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APPLICATION OF REMOTE SENSING TECHNOLOGY IN ENGINEERING GEOLOGICAL SURVEY OF DATONG-YUNCHENG HIGHWAY (HUOZHONU-LINFEN PART)

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ABSTRACT: This paper introduces the application of 3D stereo image technique to route selection of Huozhou-Linfen part along Datong-yuncheng highway. Basing on remote sensing image feature we have studied the terrain, engineering geological type of rock and soil, and active faults in this area. By combining with field survey, finished the dividing of highway engineering geological unit, 1:10000 engineering geological plane map and vertical section map, and realized the goal of providing detail information of engineering geology for highway planning company in short period of time.

1. INTRODUCTION

Shanxi province is abundant of colorful and attracting ancient cultural sites and scene spots, for example: the famous Yungang rock cave, Jinci temple, Yaomiao temple, grandiose Hukou waterfall of the Yellow River. On the east of Shanxi is Taihang Mt., and on the west is Luliang Mt. The Fenhe river pass through the province from north to south forming a band of scenic area, for example, the Hengshan Mt., Wutai Mt., Yangquan, north Wudang Mt., Taiyuan, Mianshan Mt., Lingkong Mt., Linfen, Linshan Mt., Jincheng and Yuncheng are all famous touring places. In order to expedite the development of tourism and economy of Shanxi province, Shanxi government is actively preparing to conduct Datong-Yuncheng highway project, which pass throughout the province from north to south. In order to guarantee the highway plan to start early, we undertake the task of using remote sensing technology to performing engineering geological survey in Huozhou-Linfen part of Datong-Yuncheng highway, which are finished in short period of time, and provide reliable engineering geological data for highway plan and design unit. This paper mainly introduces the methods of application of remote sensing technology to highway engineering geological survey.

2. HIGHWAY ROUTE SELECTION USING REMOTE SENSING TECHNOLOGY

2.1The rule of highway route selection

Shanxi province is short of farmland. With the exploration of tourism resources and mineral resources, and the development of city and road construction, farmland is decreasing. In order to protect farmland, the rule of highway route selection is that road should occupy farmland as less as possible.

During plan, for a given length of road, the route should avoid passing through towns, villages, ancient architectures and area with complex engineering geological condition, in order to minimizing dismantle compensation fee and construction difficulty, quicken work plan and saving project expense.

2.2 Method for application remote sensing technology in route selection

Using remote sensing technique build 3D stereo model. Because 3D stereo can visually and truly reflect the feature of terrain, geological body of disaster, town and village construction, it can be used to efficiently select highway route. The specific method is:

First, geometrically rectify the panchromatic air photo (at a scale of 1:10000) in 1998, and TM color image (R5, G4, B3) in 1997. Then performing fusion of air photo with TM543 to form 1:10000 color orthographic image. Basing on air photo to produce DEM and take the orthographic image as surface image to build 3D stereo model. At last, to view 3D stereo image from different perspective angle by applying the ERDAS, ENVI or PCI image processing software, and according to several viewing and analyzing results to choose most reasonable route.

3. ENGINEERING GEOLOGICAL SURVEY BY USING REMOTE SENSING TECHNOLOGY

3.1Working area

The working area is a strip formed by extending 1.5km on both sides of the pre-selected highway route. At parts with complex engineering geological conditions, the strip may be wider according to specific situation.

3.2 Division of terrain form

According to 3D stereo image, the terrain can be divided as follow:

3.2.1 Loess hill area: Locating between Yangzaocun village of Huozhou city and Mingjiang town of Hongdong county. It′s feature is that there are many gully. Extending direction of the gullies is from west to east, approximately vertical to the highway route. The steep gullies usually are U shape, averaging 5-50m in depth and 10-80m in width, short of water throughout year, and often become the water pass when flooding. The gully walls are very steep.

3.2.2 Basin-plain area: Locating between Mingjing town of Hongdong county and Linfen city distributing along the 3 level terraces. Fully well developed at the first terrace, reaching 1100m in width and with less relief, which is the primary farmland in Linfen basin. The second terrace is in band or strip shape reaching 5-10m in width. The third terrace is the highest one. Its back connects with the loess hill, which is important part of the basin-plain area. At some parts, the third terrace is in band shape, on which develops many narrow and deep gulches.

