The third ‘ Short-term prediction of rock failure competition(STPRFC)’

(Notice 1)

August 10-12, 2023, Taiyuan, Shanxi

The prediction of natural and engineering disasters in rock mass systems such as earthquakes, landslides, rock bursts, and gas outburst is a problem far from being well solved. Professor Zhao Yangsheng at the Taiyuan University of Technology, proposes the concept of ‘short-term prediction of rock failure’, and advocates to promote the research in this area through competition. The first (October 2021) and second (August 2022) ‘ Short-term prediction of rock failure ’ competitions were held in Taiyuan University of Technology, China, organized by the Chinese Society of Rock Mechanics and Engineering, the organizing committee of Chen Zongji's lecture in the Journal of Rock Mechanics and Engineering, Taiyuan University of Technology, Shanxi Provincial Society of Rock Mechanics and Engineering, and the Key Laboratory of the Property-improving Mining of Ministry of Education.

The contents of the competition include: (1) the time of rock failure, (2) the energy released by rock failure, and (3) the location and type of rock failure. The competition has the following characteristics: a) the answer is unique; b) the contents possesses practical and scientifical significance; c) the competition process is challenging; d) comparison is made between different theories, methods, and instruments. So far, there has been no competition in the world regarding the prediction of the rock failure by using different test theories, methods, and instruments in the same rock-loading test process.

The competition requires 5-7 teams to develop the test methods and rock mechanics theory, and predict the instability and failure of rock specimens under the compression of a uniaxial text machine. The prediction results are compared according to the competition rules. In 2021, 14 universities and research institutes in China participated in the competition, and in 2022, 10 universities and research institutes in China participated in the competition. The main test methods used by the team include strain (displacement) measurement, wave velocity and acoustic emission measurement, thermal infrared imaging measurement, speckle displacement field measurement, etc. The adopted theories include neural network and other machine learning algorithms, finite element, discrete element, inverse analysis, etc. In the two competitions, the errors of the best prediction results are within 100 s in terms of rock failure time, and within the range of 0.8~0.9 in terms of the ratio of the best failure energy prediction value to the actual value.

We sincerely invite rock mechanics research teams from all over the world to participate in this competition and learn from each other in the competition to promote the development of rock mass disaster prediction theory and technology.

Relevant matters are hereby notified as follows:

1. Organizational unit

Organizer: Journal of Rock Mechanics and Engineering, the Taiyuan University of Technology, Shanxi Society of Rock Mechanics and Engineering

Undertaker: Key Laboratory of In-situ Modified Mining, the Taiyuan University of Technology, Ministry of Education

2. Organizing Committee

Director: Zhao Yangsheng

Deputy director: Li Shucai, Liu Caicai, Pan Yishan

Members: Yang Qiang, Ji Hongguang, Wang Jiachen, Zhu Wancheng, Tan Yunliang, Wang Laigui, Li Xibing, Zhang Guang, Feng Zengchao, Wu Aiqing, Huang Lixing, Huang Hongwei, Feng Tao, Li Xiao, Tang Chun'an, Li Ning, Yang Ganshe, Liu Xinrong

3. Competition arrangement

3.1 Place of competition:

Key Laboratory of In-situ Modified Mining, Taiyuan University of Technology, Shanxi Province, China

3.2 Competition content:

The participating teams use their theories, methods, and testing instruments to monitor the process of uniaxial compression test of rock loaded at a constant displacement rate in real-time, and predict the time of failure, the main fracture surface, and the energy of failure before the failure of the specimen. The supporting materials of the prediction results shall be submitted within the specified time, including but not limited to: the prediction principle, monitoring equipment, data processing method, calculation basis, calculation process, and calculation results, etc.

3.3 Experimental conditions of the competition:

Testing machine: XPS-1000 servo control multi-function testing machine in the key laboratory of the Property-improving Mining of Ministry of Education, Taiyuan University of Technology. The axial pressure is 10MN, the axial displacement, and load can be servo-controlled and loaded, and can be recorded and stored in real-time. It can be loaded at a constant displacement rate, constant load rate, or in a certain slope and pulse form. This competition uses constant displacement rate loading.

Rock specimen size: 200mm * 200mm * 400mm rectangular specimen, rock specimen lithology: granite and sandstone specimen.

3.4 Experiment and competition procedures:

1) Place the test piece on the testing machine and apply 1000N preload.

2) The participating teams shall arrange and install sensors and test instruments, and the installed sensors and test equipment used shall not interfere with the test of other participating teams (**It is not allowed to install sensors that actively transmit electromagnetic or vibration signals**).

3) After the test instruments of all the participating teams are installed, the testing machine begins to load at the same displacement rate. All participating teams use their instruments to monitor a series of physical and mechanical information such as rock deformation and damage in real-time.

