Reform and Practice of Experimental Teaching System for Drilling Engineering

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Abstract: Drilling engineering is a practical subject. Combined with the virtual experiment project on the Internet, this paper has been building scientific and reasonable tri-layer experimental teaching system. Meanwhile, it builds the drilling experiment teaching platform for drilling experiment teaching cooperating with the production unit, which is conducive to cultivating drilling engineering talents with broad foundation and innovative ability.

1. Introduction

Drilling engineering is a practical application technology project. It is a technical method to directly obtain geological data and information of underground resources. Protection and other aspects play an important role [1], it covers mechanical, rock mechanics, material mechanics, hydraulic transmission, fluid mechanics, electronic computing technology and information technology and other multidisciplinary technology applications, "Easy is easy, difficult to enter the ground", "into "The ground" is to solve the broken rock, maintain the stability of the hole wall, improve the drilling efficiency and the quality of drilling, which are inseparable from the efforts of the drilling technicians, and cultivate the prospecting engineering technicians with wide foundation and high innovation ability, drilling engineering experiments. Teaching is a very important link. The scientific and reasonable drilling engineering experimental teaching system plays an important role in the cultivation of innovative talents.

2. Construction of Drilling Experiment Teaching Platform

Platform construction objectives and ideas: The experimental platform should be able to carry out drilling-related rotary drilling, rope core drilling and boring drilling tool directional drilling experiments in the laboratory, and at the same time can complete geostress measurement and hydrogeology. The experimental platform shall include drilling equipment, drilling tools, drill bits, etc. on the ground, and a directional drilling hole shall be formed in the interior. Within this drilling hole, the relevant content of the drilling experiment teaching shall be completed, in order to support the experimental teaching of the drilling course and the innovative research of the university students. Training, geological engineering professional understanding, production and graduation internship has become an experimental teaching research platform for training innovative drilling engineering and technical personnel.

One vertical shaft 300m hydraulic drilling rig; one set of 7m high drilling rig; one set of Φ35 wired while drilling inclinometer; one JCH-3 logging winch; one NBB250/60 mud pump; one full hydraulic drilling rig, TK -3 drilling rig; fracturing method for measuring geostress equipment; hydrogeological testing instruments.

Drilling tools: 300mΦ75 rope core drilling tool, 300mΦ50 drill pipe, LF-65 screw drilling tool, Φ89 single acting double pipe core drilling tool, Φ89, Φ76 hydraulic impactor, all kinds of hard alloy, diamond drill bit, composite piece And roller cone drills, etc.

According to the conditions of the laboratory, as shown in Figure 1, the equipment and equipment assembled in the laboratory are required to be installed. All equipment installations should be well-stabilized and stable. The rig installation ensures that the crane, the vertical axis of the rig and the opening point are in a straight line. . Mud circulation tank size: width 400mm ×

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depth 300mm, mud pool size: length × width × depth 1200 × 1200 × 1500mm.

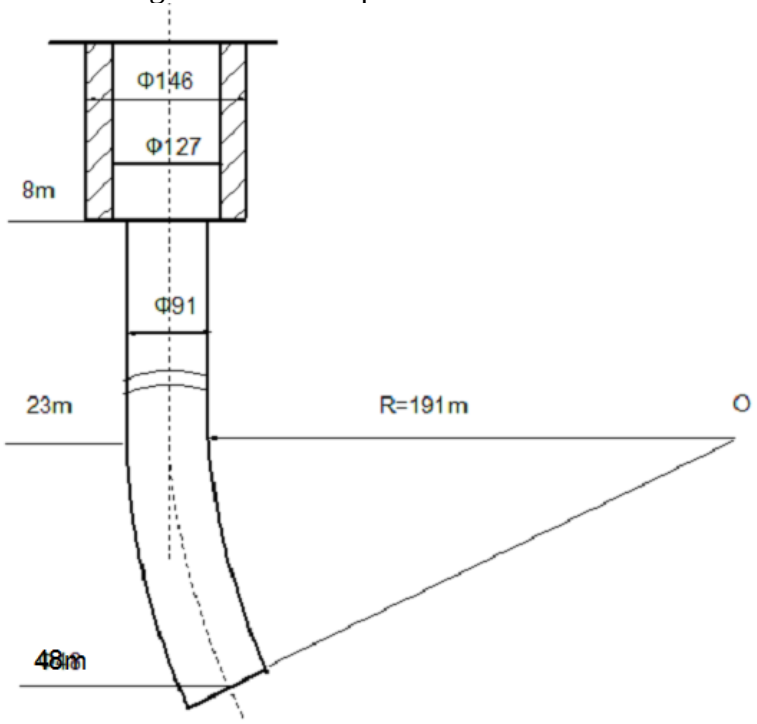

Figure 1 drilling structure diagram

Laboratory underground stratum composition: 0-1.6 m is miscellaneous fill, poor cementation; 1.6-6.8 m is Quaternary strata, red clay; 6.8-8.0 m is weathered limestone rock formation; 8.0-48 m is limestone and sandstone The interbeds are stable and the rock layers are stable. Among them, the 19-21m sandstone layer is a subterranean aquifer.

