

# Study on Establishment and Application of Mine Overburden Structure Fracture Degree Model

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*Abstract:* Mine overburden movement is a very complicated process in time and space. According to characteristics of overburden movement and fracture developing laws after mining, the concept of structure fracture degree is proposed. Structure fracture degree is the expression of rock fracture degree in quantity, expressed by  $D$ ,  $0 \leq D \leq 1$ , when  $D=0$ , means intact rock, when  $D=1$ , means full cracked rock. Structure fracture degree is decided by the location of rock layer and mining area. In order to estimate the overburden fracture degree in any time and location, two methods for fracture degree calculation are proposed, one method is based on calculation of crack quantity and extent, the other is based on calculation of rock-mass strength reduction. Classification and legend description are done for overburden structure fracture degree, Dynamic mechanics model is established. All these research are the academic basis of calculation of overburden movement.

*Keywords:* Rock Strata Movement, Structure Fracture Degree, Classification and Legend Description, Dynamic Mechanics Model

## 1. Introduction

Establishment of mine overburden structure mechanics model is the basis of rock strata movement analysis and deformation calculation. In recent years the research of dynamic structure mechanics model has carried by many academicians. In my opinion, a real dynamic model must have two characteristics, firstly, it can reflect overburden structure evolvement course; secondly, it can reflect rock creep deformation characteristic.

## 2. The structure fracture degree model

### 2.1 Basic assumption of model establishment

(a)The fracture degree is expressed by the letter "D". The fracture degree is minimal when no cranny occurs which is vertical to rock layer surface, the value of  $D$  is close to 0. the fracture degree of falling rock above coal seam is maximal, the value of  $D$  is close to 1.

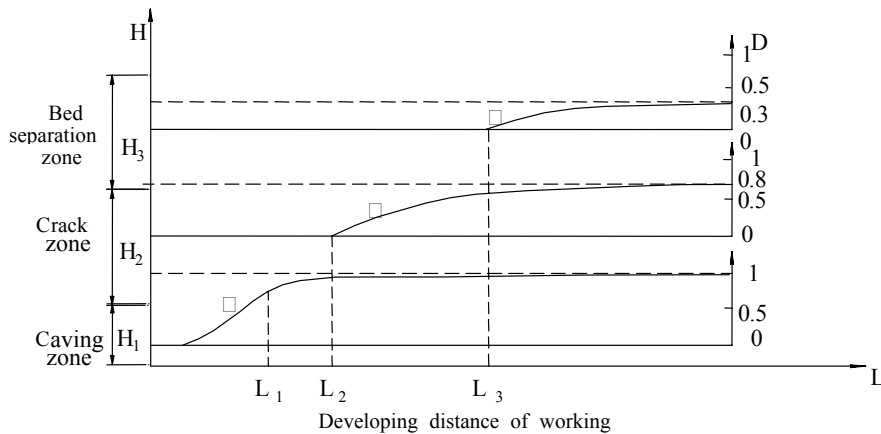
(b)The boundary of fracture scope is decided by rock layer fracture angle.

### 2.2 Meanings of the structure fracture degree

The structure fracture degree have two meanings: the facture degree decreases gradually from coal seam roof to upper rock layer,  $0 \leq D \leq 1$ , for a specific rock layer, the value of  $D$  is decided by the location of the rock layer and advancing distance of working face, it not only reflects the time effect but also space effect. The developing course of fracture degree of different rock layer is showed as figure.1,  $D$  is fracture degree,  $L_1, L_2, L_3$  are advancing distance of working face. The curve  $\square$  shows the developing course of fracture degree of falling rock layer, the curve  $\square$  shows the developing course of fracture degree of crack zone rock layer. The fracture degree can be expressed by following function:

$$D = \begin{cases} f(h, l) & 0 < h \leq h_0 \\ 0 & h > h_0 \end{cases} \quad (1)$$

where,  $h$  is the distance of rock layer to coal seam roof;  $h_0$  is the uppermost breakage boundary.  $l$  is the advancing distance of working face;



**Fig.1 The developing course of fracture degree of different rock layers**

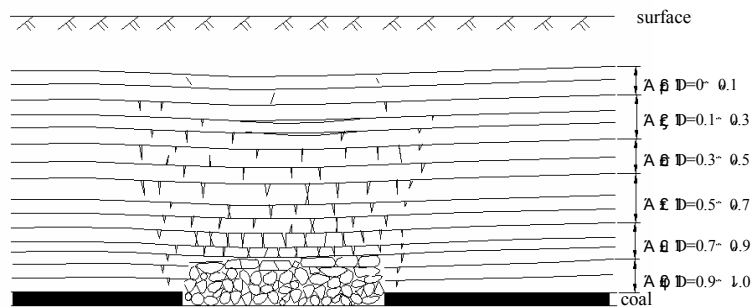
**2.3 Classification and legend description of the structure fracture degree**

The main forms of rock layer breakage are fracture and bed-separation, in order to describe the fracture degree of each rock layer in the course of

mining, the fracture degree is defined 6 levels, Classification and legend description of the fracture degree are listed as Table.1. Mine overburden fracture characteristic and corresponding fracture degree are showed in Fig.2.

