Practice and Teaching Reform of Engineering Geology for Urban Underground Space Engineering

Zhao Junlan

College of Architecture, North China University of Technology, Beijing 100144, China
zjl@ncut.edu.cn

Abstract: Engineering geology is an important compulsory professional basis course for the urban underground space engineering. Its teaching hours is a few but rich in content. This course pays equal attention to theory and practice, whose teaching is difficult and endowed with challenging. In order to adapt to the "deep, large and especial" construction for urban underground space engineering, we must reform the practice and teaching system of engineering geology. The reformed course is closely combining with the construction practice of underground engineering and reflecting the latest academic achievements. We strengthen the practice and open teaching, focus on training students' innovation ability and innovative thinking in the teaching process.

1. Introduction
Urban underground space engineering construction is carried out in a variety of geological environment, and there must be some mutual correlation and restriction between underground engineering construction and geological environment. Underground engineering construction must be based on the specific geological environment and engineering construction mode, scale and type, foresee the basic form and law of mutual restriction between the two, and reasonably and effectively develop and properly protect the geological environment. Engineering geology studies the relationship between human engineering activities and geological environment, and is an applied discipline serving engineering construction. With the characteristics of "deep, large and special" in underground space engineering construction, advanced underground space construction technologies such as shield machine and top-down construction method are widely used. Civil engineers are required to have necessary engineering geological knowledge to solve geological problems in engineering, so as to achieve the purpose of rational development and utilization of land and environmental protection. Therefore, engineering geology is an important part of the curriculum system of urban underground space engineering. This course has the teaching characteristics of concept and practice.

Due to the continuous development of science and technology, the engineering geology service field has been continuously widened, the research vision has been widened, the technical methods have been constantly improved, and the mutual penetration of disciplines has been strengthened. At the beginning, the geological problems in civil engineering have been mainly studied, that is, to find out the engineering geological conditions of the site and evaluate the stability of the foundation, so as to provide the basis for construction engineering, road and bridge engineering, water conservancy
Based on geological data, it has developed into a comprehensive subject which studies engineering problems such as land use, urban planning, mineral exploitation and development, marine development, geological disaster prevention and environmental protection. With the development of science and technology, the emergence of new theories, technologies and methods of geotechnical engineering has put forward higher requirements for the engineering geological knowledge and skill quality of underground engineering technicians. In addition to solid basic geological knowledge of rock, geological structure and stratigraphy, the students also need to master the foundation of field geological work skills and methods. In order to meet the needs of high-quality and intelligent talents in the construction of underground space, and make the engineering geology teaching better serve the society, we have carried out the reform and exploration of the engineering geological practice teaching system of urban underground space engineering specialty, explored the best practice mode, improved the practice efficiency, and cultivated the students’ ability of comprehensive analysis and problem-solving.

2. Discussion on practice teaching reform of engineering geology

The teaching link of engineering geology course is composed of theory teaching and practice teaching (Experiment and practice). Engineering geology theory teaching is the basis of engineering geology. The main contents include: minerals and rocks, geological structure, quaternary geomorphology, rock and rock engineering properties, groundwater, adverse geological processes and geological disasters, engineering geological problems of tunnels and underground caverns, engineering geological evaluation of special soil, engineering geological exploration and application. The first five parts are the basic knowledge of engineering geology, and the last four parts are specialized engineering geological problems. The practical teaching of "Engineering Geology" includes laboratory experiment, field geological practice and comprehensive practice. Among them, the recognition of laboratory rock and mineral specimen is an indispensable teaching link of engineering geology course and the basis of field recognition and identification of rocks. This teaching link can make learners have a perceptual understanding of mineral rocks, and lay a certain foundation for the analysis and treatment of practical engineering geological problems. Field engineering geology practice enables learners to have a more direct understanding of rocks, engineering geological conditions, engineering geological problems, etc. Through practice, we can understand and master the methods and steps of engineering geological evaluation, and improve the ability to solve practical engineering geological problems. Through comprehensive exercises, students can improve their ability to integrate theory with practice and analyze and process problems comprehensively.