As shown in Figure 2, a borehole with a hole depth of 48 m is drilled indoors. The drilling structure is as follows:

One open, Φ146 cone bit + Φ50 drill pipe + Φ50 active drill pipe, hole depth 8m, drilled through weathered limestone rock formation, Φ127 casing, cement mortar fixed pipe;

Two open, Φ91 diamond drill bit + Φ75 rope core drilling tool + Φ75 rope core drill pipe + Φ50 active drill pipe, hole depth 23m;

Oblique section, Φ91 diamond oblique drill bit + LF-65 type 1.50 curved outer tube screw drill + Φ76 non-magnetic drill collar + Φ75 rope core drill pipe + Φ50 active drill pipe, wired while drilling inclinometer with drilling orientation Drilling, hole depth 48m, oblique strength 90/30m.

3. Construction of Three-Level Experimental Teaching System

3.1 Problems in Drilling Experiment Teaching.

Drilling engineering equipment is mostly equipment with large volume, high unit price, high power and long service life. The introduction of such equipment in university laboratories needs to solve equipment operation problems, installation problems, experimental environmental problems, due to less experimental time and low equipment utilization. The problem is that the equipment update rate is low, and many advanced drilling technology equipments are not introduced into the school for experimental teaching. The experimental technology is much behind the first-line production exploration units.

There are many verification experiments in the experimental content, which is not conducive to cultivating students' practical ability and innovation ability. According to the school's goal of cultivating students: strive to cultivate the all-round development of morality, intelligence, beauty, broad foundation, strong ability, high quality, social responsibility and international vision, adhering to the spirit of "good learning, innovation," and can make the country rich and strong and social

progress High-quality talents who have made contributions, all majors have carried out reforms in training programs, and the basic courses have been strengthened. The number of professional courses has been reduced. This inevitably reduces the experimental class. The content of the experimental courses is mostly based on confirmatory experiments. On the basis of basic experiments, some comprehensive experimental and design experimental project selections are selected by students according to their own time and interests after class, and the number of participants is relatively small, and the experimental results are not satisfactory.

In view of the above situation, in the field of laboratory basic conditions construction in recent years, we actively cooperated with the drilling production line to bring the mature drilling technology and drilling tools to the laboratory, and hired drilling enterprise technicians to conduct experiments and integrate experiments. Experimental teaching resources, re-approval of experimental projects, construction of a three-level experimental teaching system, construction of drilling engineering virtual simulation experimental teaching system and on-site teaching video to improve the quality of experimental teaching.

3.2 Construction of Three-Level Experimental Teaching System for Drilling Engineering.

In 2002, the Ministry of Education promulgated the "Assessment Indicators and Grades for Undergraduate Teaching Work in Ordinary Colleges and Universities", which put forward certain requirements for comprehensive and design experiments in practical teaching; the "Basic Course of Jiangsu Province Higher Education" formulated by the Jiangsu Provincial Department of Education In the "Standards for Acceptance of Experimental Teaching Demonstration Centers", in the "secondary indicators" of the "teaching content", it is clearly stated that "the experimental content includes three levels of basic experiments, improved experiments, and innovative research experiments" [2]. In order to straighten out the experimental teaching system of drilling engineering and solve the problems existing in the laboratory, while strengthening the basic experiment, integrating the experimental teaching project, combined with the research project, the innovation project of college students and the development and utilization of new teaching instruments, the verification experiment is upgraded to comprehensive. Design experimental projects, build a three-level teaching system of basic, comprehensive design and research innovative experiments to meet the needs of the society for the training of innovative prospecting engineering engineers.

The basic experiment is divided into confirmatory experiment and demonstration experiment. This kind of experiment is to verify the science of the principle, method, process or result through the experimental process or experimental result after the student has gone through the course of drilling engineering theory or one stage of study. Sex experiments to deepen students' understanding and understanding of drilling engineering science. Through basic experimental technical training, students will enhance the operational skills of rock mechanics testing instruments, drilling equipment, hydraulic system components and mud testing instruments, master rock mechanics calculations, mud performance testing and calculation, drilling mechanical drawing mapping, drilling drill bits basic skills such as mapping.