4) The testing machine is continuously loaded, and the participating teams continuously monitor the physical and mechanical information that occurs during the stress process of the test piece, predict the time of failure, the main fracture surface, and the failure energy, and submit the prediction results at propert time.

5) The testing machine continues to load until the test piece is unstable and damaged, and the participating team continuously monitors all physical and mechanical information until the end of the test.

6) The review committee gives the coordinates of the fracture surface and the standard answer of the fracture surface according to the accurate failure time, load-displacement curve, and displacement-time curve recorded by the testing machine in real-time, and the accurate main fracture surface given by the sketch after the failure of the test piece.

7) Each team shall complete the failure prediction of one granite and one sandstone specimen, respectively, and submit the supporting materials within 2 hours after the test of the second specimen.

8) The evaluation committee will score according to the forecast results and supporting materials submitted by the participating teams.

3.5 Composition of participating teams:

Each unit (university, scientific research institute, State Key Laboratory) can only set up one team, and each team is composed of three members. At least one member is a non-student, and the other two members are not limited to education and professional title. During the competition, only the contestants can operate, process, and analyze the data on-site and submit the prediction results.

3.6 Competition rules:

1) The sponsor, Taiyuan University of Technology, is responsible for preparing the basic test conditions of the test piece, test machine, and competition, and implementing the whole process of uniaxial compression of the test piece. The displacement load and displacement time curve measured by the testing machine in real-time during the competition will not be provided to the participating teams but will be announced after the competition.

2) The instruments, meters, and calculation software used by the participating teams to monitor, predict and predict the failure of rock specimens are all provided by the participating teams. The organizers will not provide them.

3) During the test, 6-7 teams will simultaneously monitor the same sample in real-time. Considering that it is impossible to set too dense monitoring points for real rock mass failure prediction, this competition limits each team to set no more than 5 sensors (such as strain gauges, acoustic emission probes, etc.) on the sample surface, and the maximum linearity of the contact surface between a single sensor and the sample is less than 20mm. It is not allowed to drill holes in the test piece or inject fluid into the test piece. The number and size of sensors or non-contact test probes installed outside the test piece are not limited.

4) Each team should submit the real-time prediction results before the test piece is damaged. Otherwise, it will be counted as zero.

3.7 Review criteria:

1) Standard answer: the evaluation committee gives a standard answer according to the load-displacement curve, displacement-time curve recorded by the testing machine in real-time, and the spatial coordinates of the main fracture surface determined after the failure of the test piece.

2) Predicted instability failure time: it is referred to as the time of instability failure of the specimen, defined as the point of 1/2 of the peak intensity of the stress-strain curve after the peak intensity. The standard answer is determined by the review committee according to the load-displacement curve recorded by the testing machine in real-time, and the absolute value and advance forecast time of the difference between the instability failure time and the standard answer submitted by each team account for 20 points each, with a full score of 40 points.

3) Predict the main fracture surface: the main fracture surface refers to the through fracture surface that causes the specimen to fail. The evaluation committee will give the standard answer according to the sketch of the specimen after failure. The total score is 20 points based on the square root of the square sum of the relative error between each fracture coordinate and the standard answer.

4) Prediction of fracture energy: fracture energy refers to the elastic strain energy accumulated before the peak strength. The evaluation committee determines the standard answer according to the load-displacement curve recorded by the testing machine in real-time. The absolute value of the relative error between the predicted energy and the fracture energy of the standard answer, with a full score of 40 points.

5) Weighted value of supporting material ξ: The supporting materials shall give the basis of their prediction of the above three indicators. The supporting material corresponding to each indicator should be correct and logical. The weighted value is 1 point, and the prediction without or not consistent with the supported materials are counted as 0. The weighted value of supporting materials for each team is the average value of all markers.

6) Rank the first, second, and third places according to the scores of each participating team.

4. Important time nodes

- June 30, 2023: deadline for registration of participating teams
- July 10, 2023: the organizing committee will conduct the qualification review and notify the deadline of the participants
- August 9, 2023: participating teams report and prepare for the competition
- August 10-11, 2023: On-site competition was held in the Key Laboratory of Property-improving Mining of Ministry of Education at Taiyuan University of Technology
- August 12, 2023: The competition test curve was announced and the academic discussion on short-term and imminent prediction of rock fracture was carried out.

  Please send the application form and relevant materials to the designated mailbox of the competition on time: alv-1001@163.com

5. Other matters

To protect the intellectual property rights of the participating teams, the people who have nothing to do with the competition are not allowed to enter the test site. Relevant academic materials will be collected after the meeting.

The organizer reserves the right to interpret this event.

6. Contact information

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‘Short-term prediction of rock failure Competition’ Organizing Committee

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