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The Parameters Back Analysis in Digital Slope Information Technology

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Abstract

The continuous development of Internet and big database accelerate the data infiltration of constructions in various aspects. Three-dimensional Slope Information System which is based on web has auxiliary decisive significance on both planning slope engineering and constructions. According to the real construction projects and the slope information system developed independently, the inversion of rock mass macro-mechanics parameter to meso-mechanics parameter are discussed.

Keywords: digital slope, integrated application system, parameters back analysis

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INTRODUCTION

Albert Arnold Gore Jr, the former vice president of the United States put forward the concept of Digital Globe at the perspectives of multi-dimensional and multi-source data in 1998. It keeps motivating the applications and innovations of cross-field technologies in civil engineering (Gore 1998). The continuous development of Internet and big database accelerate the data infiltration of constructions in various aspects (Lv et al. 2016, Zhao et al. 2016). Three-dimensional Slope Information System which is based on web has auxiliary decisive significance on both planning slope engineering and constructions.

In the slope information system the mechanical parameter of rock and earth mass is vital to geotechnical engineering design, construction, calculating and analyzing, which affects the safety, economy and use of projects. The mothed of inversion of rock mass macro-mechanics parameter to meso-mechanics parameter are given in this paper.

PARAMETERS BACK ANALYSIS

As to the calculation method of discontinuous medium, the macroscope parameter and microscope parameter of rock and earth mass are of high nonlinearity (Dong et al. 2018), the correlations of macroscope parameter and microscope parameter can not be expressed in an exact mathematical expression. Particle simulations by particle flow and the selection of meso-mechanics parameter is based on numerical simulation model. It is tested after giving the model assumed meso-mechanics parameter and it compares the calculated macroscope parameter with the experimental results. Keeping adjusting meso-mechanics parameter until the calculation are basically consistent with experimental results. At this time, the meso-mechanics parameter can be applied into the project simulation. Shown as **Fig. 1**, on the one hand, the dissertation does advanced development on PFC to realize the interface of project modeling analysis. On the other hand, BP neural network algorithm based on WEB is adopted to realize the inversion of rock mass macroscope parameter to particle meso-mechanics parameter.

The basic idea of advanced development on PFC is shown in **Fig. 2**. Based on complex geometry grid, the complex slope model is separated into many small modules. By assembling the sample rock mass particle, the modeling of complex model is realized. This method is shown in **Algorithm 1**.

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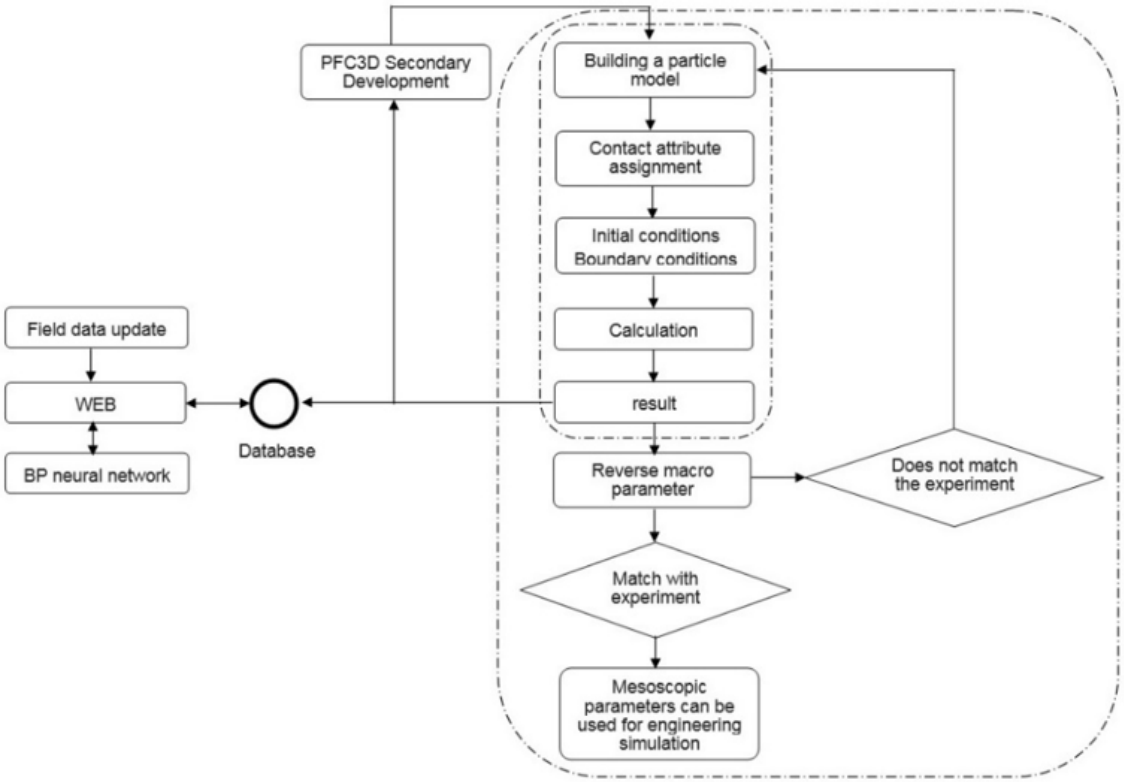

