Measuremental Principle and Experimental Research of Stope Floor Specific Pressure

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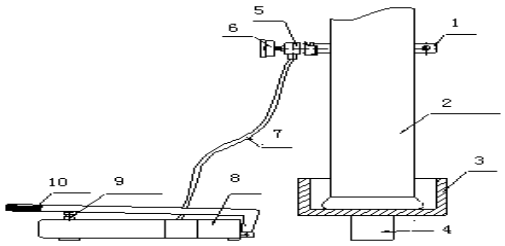
Abstract: The measurement of floor specific pressure is the important project foundation in choosing reasonable pit support, support form and support parameter, and the significant indicator to classify the seam floor. On the basis of principle analysis on floor specific pressure measurement, Daizhuang coal mine in Zibo mining group had tests on the floor specific pressure in 4324 mechanized working face during the first and periodic pressure, the floor (limit) specific pressure, floor allowable specific pressure, floor stiffness and floor allowable stiffness are obtained. At the same time, according to the floor classification standard of gently inclined seam of coal faces, the floor of 4324 working face is classified, and floor suitability of the mechanized support is evaluated. So it is very important for determining reasonable support, support density and avoiding blindly increasing support codes, density and the amount of work of pillar and prop drawing by strengthening the floor specific pressure measurement, coupling with the analysis and application of the floor specific pressure parameter.

Key words: floor (limit) specific pressure; floor allowable specific pressure; floor stiffness; floor allowable stiffness; floor classification

The interaction of stope support and floor is an important problem for surrounding rock control and supporting optimization design, and floor specific pressure test is an important engineering design basis for supporting parameters design and selection in coal mine. It is shown by practice that, only pay attention to roof management but neglect the floor management to bring great difficulties in production management. Especially, the supports are moved and roof control is very difficult on the condition of soft roof and floor, and one of the important reasons is that the floor permitting specific pressure is so small that leads the floor to be destroyed by supports and makes the props press into the floor. As a result, it becomes very important to strengthen the test of floor specific pressure, track the analysis and utilization of floor specific pressure parameters, determine the supporting density real-timely and reasonably and avoid increasing the supporting density and workload of adding props and prop drawings.

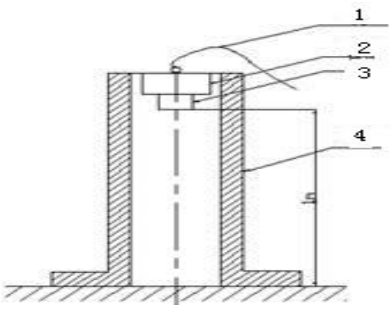
1 Testing Principle Of Floor Specific Pressure

The damage of coal seam floor is a process from quantitative change to qualitative change. The floor will have an elastic deformation when it bears the prop load, and the elastic deformation increases with the supports working resistance increasing, when it comes to the limitation, brittle fracture will occur in floor. The floor specific pressure gauge is divided into static type and impact type , we can see the static type DZD−40A from Figure 1, impact type DCYM－Ⅱ from Figure2, and Punching die structure from Figure 3.



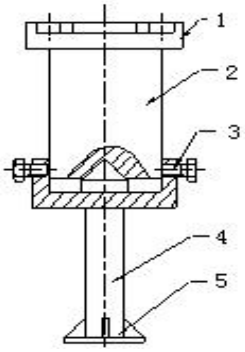
1- Three-way valve 2- Hydraulic prop 3- Locator 4-Punching die 5-Liquid-pressure gun 6- Pressure gauge 7- Perfusion tube 8- Hydraulic pump 9- Liquid inlet of emulsion 10- Pressurizing handle

Figure 1 Static type DZD-40A specific pressure gauge



1-Lift-rope 2-Impact rammer 3-Punching die 4-Impact cylinder

Figure 2 Impact type DCYM-Ⅱ floor specific pressure gauge



1-Punching die epitheca 2-Working face supports 3-Fasteningbolt
4-Punching die upright column 5-Punching die

Figure 3 Map of punching die structure

DZD-40A type specific pressure gauge is comprised of individual hydraulic prop, hand topping-up pump, locating seat of individual prop and four Punching dies of Φ 40、Φ 60、Φ 80、Φ 130mm.When it is used, according to the conditions of floor to choose reasonable Punching die, and this kind of floor specific pressure gauge is suitable to measure level Ⅰ, Ⅱ, Ⅲ floor. Impact type DCYM-Ⅱ floor specific pressure gauge is comprised of impact- cylinder、impact-hammer and six Punching dies of Φ5、Φ8、Φ12、Φ16、Φ20、Φ 24mm. When it is used, according to the conditions of floor to choose reasonable punching die to match with impact-hammer. The specific operational method is as follows.