2.1 Informatization construction assists practical teaching, stimulates students' interest in learning and cultivates students' innovation ability

The computer aided teaching system of Construction Engineering Experimental Center Based on Internet website is an important content of field geological practice teaching reform. It is very effective to solve the new problems encountered in field geological practice and has important application value. In the exploration of practice teaching reform of engineering geology course, the new theory, new technology and new method of engineering geology are continuously enriched. In the exploration of the practical teaching reform of the engineering geology course, the teaching content will be continuously enriched with new theories, new technologies and new methods of engineering geology. Using the teaching information management platform of the Jiangong Experimental Center, we have established a complete range of mineral specimen photos taken by the Geological Museum of China University of Geosciences, the Songshan National Geological Park video, and the Zhoukoudian geological internship multimedia video internship video, etc. Teaching materials and links to various engineering geological network resources to build an engineering geological network teaching platform, and constantly update information to help students track the frontier development of engineering geology; Based on multimedia technology, through the combination of CAI system "guidance" and "learner guidance" It is helpful to cultivate students' innovative ability.
The contents of information assisted practice teaching mainly include: naked eye identification of common rock forming minerals and three types of rocks; observation of stratum profile; basic identification of folds and fault structures; understanding of various internal and external dynamic geological phenomena; understanding of groundwater types and hydrogeological conditions; evaluation of engineering geological conditions such as stability analysis of caverns and slopes; environmental geology and geological disasters The analysis and treatment method of the problem and the influence of the above engineering geological conditions on the engineering construction. Students can browse, download and store the teaching resources of "Engineering Geology" practice through the website, and communicate with teachers and students in BBS discussion area. For example, in practice teaching, the prediction and evaluation of engineering geological disasters, the interpretation and analysis of geological maps and other teaching contents, such as the Three Gorges project, the Luanhe River Diversion Project to Beijing, the East Kunlun Mountain Fault Zone and the west of Kunlun Mountain Pass earthquake with M = 8.1, the engineering geological analysis of the Olympic site, the landslide of Lianziya dangerous rock mass and Huanglashi landslide control project in the Three Gorges project, and the stability under the foundation of Nanjing Metro Factors analysis and countermeasures, environmental geological problems caused by Xiaolangdi water control project, sedimentary environment and engineering geological characteristics of peat soil in Yunnan Plateau, engineering geological analysis of Chongqing Light Rail Line 1 and other engineering geological documents and materials, enrich the network teaching platform and combine with engineering examples to make the practical teaching content vivid, real and vivid. The students can understand the analysis ideas and methods of stress distribution characteristics, deformation and failure conditions and mechanical mechanism of surrounding rock and soil mass of underground engineering shaft, chamber surrounding rock and slope, familiar with the main factors affecting the stability of surrounding rock and interaction characteristics, master the engineering geological evaluation theory and method of slope stability, and the main prevention of deformation and failure of underground space engineering slope. It can apply geological analysis methods such as stereographic projection and solid proportion projection to the investigation and evaluation of underground engineering geological conditions; master the fault and its influence on the project, earthquake magnitude and intensity, earthquake site effect, liquefaction of sandy soil foundation and seismic subsidence of soft soil foundation. The formation conditions, classification and engineering geological problems of karst and soil cave, formation mechanism of landslide and collapse, morphological characteristics and classification of landslide, stability evaluation of slope and treatment of unstable slope. This paper has mastered the prominent engineering geological problems in the construction and production of underground engineering and the environmental effects of underground space development. From the perspective of the interaction and restriction between underground engineering activities and geological environment, the occurrence conditions and laws of underground engineering geological problems are studied, and the engineering properties of underground soft rock, the deformation and failure mechanism of weak surrounding rock, the stability type of surrounding rock and the evaluation basis are analyzed. The main engineering geological problems of underground soft rock are analyzed, evaluated and preventive measures are taken; the formation mechanism and development environment of main geological disasters in underground space mining are understood; the analysis theory and evaluation methods of environmental effects of underground space development are basically mastered; and the prediction and prediction technology of engineering geological disasters in underground space are familiar. The practice teaching method is vivid, intuitive, easy to understand and easy to operate. Through practice, students can deepen their comprehensive understanding of engineering geology course, enhance their ability to analyze and solve problems, and establish independent scientific research and work methods, so that students can understand the development status of the discipline, grasp the frontier trends, broaden their knowledge and broaden their horizons Lay the foundation for future work and social development.
2.2 Reform of practical teaching content, cultivate students’ ability of integrating theory with practice and comprehensive analysis and problem-solving ability