Fig. 1. Framework of Advanced Development on PFC

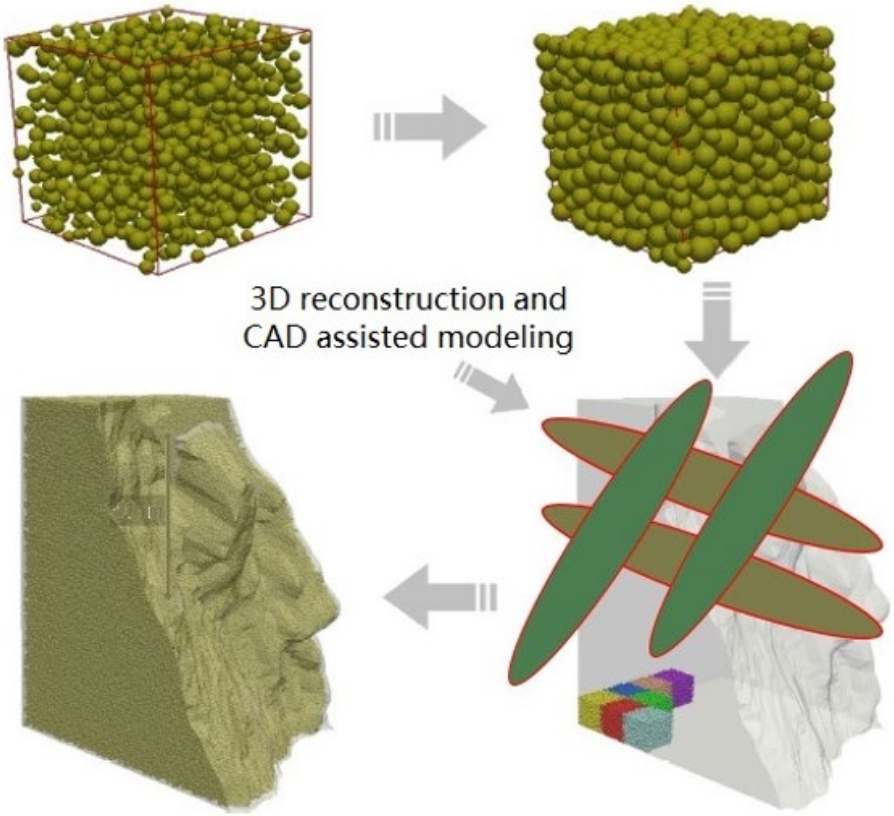

Fig. 2. The Basic idea of Advanced Development on PFC

Algorithm 1. PFC Complex Model Modeling

```
Input: *.stl Format file
/*Step 1: Making a sample of the particle model */
 MYSQL->query
// Query the database through SQL statements to obtain geotechnical model parameters
 Return [Sample size, joint modulus, stiffness ratio, tensile strength, cohesion, friction coefficient]
 Solve // Balance the internal stress of the sample particles
/*Step 2: Get model boundaries */
Import geometryInput // Loading geometric mesh model
Get geometry boundary // Get geometric boundaries
/*Step 3: Sample assembly*/
 Brick assemble // Fill in equal intervals according to sample size
If ball in wall: keep else delete // Interpret whether the particles are inside the model
/*Step 4: Balance internal stress */
 Solve until contactForce==0 //
```

Table 1. Meso-mechanics Parameter

The range of meso-mechanical parameters of the straight joint particle bonding model					
	Joint modulus /GPa	**Stiffness ratio**	**tensile strength/MPa**	**Cohesion /MPa**	**Coefficient of friction**
	20-80	**1-2.5**	**7-22**	**20-80**	**0.2-0.7**
Numbering	**Test uniform design table**				
ucs1	20	1.3	13	60	0.56
ucs2	24	1.7	20	44	0.5
ucs3	28	2.1	12	28	0.44
ucs4	32	1	19	72	0.38
ucs5	36	1.4	11	56	0.32
ucs6	40	1.8	18	40	0.26
ucs7	44	2.2	10	24	0.2
ucs8	48	1.1	17	68	0.59
ucs9	52	1.5	9	52	0.53
ucs10	56	1.9	16	36	0.47
ucs11	60	2.3	8	20	0.41
ucs12	64	1.2	15	64	0.35
ucs13	68	1.6	7	48	0.29
ucs14	72	2	14	32	0.23
ucs15	76	2.4	21	76	0.62

Table 2. Inversion Calculation of Macro-mechanics Parameter

Number	**Expected value**			**Inversion value**			**Relative error (%)**		
	Compressive strength /MPa	**tensile strength /MPa**	**Elastic Modulus /MPa**	**Compressive strength /MPa**	**tensile strength /MPa**	**Elastic Modulus /MPa**			
ch1	103	8.3	51.7	100.699	8.605	50.191	2.2	3.7	2.9
ch2	100	8.7	47.3	104.4	8.554	48.778	4.4	1.7	3.1
ch3	75	12	48.5	72.038	12.111	46.553	3.9	0.9	4.0

It is still troublesome to adjust particle simulation parameter, although flow sample simulation is realized by advanced development. In order to improve the analysis efficiency, the inversion of rock mass meso-mechanics parameter is realized, based on BP neural network. The rock mass parameter of the city circle project in Xi Ning, where starts from Jing Huang to Ping An, is considered in this dissertation. As shown in **Table 1**, the unconfined uniaxial compression and tension test are conducted by using the meso-mechanics parameter of 5-factor with 15-horizontal jointed-particle bonded model.

According to the earth mass meso-mechanics parameter obtained from inversion calculation, the macro-mechanics parameter is calculated by using the established soil discrete element numerical model, compared with randomly generated macro-mechanics parameter, shown as **Table 2**.

CONCLUSION

It can be told the maximum relative error of inversion calculation is less than 5%, which demonstrates the feasibility of inverting meso-mechanics parameter based on neural network.

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