First, raise the impact-hammer to a high degree of one meter above the impact- cylinder through the rope, then release rope to make the hammer natural whereabouts, At the same time, the punching die will act on the floor, and leave indentation (or called depth of Punching die).The depth of the Punching die pressing into the floor is thought as 2~3 m, otherwise, replace the punching die. This kind of specific pressure gauge is suitable to measure level Ⅲ, Ⅳ, Ⅴ floor. What's more, the record table should be made before the floor specific pressure is measured, and the measuring-points should choose similar lithology floor and the number of measuring-points should be more than four to ensure that the data is representative and has a high degree of accuracy. When measuring, the float coal and loose bed should be stripped off and removed primarily to make the active surface of Punching die smooth.

2 Mining Technology Conditions of Testing Area

4324 working face is a fully mechanized face in 4300 mining area of Daizhuang coal mine in Zibo mining group, the west is 4323 goaf, and east is DFF13 faults, coal seam direct roof in working face is main comprised of pink sandstone and fine-grained sandstone, the old roof is main comprised of fine-grained sandstone, direct floor is main comprised of mudstone, and the old floor is main comprised of pink sandstone. As considered floor in 4324 face is main comprised of mudstone, static type DZD-40A pressure gauge is chosen as testing instrument.

3 Analysis Of Testing Data

The floor specific pressure was tested, as the working face advancing to 20.6m and 45m,which is corresponding periods of the first weighting and the periodic weighting. In testing, clean the floor primarily, and choose face floor location with better conditions. When the instrument is contacting with the roof and floor, record the early data of pressure gage and plunger, then compress gradually, and record the data every 1~2 Mpa. When the pressure value suddenly drops and the plunger quickly elongates, which is the first layer broken point. First, according to the original records, sort out the corresponding pump pressure value:

$$h_i = H_i - H_0$$

Where: h_i −the depth of pump pressure mould pressing for i times, mm;

H_i −the numerical reading of pump pressure mould pressing depth for i times, mm;

H_0 −the early numerical reading of pump pressure mould pressing, mm,

Then, sort and figure out the floor specific pressure value of each pump pressure q_{mi}:

$$q_{mi} = \left(\frac{D_1}{d_m}\right)^2 q_i$$

Where: D_1 −diameter of Oil cylinder, *mm*;

d_m−diameter of Punching die in bottom case, *mm*

q_i−the numerical reading of pressure gage for the i times pump pressure, MPa;

According to the corresponding value q_{mi} and h_i, plot out the relation curve of floor specific pressure and press-in depth.

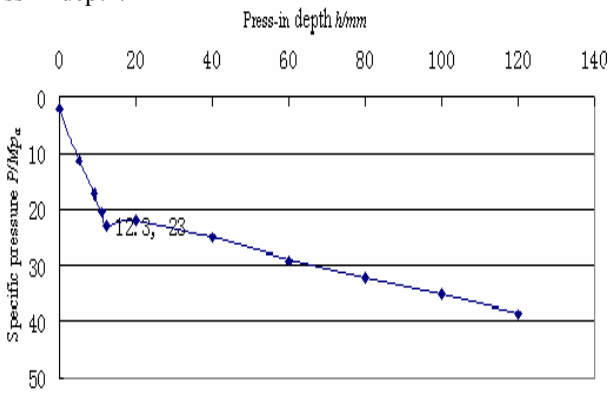


Figure 4 Curving of the first measuring-point during first weighting

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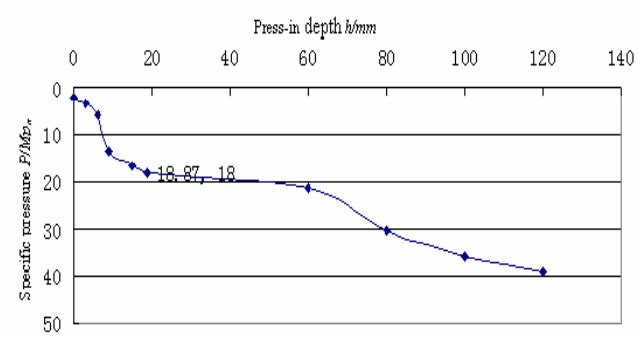