3.3 Classification of rock and soil engineering geological type

According to image feature such as color, texture, and combination etc. The rock and soil engineering geological type can be classified as follow:

3.3.1 Group of gravel and soil in river valley: Distributing in river bed and floodplain, mainly composing of alluvial sand and gravel of Holocene (Q_4), badly sorted and grounded, with non-uniformity texture, 2-10m thick. The most thickness can reach 12m.

3.3.2 Group of sub-sandy soil, sub-clay, sand, gravel: Distributing in the first and second terraces, and mainly composed of alluvial sediments of Holocene (Q_4). The rock layer can be divided into two parts, the upper part is sub-sandy soil and sub-clay and the lower part is sand and gravel.

3.3.3 Group of sub-clay and sub-sandy soil: Widely distributing on the surface of the third terrace, mainly composed of pluvial and alluvial sediments of later Pleistocene (Q_3). The upper part is composed of sub-clay and sub-sandy soil with uniformity grain, structure loose, pores big, vertical joint well developed, and high wet-sink quality. The lower part is composed of sand and gravel, sub-sandy soil and some sub-clay.

3.3.4 Group of sub-sandy soil and sub-clay: Distributing on the surface of hills, mainly composed of pluvial sediment of later Pleistocene (Q_3). Rocks are primarily sub-sandy soil, secondly sub-clay, also contain some sand and gravel. The gravel is generally in lenticular, unsteady distribution, loose structure, badly sorted and grounded, containing some calcareous concretion.

3.3.5 Group of sub-sandy soil and sub-clay containing some gravel: Distributed along the front zone of gentle slope in the middle part of the hill area, mainly composed of pluvial sediment of later Pleistocene (Q_3). Rocks are primarily sub-sandy soil, secondly sub-clay, also contain some sand and gravel, with loose structure, well-developed vertical joint, containing less water. On the surface there are some sub-clay and gravel. Some gravel are very large (10m × 10m), some are small(0.5m × 0.5m).

3.4 Investigation of engineering geological problem using remote sensing technology

3.4.1 Remote sensing investigation of active faults: On remote sensing image faults present as straight or curve line, because fault produces difference between the lithology, strata, terrain, drainage and vegetation on both sides of the fault. Proof of active faults on image include synchronization curve of water system, curve point and converge point of gullies, linear arrangement of river valley etc. According to image interpretation and field survey, four active faults are determined, which pass through the pre-selected highway route.

Shangleping fault (F1): this fault spreads northeast, making a serious northwest gullies curve.

Yuanchuan-zhaocheng fault (F2): this fault spreads northeast, from Huoshan bedrock area, via loess covered fault basin, to Luoyun bedrock area.

Mamu fault (F3): this fault spreads northwest. The southwest side of the fault is 10m higher than the northeast side. There are great different in terrain between the both sides of the fault.

Hongdong fault (F4): this fault spreads from west to east, forming obvious relief on landform.

3.4.2 Remote sensing investigation of wet-sink quality of loess: According to remote sensing image interpretation and field survey, confirm the range of sub-clay and sub-sandy soil of later Pleistocene (Q_3), which own high wet-sink quality and mainly distributed on the surface of higher terrace.

3.4.3 Remote sensing investigation of soft base: According to remote sensing image interpretation and field survey, confirm the range of riverbed and river flat along Fenhe River in which easily occur frost boiling of sand and soil, because the ground water table is shallow.

3.4.4 Survey of worked-out section in coal mine: The problem can not be solved by using remote sensing technology, it is handled by collecting preexisted data and performing field survey. According to the distribution map of worked-out section of Huozhou coal mine, a worked-out section is now 5km away from the highway route. At Xinzhi coal mine, the planning mining area cut through the route. During road building, relative units should negotiate about the problem to avoid mining effect to highway.