Field engineering geology practice enables learners to have a more direct understanding of rocks, engineering geological conditions, engineering geological problems, etc. Through practice, we can understand and master the methods and steps of engineering geological evaluation, and improve the ability to solve practical engineering geological problems. Engineering geology practice teaching includes three parts: laboratory experiment, Engineering Geology Practice and comprehensive practice: indoor experiment mainly requires students to master the knowledge and identification of common minerals and rocks; field engineering geology practice is to understand mineral rocks, geological structure, formation lithology, hydrogeology and special geological phenomena through field investigation; comprehensive practice requires students to master the knowledge and identification of common minerals and rocks Engineering geological evaluation, make comprehensive geological profile, and be able to carry out geological analysis. Students are required to be able to evaluate the geological conditions of underground engineering on the geological map, analyze the engineering geological problems that may be encountered in the construction of underground space, and put forward corresponding engineering prevention measures.

The choice of field practice base requires students to master the basic geological knowledge and professional geological knowledge, and combine with students' interest in learning and appreciate the great rivers and mountains of the motherland. We choose to practice outside school in Beijing Zhouchoudian area, Zhoukoudian Ape Man Site Museum, Yanqing silicified wood Geopark, Geological Museum of China University of Geosciences and national geological museum. Through field investigation and field practice of basic geological phenomena, we can gain perceptual knowledge, consolidate and deepen curriculum theory, so as to make theory and Practice more practical. It will lay a solid foundation for solving the main engineering geological problems in engineering construction in the future. Zhoukoudian area is rich in strata and rock resources. The strata of Zhoukoudian are fully exposed from bottom to top, including Archean, Mesoproterozoic, Paleozoic, Mesozoic and Cenozoic. Archaeozoic is Guandi complex, scattered in the margin of Fangshan rock body; Mesoproterozoic is widely exposed in Zhoukoudian area, including Changzhoudong formation, Chuanling formation, TUANSHANZI formation, Dahongyu formation, Wumishan formation, Hongshuzhuang formation and Tieling formation, and the rocks are generally slightly metamorphosed; Neoproterozoic Qingbaikou group is fully exposed in this area, including Xiamaling formation, Longshan formation and jingeryu formation; Lower Paleozoic only occurs There are Cambrian and lower Ordovician, including fujunshan formation, Baomao formation, Xuzhuang formation, Zhangxia formation, Huanyuan formation, Yeli formation, Liangjiashan formation and Majiaogou formation; Upper Paleozoic Mesozoic includes Benxi Formation, Taiyuan formation, Shanxi formation, yangjiatun formation, honglingmiao formation, Shuangquan formation, Nandaling Formation, Yaopo formation, Longmen formation and Jiulongshan formation; Cenozoic is widely distributed in the East and southeast of the area There are Yuling formation, Xinzhuang formation, dongziling formation and quaternary system in piedmont plain area. There are sedimentary rocks, metamorphic rocks and magmatic rocks exposed in Zhoukoudian area. The sedimentary rocks are mainly limestone, conglomerate and sandstone. In Zhoukoudian area, Fangshan complex intrusive body is the largest, with an area of about 60km. Quartz diorite and diorite were emplaced in the early stage and granodiorite in the later stage. The metamorphic rocks exposed in Zhoukoudian include regional metamorphic rocks, contact thermal metamorphic rocks and dynamic metamorphic rocks. The regional metamorphic rocks account for more than 75% of Zhoukoudian area, and the lithology is mainly slate, phyllite, meta sandstone, schist and marble; the contact thermal metamorphic rocks in Zhoukoudian area are mainly distributed around Fangshan complex intrusive body, and the lithology is andalusite Hornet, chlorite Hornet, contact schist and tremolite marble;Mylonite associated with ductile shear zone and detachment fault and cataclastic rock series associated with brittle fracture are widely distributed in practice area. Dynamic metamorphic rocks include mylonite, fault breccia, fault gouge and cataclasite. Abundant structural resources. Zhoukoudian is located in the border zone of
NNETaihang Mountains, near EW Yanshan Mountains and North China Plain, and its geotectonics belongs to Yanshan intraplate structural belt of North China landmass. Due to its unique geotectonic and long geological evolution process, Zhoukoudian area has complicated regional geological structure, strong rock deformation and good exposure of folds and faults. The core of the metamorphic core complex is Archean yuguandi complex, and the overlying and outer margin are a thick and thin caprock system. The geological structural elements do not include Guandi complex, basement detachment fault, Fangshan complex rock mass in the late diapiric position at the center of the caprock structural system. The structural system of caprock mainly includes bedding ductile shear zone, bedding overlying fold, viscous sausage and wedge fold, etc. The main recognized folds in the internship include the southwest Sancha complex anticline structure, Taipingshan syncline and 164 anticline in the Indosinian period, superimposed on the NNE trending Zhoukoudian fold group in Yanshanian period, and the NE trending fold group developed in the areas of luowuding, meimeimeigou and meikuanggou near Zhoukoudian. The regional fault structure includes detachment fault, nappe structure and piedmont normal fault. The nandazhai fault zone is the southwest end of the famous Babaoshannandazhai fault zone. Its spatial distribution is quite characteristic. It superimposes the normal fault of late piedmont fault, and the fault angle has two types: high angle and low angle. The joint structure is mainly exposed in dolomite on both sides of the excavation road in bajiaozhai area, and there are also dominant joints in Fangshan granodiorite rock mass. Small scale structural phenomena are also well developed, mainly including pointed circular fold, boudinage structure, sheath fold, suture line, tempestite, fish mouth structure, SC fabric, and rotational Sui ban [2].

