 Conclusions

1 Introduction

2 3D Geomechanical Model Experiments

3 Blasting Load Effect Analyses

4 Anchorage support effect analyses

5 Conclusions

5 Conclusions

(1) Blasting loads during blasting excavation will not only deteriorate the mechanical properties of surrounding rock, but also reduce its integrity. High axial geostress intensifies the fracture level and extends the fracture zone.

(2) After quantitative analysis of fracture zone distribution in blasting excavation, the radius of next fracture zone is about 1.28 times bigger than that of former fracture zone.

(3) The combination of anchor bolt and anchor cable can transfer and redistribute the stress field of surrounding rock. And it presents a good inhibition effect of zonal disintegration phenomenon.

Thanks for your attention!