4. ENGINEERING GEOLOGICAL DIVISION OF HIGHWAY

On the basis of analyzing about regional terrain, engineering geological types of rock and soil body, and engineering geological problem, engineering geological area can be divided as follow:

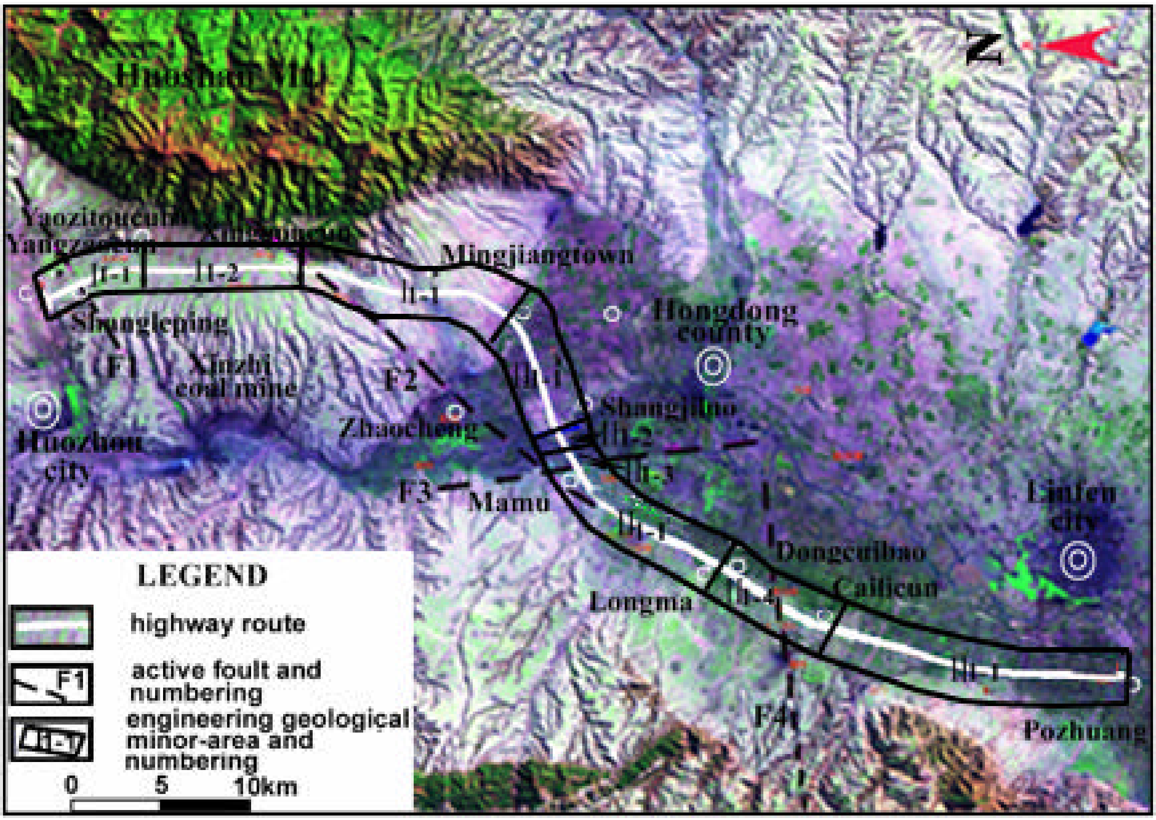

Fig.1 Landsat TM image of Huozhou-Linfen part along Datong-Yuncheng highway

4.1 Engineering geological area of loess hill(?)

Engineering geological sub-area of loess mound(**? 1**)

4.1.1 Engineering geological minor-area of sub-sandy soil (? 1-1): Distributes along the highway route from Yangzaocun village in the north, via Yaozitoucun village, and Xinggoucun village to Mingjiang town in the south, belonging to powerful erosion loess landform, with big relief, steep slope. In the part from Yangzaocun village to Yaozitoucun village, the landform inclines to north, with 680-800m elevation, 10 ° gradient. There are four bigger gullies, 20-40m in depth and 50-80m in width. Shangleping active fault (F1) passes through this area. In the part from Xinggoucun village to Mingjiang town, the landform inclines to south, with 973-418m elevation, 9 ° gradient. There are 10 big bullies, 20-50m in depth and 50-80m in width. Yuanchuan-Zhaocheng active fault (F2) pass through this part. The sub-sandy soil and sub-clay have high wet-sink quality. Thickness of sinking after absorbing water is 2-8m.