Figure 5 Curving of the second measuring-point during first weighting

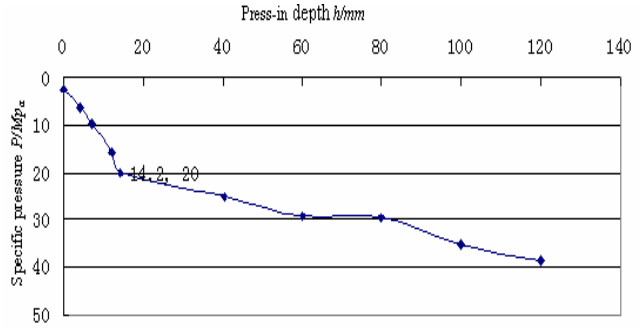

Figure 6 Curving of the third measuring-point during first weighting

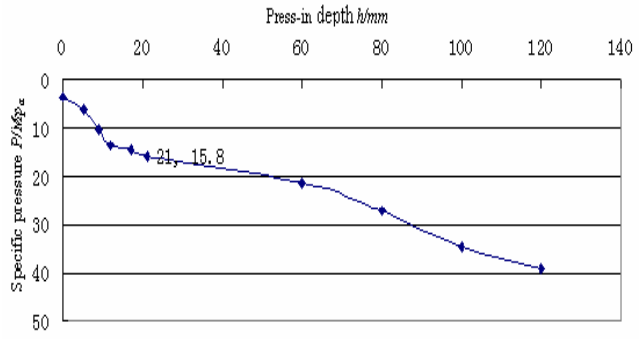

Figure 7 Curving of the fourth measuring-point during first weighting

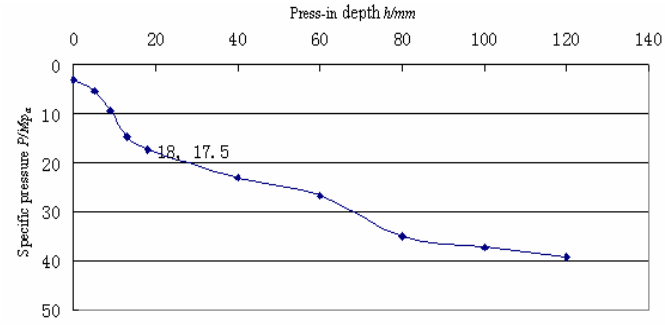

Figure 8 Curving of the first measuring-point during

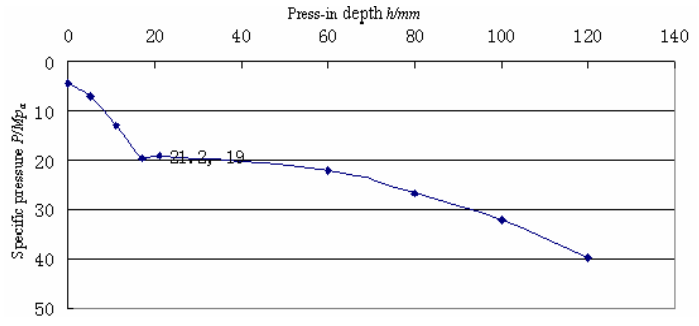

Figure 9 Curving of the second measuring-point during periodic weighting

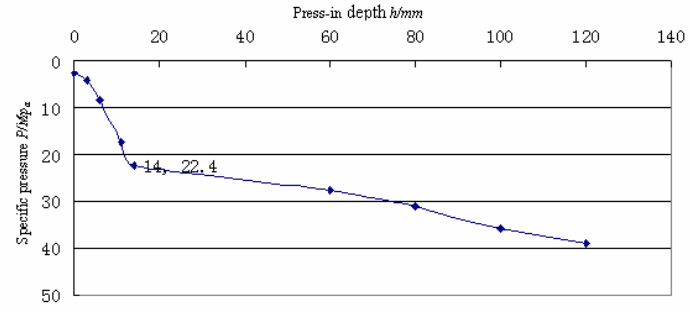

Figure 10 Curving of the third measuring-point during periodic weighting

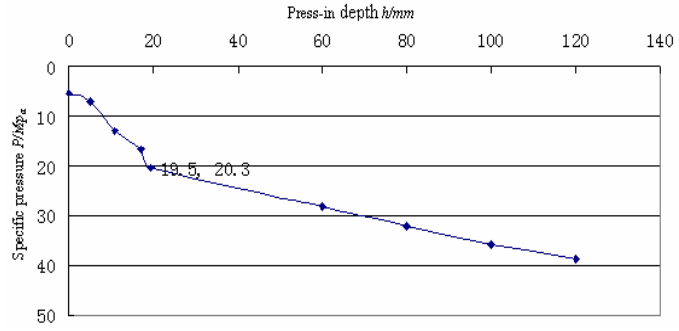

Figure 11 Curving of the fourth measuring-point during periodic weighting

From Figure 4 to Figure 11,we can find the inflection point of floor surface which is approach of destroying, and the specific pressure value of the inflection point is the compressive strength of floor q_m ,which can calculate the stiffness of the floor K_m.

$$K_m = \frac{q_m}{h_m}$$

Where: q_m−the floor specific pressure value at the inflexion, *MPa*;

h_m−the amount of indentation of Punching die at the inflexion, *mm*;

K_m−the stiffness of the floor rock stratum.

Allowable floor specific pressure q_c :

$$q_c = q_m \bullet C$$

Allowable stiffness Kc：

$$K_c = k_m \bullet C$$

Where: C−safety coefficient, generally can be taken 0.75,or 0.85 for rock stratum above medium hard.

Make statistics of data of each measuring point for this time ($q_m$andK_m),which can obtain the average compressive strength and stiffness of each surveyed area and the whole face floor, The floor specific pressure and floor stiffness summary sheet of first weighting and periodic weighting can be seen from Table 1.

Table 1 Summary table of the floor specific pressure and floor stiffness

Measure points	Cylinder pressure at the inflection point (Mpa)	Press-in volume (mm)	Floor specific pressure (Mpa)	Allowable specific pressure (Mpa)	Floor stiffness Mpa(mm)	Floor allowable stiffness Mpa(mm)