Practice route in Zhoukoudian area: basic skull training route (cognition of three major rock strata, observation of fold and fault structure; stratigraphic lithology and geological structure route); visit to Zhoukoudian ape man Museum and observation route of karst landform; make students master some basic working methods of geological work through practice. Geological compass is used to measure attitude, orientation and slope angle. Practice field description of lithology; understand bedding, joint (fracture), stratum parallel unconformity and angle unconformity; understand the influencing factors of chamber stability; observe stratigraphic boundary and lithologic characteristics, The lithology, lithofacies, thickness and its variation law, stratification mark, occurrence of upper and lower strata, and engineering geological characteristics of rock mass, such as fracture development degree, integrity of rock mass, rock hardness, rock weathering characteristics and landform characteristics.

The field engineering geology practice in Zhoukoudian area adopts "interactive" and "heuristic" teaching methods. For each knowledge point, three questions can be raised, that is, "what, why and how to do it". For example, when explaining the content of "slope geological process", we can start from the knowledge chain of "what is the slope geological process? Why should we study the slope geological process? How to study the slope geological process? What should be paid attention to in the engineering?" the end point is the engineering application. In this way, students' learning initiative can be mobilized, from "passive" to "active", and from boring to interesting. Such as field practice bad geological phenomenon: collapse. Collapse (collapse, collapse or collapse) is a geological phenomenon in which the rock and soil mass on a steep slope suddenly separates from its parent body, collapses, rolls and accumulates at the foot of the slope under the action of gravity. The content of the practice is to observe the unloading cracks formed by the stress release and adjustment of the rock mass caused by the construction of the highway, and the fracture cutting destroys the integrity of the rock mass, and describes the types and characteristics of the collapse, the internal conditions and external inducing factors of the formation, the determination of the collapse boundary and the identification method of the collapse body; the karst phenomenon is observed in the field, and the practice content is investigated in Zhoukoudian area The cave in Zhoukoudian area is rich in "keel" and has become the research base of cave Paleontology and paleoanthropologists. It has accumulated a lot of research results of Cave Research in Zhoukoudian. Before the internship, the question was raised: since the Beijing cave has no roof, how can Beijing people live in the cave for hundreds of thousands of years? The formation age of Zhoukoudian topography? How to solve karst engineering geological problems? With these problems, students access to a large number of literature, improve
students' ability to acquire knowledge, and promote students' initiative and enthusiasm of autonomous learning and research-based learning. Students understand the geology of carbonate rocks in Zhoukoudian. Most of the carbonate rocks exposed in Zhoukoudian are concentrated in the area of Longgu mountain and jigushan mountain. Although some carbonate rocks are exposed in Taiping mountain and Dongshankou area, the area is not large. The carbonate rocks in this area can be divided into three periods from old to new: Cambrian (C2) Zhangxia Limestone: distributed in the west side of Longgu to jinshanyuan line. The occurrence of the formation is oblique to the north with an inclination of about 40° and the Cambrian (C³) CHAOMIDIAN Limestone: the distribution range is consistent with that of Zhangxia limestone, and the stratigraphic attitude is also roughly the same. Ordovician (ο2-3) Majiagou Limestone: mainly distributed in the east side