4.1.2 Engineering geological minor-area of sub-sandy soil and containing some gravel (? 1-2): Distributes along the highway route from Yaozitoucun village in front of Huoshan Mt. to Xinggoucun village, belonging to weak erosion loess landform, less relief. The landform inclines to Fenhe river valley. There are 12 smaller gullies spreading from west to east, 5-10m in depth and 10-20m in width. The pluvial sub-sandy soil, sub-clay and containing some gravel of later Pleistocene (Q_3) has high wet-sink quality. Thickness of sinking after absorbing water is 2-10m.

4.2 Engineering geological area of basin-plain (?)

Engineering geological sub-area of dip plain (**? 1**)

4.2.1 Engineering geological minor-area of high terrace sub-clay (? 1-1): Distributes in the parts from Mingjiang town to shangjiluo village, Mamu village to Longma village, and Caili village to Bozhuang village, locating on Linfen third terrace, belonging to plain alluvial landform. From Mingjiang town to shangjiluo village, the landform inclines to west, with 2 ° gradient, Forming steep wall at Fenhe river valley, 50m higher than the first or second terrace. From Mamu village to Longma village, the landform inclines to the east, 6‰ slope decline, 15m higher than the first or second terrace. Mamu active fault (F3) passes through this area. From Caili village to Bozhuang village, the landform dip to south, with 3 ° gradient, 520-450m elevation, farming well-developed. The rock is mainly pluvial and alluvial sub-clay of later Pleistocene (Q_3), sorting well, pores big, structure loose, vertical joint well-developed, wet-sink quality of sub-clay in this minor-area is medium. Thickness of sinking after absorbing water is 2-6m.

4.2.2 Engineering geological minor-area of lower terrace sub-sandy soil and sub-clay (? 1-2): Distributes in the current riverbed, first and second terraces, belonging to alluvial accumulation landform, less relief. The upper part is mainly sub-sandy soil and sub-clay of Holocene (Q_4), 5-10m in thickness. The lower part is mainly sand, gravel, and some sub-sandy soil of Holocene (Q_4). The strata have double structure. Wet-sink quality of the sub-sandy soil on the surface is weak. Sinking thickness is 2m. Because the ground water table is shallow, it is easy to occur frost boiling, therefore engineering geological condition in this minor-area is bad.

4.2.3 Engineering geological minor-area of modern river valley gravel (? 1-3): Distributes in Fenhe river valley and flood plain, composed of alluvial gravel and some clay of Holocene (Q_4) (according to drill data, it is 12m thick), engineering geological condition is bad.

4.2.4 Engineering geological minor-area of alluvial fan (? 1-4): Distributes in the middle-lower part of the alluvial fan from Dongcuibao vilage to Caili village, less relief, landform dipping to south, slope decline 21%, belonging to alluvial and pluvial accumulation plain landform. In this part, there are four gullies, spreading from west to east, perpendicular to the route, 80-100m in width and 10m in depth. Hongdong active fault (F4) passes through this area. The rock is mainly sub-sandy soil and sub-clay of later Pleistocene (Q_3), pores big, structure loose. Thickness of sinking after absorbing water is 2-10m.

5. CONCLUSION

On the basis of analyzing and studying about hydrogeology, geology, earthquake, mining data and remote sensing data in the area of Datong-Yuncheng highway, we complete engineering geological survey, division of landform, and engineering geological types of rock and soil body in short period of time, provides amount of basic data for highway engineering planing and feasibility argumentation.

Now it is possible to build 3D stereo image model, which is proved to be very useful for route selection study. In order to make route selection and design more scientific and reasonable in the future, it is necessary to build GIS and various sorts of database, and at the same time do some necessary field survey.