The comprehensive design experiment refers to the students who have completed the study and training of the theoretical and experimental courses in one stage, and comprehensively applied the knowledge and skills learned to complete the experiments of certain experimental contents. Such experiments are generally carried out by experimental teachers, requiring students to self-study experimental plans, prepare data tables, complete experiments independently, conduct experimental phenomena observation and analysis, and cultivate students' independent hands-on ability and good scientific literacy, occupying in experimental teaching links. The outstanding position, for this reason, in the experimental teaching system requires that each course has more than one comprehensive design experimental project according to their respective characteristics, which can be selected for the project, and the students choose according to their interests. Through experiments, students will be able to comprehensively apply their knowledge to solve practical engineering problems in rock properties, mud systems, drilling processes, and directional drilling.

Researching innovative experiments is mainly to cultivate students' inquiry ability and

innovative spirit, and promote the comprehensive development of students' practical knowledge. The main sources of experimental projects: extracurricular scientific and technological innovation practice activities, such as academic competitions (geological skills competition, China Petroleum Engineering Design Competition), university students scientific research innovation training programs (national, provincial and school), teacher research projects, etc.; The research projects for university students and the research projects of teachers are summarized into open experimental projects for students to choose. These experimental projects can be added to the content of the experimental courses. Attracting students into the laboratory encourages students to explore, discover problems and solve practical problems through experiments, thus improving students' innovative ability and innovative consciousness.

"Hydraulic Transmission", "Drilling Equipment and Process", "Directed Drilling", "Drilling Fluid and Completion Fluid", and "Rock Mechanics" course experiments are "Professional Direction of Geotechnical Drilling Engineering" and "CBM Engineering" open. According to the laboratory situation and the status quo of academic development, combined with the teacher's scientific research project and Dachuang project, the experimental content reform and adjustment were carried out according to the laboratory drilling platform. For example, the adjustment of the experimental content of the "Rock Drilling Engineering" course: "Mud Preparation and Performance Test Experiment" content combined with the teacher research project, the introduction of low temperature drilling fluid into the experiment, group experiments, four groups to complete 27 mud formula Experiment, through the collaborative experiment to determine the optimal ratio of drilling fluid; the original drilling operation demonstration experiment, the actual operation of the integrated drilling experiment on the drilling platform, the students according to the experimental requirements for the design of the drilling process, familiar with the drilling rig, mud Pump operation and drilling experiments according to design values. The "Drilling Equipment and Process" verification drilling equipment, tools and understanding experiments, gradually changed to actual drilling experiments on the drilling platform. Through the adjustment of these experimental contents, students' interest in experiments can be enhanced, and the ability to improve hands-on ability and solve practical problems in engineering can be enhanced.

Table 1 Three-level experimental teaching content of drilling engineering

Item Number	Experiment project name	Time allocation	Experimental attribute	Opening request	Course
	Basic experiment				
01	Hydraulic components and basic circuit experiment	4	verification	Must do	Hydraulic transmission
02	Rock compression, tensile and shear strength tests	2	verification	Must do	Rock mechanics
03	Drill structure observation and mapping	2	verification	Must do	Drilling equipment and technology
04	Rope core drilling tool structure experiment	2	verification	Must do	Drilling equipment and technology
05	Hydraulic impactor structure experiment	2	verification	Must do	Drilling equipment and technology
06	Screw drilling structure observation experiment	2	verification	Must do	Directional drilling
07	Rig structure observation and operation experiment	2	verification	Must do	Drilling equipment and technology
08	Mud pump structure observation experiment	2	verification	Must do	Drilling equipment and

					technology
09	Drill, drilling tools and drilling equipment observation experiment	2	verification	Must do	Rock drilling engineering
10	Mud preparation and performance test	2	verification	Must do	Drilling fluid and completion fluid rock and earth drilling engineering
	Comprehensive design experiment				
11	Rock compression deformation experiment	2	Comprehensive	Must do	Rock mechanics
12	Rock drillability classification	4	Comprehensive	Must do	Rock mechanics
13	Diamond drilling procedure parameter adjustment experiment	2	design	Must do	Drilling equipment and technology
14	Non-dispersive low solid phase polymer slurry preparation and performance adjustment experiment	4	design	Must do	Drilling fluid and completion fluid
15	Directional drilling experiment while drilling	4	Comprehensive	Must do	Directional drilling
16	Rope core drilling experiment	4	Comprehensive	Must do	Drilling equipment and technology
17	Drilling and tilting and hydrological measurement experiments	2	Comprehensive	Must do	Drilling equipment and technology
18	Drilling engineering comprehensive drilling experiment	4	Comprehensive	Must do	Drilling equipment and technology Rock drilling engineering
	Research innovative experiments				
19	Preparation of low temperature drilling fluid drilled into dry ice formation	1 week	Research training	Choose to do	
20	Experimental study on the slope of screw drilling tool combination	1 week	Research training	Choose to do	
21	Oil drilling engineering design	1 week	Subject competition	Choose to do	
22	Drill hydraulic system circuit design experiment	1 week	Research training	Choose to do	
23	Different ground layer drilling procedure parameter design experiment	3days	Open experiment	Choose to do	
24	Development of equipment for coalbed methane drilling		Research training	Choose to do	