Classification	The fracture degree(D)	Legend	Description
□	0□0.1		The rock layers move all together, few tiny crack exists
□	0.1□0.3		The magnitude of tiny crack is few, there are bed-separation
□	0.3□0.5		There are tiny crack in rock layer, the continuity of crack is poor, few break up
□	0.5□0.7		The rock layer have good arrangement, some break up and have connected crack
□	0.7□0.9		Rock layer break up completely, it have good arrangement and continuity crack
□	0.9□1.0		Rock layer break up completely, the rock block is abnormity, messy ,no arrangement

**Table.1 Classification and legend description of the fracture degree**



**Fig.2 Mine overburden fracture characteristic and corresponding fracture degree**

**2.4 Calculation methods of fracture degree**

It is easy to describe rock layer’s fracture degree in word, but it is difficult to express in data, so two approximative calculation methods are proposed.

**2.4.1 Calculation method of fracture degree based on crack magnitude and extent**

As we all know, crack occur firstly before severe breakage happen, the extent and magnitude of crack lie on many factors, including lithology,

rock layer thickness, the distance from it to coal seam, the advancing distance of working face and so on. We suppose that the crack average extent of one rock layer is maximal, expressed as  $\delta_{max}$ , so the rock layer's fracture degree is maximal, D is close to 1, the other rock layer's fracture degree can be expressed as  $D = \delta / \delta_{max}$ , in which  $\delta$  is crack average extent of the rock layer, the crack extent is an equivalent value, called equivalent crack extent here.

$$D = \begin{cases} \delta / \delta_{max} & 0 < h \leq h_0 \\ 0 & h > h_0 \end{cases} \quad (2)$$

In fact, the calculation of crack magnitude and extent is not easy thing, luckily, some research result have been achieved in recent years, according to limit tensile deformation value of rock layer, crack extent can be calculated, experiential function can be established for the same kind of strata. In addition, overburden crack zone height observation experiments have processed in China for many years, the water leak quantity in rock layer can reflect crack developing degree, which can be used in calculation of fracture degree.

**2.4.2 Calculation method of fracture degree based on weakening degree of rockmass**

Rock layer is in preliminary stress situation before mining, its mechanics characteristic can be described by elasticity module E, poisson ratio  $\mu$  and other parameters, after excavation, the mechanics parameter value often decreases because of disturbance, the decreasing degree reflects the rock-mass weakening degree. If preliminary elasticity module of one rock layer is expressed as  $E_0$ , after excavation, it is expressed as  $E'$ , then the structure fracture degree can be expressed as the following function,  $D = 1 - E' / E_0$ . When

$E' = E_0$ ,  $D = 0$ , this means no new crack exists or no breakage happens, when  $E'$  is very little, D is close to 1, this mean severe breakage.

**2.4.3 An example of the structure fracture degree calculation.** The crack extent of one rock layer lies on its mechanics characteristics, mining thickness and distance from rock layer to coal seam, the average crack extent of each rock layer is calculated in Yangquan Mine China [4], applying the research result and the first calculation method, the fracture degree of each rock layer is obtained, the relation between D and distance(from one rock layer to coal seam) is show as Fig.3.

**3. The meaning and application of the structure fracture degree model**

(a) The structure fracture degree model can be used to guide dynamic numerical simulation, because structure change is considered in the simulation steps, the calculation result accord with engineering practice much more.

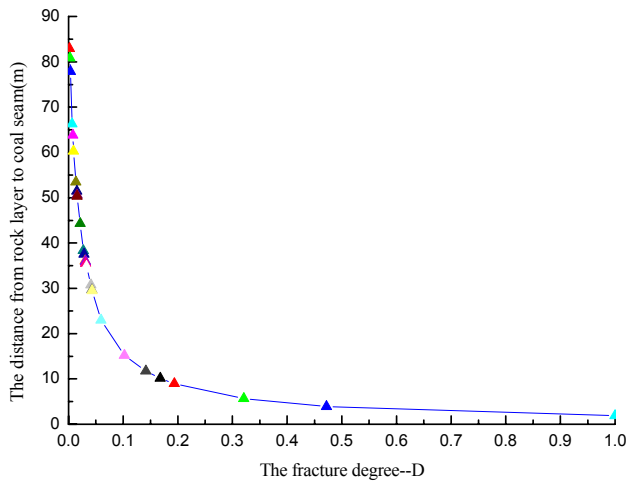
(b) The model is the academic basis of visibility of overburden movement. Applying the classification and legend description of the fracture degree, visibility gallery of different level can be established.

**4. Dynamic mechanics model**

Rock creep experiment in different stress level prove that rock has the characteristic of instantaneous elasticity and creep deformation, according to subsidence-time curve in situ, W-t curve have horizontal tangent after one time. So H-K model is suitable for overburden creep problem, the function of H-K model is list as follows.

$$\varepsilon = \frac{E_0 + E_1}{E_0 E_1} \sigma - \frac{\eta_1}{E_0} \dot{\varepsilon} + \frac{\eta_1}{E_0 E_1} \dot{\sigma} \quad (3)$$

Combining structure fracture degree model and H-K creep model together, the dynamic structure mechanics model is established, there are important meanings for research of overburden movement laws.



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**Fig.3 The relation curve between D and the distance from rock layer to coal seam**

## 5. Conclusions

- (a) The structure fracture degree model can describe the dynamic developing laws of overburden movement, which is a time-space model. Establishment of the dynamic structure mechanics model has important meanings for research of overburden movement laws.
- (b) The fracture degree D can describe the characteristic of overburden structure evolvement course. Classification and legend description of the fracture degree are established and the calculation method of fracture degree is proposed.
- (c) The structure fracture degree model can direct dynamic numerical simulation calculation, also it is the academic basis of visibility of overburden movement.

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