of Longgu mountain to jigushan area, the stratum occurrence inclines to the East, northeast and northwest; the Carboniferous (C²) Benxi Limestone: distributed in the South and north side of Taiping mountain, the occurrence changes along the Taiping mountain syncline; the development type of Zhoukoudian Karst Cave: the karst cave in Zhoukoudian is relatively developed, and most of the caves contain abundant mammalian fossils And ancient human cultural relics. These caves are mostly concentrated in Longgu mountain, Taiping mountain and jigushan area. According to its morphological characteristics, it can be divided into two categories: 1) vertical pipe or fissure bag type: this kind of cave is mostly developed in the rock stratum with complex geological structure or joint development. The dip angle of the strata around the cave is 40-50° and the joints perpendicular to the bedding plane are developed, which makes the Ordovician limestone fracture into a nearly square shape. When the horizontal flow of the paleohydrological network of Longgu mountain continuously converges and increases the discharge, this "seepage type" dissolution and plasticity is particularly significant. During this period, due to the uplift of the mountain, the dissolution decreased, and the cave deepened and expanded, resulting in the formation of an ape man cave with a depth of 40 meters, a length of more than 100 meters and a width of nearly 10 meters. The width of the cave is not controlled by this kind of cave. (2) horizontal karst cave type or terrace type: this kind of cave is generally formed at the level close to the local erosion base surface or underground seepage at some water resisting interface for a long time, and the Jingliu effect is strengthened to promote chemical dissolution and mechanical erosion, and expand the scope of karst cave. After the crust uplifted, the karst caves exposed to the surface. Most of these caves are distributed in layers, and their body is long and wide, sometimes consistent with the river terrace outside the cave. In recent years, with the development of Quaternary geological work, the cave accumulation in Zhoukoudian, especially the first site, has become a very important correlation section between mountain area and plain. Therefore, such as cave evolution, accumulation age, sedimentary environment and so on have important research value. Beijing Rendong is located in Ordovician limestone with complex structure and developed joints, which belongs to stepped type in cave morphology. When the Beijing man cave is gradually higher than the erosion base level, the surrounding area of the cave is relatively fragile, especially the east wall near the river bed (Zhoukou River), which is prone to mechanical damage and accelerates the collapse of the tunnel wall. The geological development of karst cave in site and the causes of karst leakage were studied.

Through the lively and interesting field teaching practice, compile the attached drawings including the actual stratigraphic section diagram, comprehensive stratigraphic histogram, actual material diagram, structural outline diagram, geological diagram, analysis and evaluation report of engineering geological conditions in Zhoukoudian area, so that students can learn on the basis of deepening understanding Analyze the close relationship between civil engineering and geology; make students familiar with common geological problems and treatment methods in civil engineering construction, and the rich practical teaching environment provides a strong guarantee for cultivating the ability of college students to integrate theory with practice. Engineering geology practice strengthens the cultivation of students' geological thinking and engineering geological thinking ability, and in the process of practice, stimulates students' love for geological science and the spirit of continuous exploration of science.
2.3 Carefully design the content of comprehensive practice practice and carry out engineering practice and research