With the development of information network technology, network experimental teaching as a supplement to practical experimental teaching plays an increasingly important role in improving the quality of experimental teaching and training students' practical ability and innovative thinking ability [3]. In terms of drilling, the drilling equipment used in the field is large in size and the

drilling process is irreversible. The drilling situation in the construction process is complicated. The situation in the borehole can only be inferred according to the ground instrument, and the construction time is long. The students are working hard for safety reasons. The virtual experiment project of drilling engineering was developed, and the virtual simulation experiment platform built by the school was used to facilitate students to conduct online self-learning and conduct pre-study, review and operation design experiments. At the same time, the experimental teaching video production is carried out, enriching the experimental teaching content.

Currently, the teaching resources available online for students are:

Teaching video: “Shuzhou Luling Coalbed Methane Drilling Engineering Teaching Video” “Single-moving double-tube coring structure observation and disassembly assembly experiment” “Rod core drilling tool structure observation and disassembly assembly experiment”.

Virtual simulation project: "directional drilling virtual simulation experiment teaching system", "hydraulic transmission virtual simulation experiment". Through network virtual experiments, students can carry out hydraulic circuit design, hydraulic system flow, pressure control, etc. Directional drilling virtual experiments can be used to design drilling parameters, directional drilling trajectory design, and connection and disassembly experiments of directional instruments.

4. Experimental Teaching Team Construction

At present, the experimental teacher team consists of experimental teachers, enterprise teachers (part-time), experimental technicians, and graduate students [4]. The experimental teachers are composed of teachers with rich theoretical and experimental teaching experience, and are the main body of experimental teaching and laboratory construction. Mainly responsible for the formulation and implementation of the experimental syllabus, the planning and implementation of laboratory construction, experimental teaching; corporate teachers responsible for production practice, extracurricular experimental teaching and experimental syllabus development, engaged in scientific research and guidance of student practice, technological innovation and other activities; experimental technology The personnel are responsible for the daily management of the laboratory, the opening of the laboratory, the maintenance of the instrument, the guidance or assistance of the experimental teaching of the experimental teacher, etc.; the graduate student assists the teacher or the experimental technician to prepare and guide the experiment, open laboratory and large-scale instrument and equipment development, etc. The management is managed by the experimental technicians.

There are 13 experimental teachers in the laboratory, 4 part-time employees, 1 experimental technician, including 5 professors, 11 associate professors, 2 lecturers, 14 doctorates, 3 masters, and 4 graduate students. Through a series of policies, the college mobilizes the enthusiasm of the laboratory team: the new teacher must work in the laboratory for two years; break the boundary between the experimental teacher and the theoretical teacher, the experimental teaching workload is equal to the theoretical teaching workload; Management Measures, clarifying the performance evaluation of laboratory construction projects, university students' scientific research training programs, discipline competitions, large-scale instrument and equipment development, self-made instruments, etc.; “Graduate Management Measures”, clarifying the requirements for graduate students to help with credits; Teacher tutor system; "Young teachers go abroad, business training programs" and so on. After years of construction of the laboratory team, a team of drill-oriented engineering experimental teaching teams capable of modern experimental teaching, innovative talent training and advanced teaching concepts have been gradually formed.

5. Conclusion

After years of construction, the drilling engineering experimental teaching system covers basic, comprehensive design and research innovative experimental content, assists network virtual simulation experiment content and drilling engineering teaching video, and cooperates with Jiangsu Coal Geological Exploration Team 2, Wuxi Prospecting Tools Factory, etc. Unit cooperation, built a

300m vertical axis hydraulic drilling platform in the original drilling laboratory, forming a directional drilling of the two-path structure, which can realize the actual operation experiment of the experimental teaching content related to the indoor drilling engineering. The Drilling Engineering Laboratory has become an active and co-construction with the first-line production units and research institutes of the exploration project. It has a team of drilling engineering experimental teachers with unity and advanced teaching concepts. It has advanced drilling equipment and drilling technology to support geotechnical drilling.

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