Data of the first measurement（first weighting）	23.0	12.3	35.93	26.94	2.99	2.24
	18.0	18.87	28.08	21.06	2.34	1.75
	20.0	14.2	31.2	23.40	2.60	1.95
	15.8	21.0	10.1	7.584	0.41	0.311
Average	19.2	16.59	26.32	19.74	2.1	1.56
Data of the second measurement（periodic weighting）	17.5	18	27.3	20.47	2.27	1.71
	19.0	21.2	29.64	22.23	2.47	1.85
	14	22.4	21.8	16.38	1.82	1.36
	20.3	19.5	31.66	23.75	2.64	1.97
Average	17.7	20.27	27.6	20.7	2.3	1.72

Table 2 Floor classification of inclined seam face

Floor categories		Basic key Figureure		Auxiliary key Figureure	Reference index	General lithology
Designation	*Code name*	*Allowable specific pressure qc (MPa)*	*Allowable stiffness Kc（MPa/mm）*	*Allowable penetration Bc（mm^{-1}）*	*Allowable uniaxial compressive strength Rc (MPa)*	
Dead-soft	Ⅰ	<3.0	<0.035	<0.20	<7.22	Placing sand, Mud stone, Apple coal
Soft	Ⅱ	3.0～6.0	0.035～0.32	0.20～0.40	7.22～10.80	Mud shale, Coal
Little-soft	Ⅲa	6.0～9.7	0.32～0.67	0.40～0.65	10.80～15.21	Medium-hard coal,Laminated
	Ⅲb	9.7～16.1	0.67～1.27	0.65～1.08	15.21～22.84	Hard coal, Tight shale
Medium hard	Ⅳ	16.1～32	1.27～2.76	1.08～2.16	22.84～41.79	Tight shale, Arenaceous shale
Hard	Ⅴ	>32	>2.76	>2.16	>41.79	Thick arenaceous shale, Aleurolite, Sandstone

From the calculating, we can work out that the allowable specific pressure of floor is 20.22Mpa and the allowable stiffness is 1.64MPa/mm. According to table 2,as it is followed, we can see that floor of working face is classified as medium hard Ⅳ level, which meets the requirements of the support base for 1.44～2.97Mpa.

4 Main Conclusions

In this paper, floor of mining coal seam face was classified as medium hard Ⅳ level through testing of the floor specific pressure in 4324 fully mechanized face of DaiZhuang coal mine of Zibo Mining Group, meanwhile, the adaptability of supports to floor was evaluated. The testing of floor specific pressure has great realistic significance for optimizing the supports system of working face and achieving high-yield and high–efficiency of mine.

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