The design principles of comprehensive practice practice content include: putting the cultivation of students’ scientific quality and innovative spirit in the first place; highlighting the teaching of basic theory, basic knowledge and basic skills; expanding the content of the course and keeping close to the development trend of the discipline; in the teaching method, it mainly focuses on the key points, difficulties, methods and applications; and The combination of practice and lecture not only pays attention to the cultivation of students' logical thinking ability, but also pays attention to the cultivation of students' innovative spirit and self-learning ability. Theoretical teaching is combined with experiment and engineering practice. The content of comprehensive exercise is the engineering geological evaluation of underground engineering development. According to the idea of sustainable development of urban underground space, as shown in Figure 1 (underground resources survey and evaluation system), the comprehensive exercise content is as follows: the contents of urban geological survey for underground space development and urban planning, evaluation method of urban underground resources potential and identification of geological environment constraints for urban underground development, interaction mechanism of underground resources development and utilization in different cities, potential and sustainable development of urban underground resources, influence of underground space development on urban environment, and construction funds of underground engineering. Comprehensive practice teaching should be carried out on the three subjects of source investigation and evaluation system; the analysis methods of engineering geological problems and the measures to be taken for adverse geological conditions should be mastered; the formation mechanism of various geological processes, the influencing factors, the influence on the engineering and the treatment methods are understood; and the engineering geological problems that may be encountered in civil engineering are analyzed and evaluated.

Fig. 1 theme 1, 2 and 3 of underground space development resources investigation and evaluation system

3. Conclusion
The reform of Engineering Geology Practice Teaching is explored with emphasis on foundation, quality and ability training. Engineering geology teaching website is an open auxiliary teaching system, which includes electronic teaching plan, teaching syllabus, experimental guide book, learning guide, teaching video, multimedia courseware, exercise set, reference literature, etc., so that students can learn autonomously; it can provide students with a large amount of expandable information, collect domestic and foreign engineering geological network resources, rock and mineral specimen pictures, geology, etc. Quality video, audio and video, teaching reference books and engineering examples are provided for students' reference. The establishment of Zhoukoudian practice base enriches the environment of practical teaching resources, which provides a strong guarantee for the cultivation of students' ability of integrating theory with practice, strengthens the cultivation of students' ability of geological thinking and engineering geological thinking, and stimulates them in the process of practice.
Students' love for geological science and the spirit of continuous exploration of science. The comprehensive practice focuses on the deep analysis of the engineering geological conditions and the engineering geological problems arising from the underground space development, puts forward the solutions, and cultivates the students' ability to analyze and solve problems by using the knowledge they have learned. Urban underground space engineering is a new major in our university. There are still many problems in the practical teaching of engineering geology. It is necessary to learn from the engineering geological practice teaching experience of other colleges and universities with long educational background and remarkable school running effect, so as to promote the construction and development of the course.

The author's introduction: Zhao Junlan (1962 - ), female, Xishui, Guizhou Province, Professor, Director of management department, research direction: geotechnical information technology, "3S" technology and application

Acknowledgments
This project is supported by The Special Education And Teaching Project of Beijing Education Commission.

Reference
[1] Hu Xiuwen. (2005) Discussion on Zhoukoudian geological practice teaching in the direction of civil engineering and geotechnical engineering [J]. China Geological Education, (2): 62-65.
[2] Bai Mingzhou, Wang Meng, Liu Ying, et al.(2006).Teaching reform of engineering geology [J]. Higher architectural education,15 (2): 93-96.
[3] Wu Zhenxiang, fan Xiufeng.(2007) Application of various teaching methods in Engineering Geology Teaching [J]. China Geological Education, (4): 109-110.
[4] Niantingkai, Yang Qing.(2009) Some thoughts on practical teaching reform of engineering geology [J]. Theory and practice of civil and architectural education reform, (11): 107-109.
[5] Chen Yonggui, Wang GUIYAO, Huang Shengwen, Zhang Jun, Liang Bin,(2009) reflection on practical teaching reform of geotechnical engineering for civil engineering specialty [J]. Higher architectural education, (3): 104-106.