



## Project

- Acceptance of the tunnel section between Qianjianglu and Fengtanlu with a length of 23.68 km and 15'500 tubbing rings

## Duration

- April to May 2017

## Contractor

Huadong Engineering Corporation  
华东勘测设计研究院  
www.ecidi.com

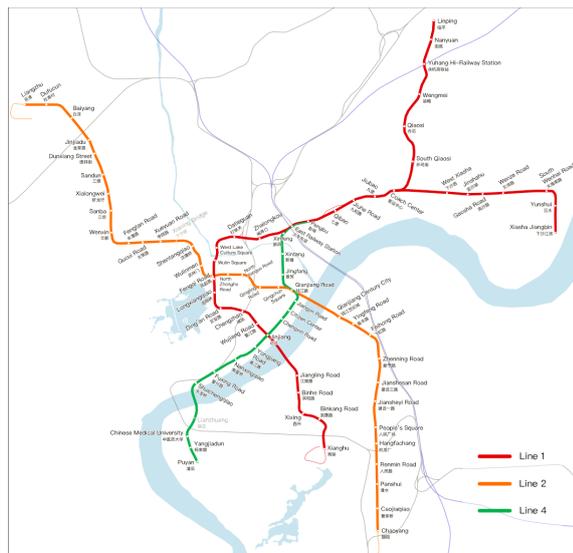
## Tasks

- Comprehensive 3D information acquisition of current tunnel status
- Analysis of tubbing deformation and tubbing displacement
- Set up of a database for tunnel damages with statistical reports

## Challenges

- Serious tunnel deformations because of weak geological conditions
- Demand for high accuracy
- Analysis of tunnel deformation of 3 mm
- Detection of crack width of 0.3 mm

## Highly accurate kinematic 3D damage detection for acceptance of tunnel section



Hangzhou Metro is a metro system that serves the Chinese city and the suburbs of Hangzhou in the Zhejiang Province. The system opened on 24 November 2012. It is the 17<sup>th</sup> city in China to operate a rapid transit system.

Line 2 of the Hangzhou Metro is a north-south rapid transit line, connecting the downtown area with the districts of Xiaoshan and Yuhang. The first phase of the line, between Qianjiang Road and Chaoyang stations,

entered in service on 24 November 2012 after six years of construction. It was extended to Gucui Road on 3 July 2017, and then to Liangzhu on 27 December in the same year.



«East China is one of the fastest-growing metro areas in the world. The increasing length of the network has posed great challenges in terms of tunnel maintenance. Our

company is a leading survey design and research institute and has extensive experience in the field of construction surveying. We manage a lot of projects in the field of operation and maintenance monitoring in the Hangzhou area. After a thorough investigation, we finally decided to use the Amberg GRP 5000 system. Due to the poor geological conditions, we needed a measurement system with the highest accuracy to minimize the risks and costs.

The GRP 5000 manufacturer and the distributor provide us efficient support, always respond fast and have developed tools to meet our special needs, which make the cooperation pleasant and easy.»

Jianjun Lu 卢建军  
Senior Surveying Engineer &  
Project Leader  
Huadong Engineering Corporation

### Amberg Technologies' products used

- Amberg GRP 5000 system with Amberg Profiler 6012
- Amberg Rail 3.0 software with the relative Clearance module
- Amberg TunnelMap software

### Customer benefits

- All in one solution for tunnel and railway
- Highest accuracy, resolution and reliability regardless of light conditions
- Visualisation of various types of damages: concrete spalling, water damage, cracks > 0.3 mm
- All the data can be digitized with Amberg TunnelMap
- Generation of statistics, reports and comparisons

### Contact

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## Analysis of tubbing deformation

The weak geological conditions such as soft soil layers, high underground water levels and extensive sludgy layers have caused various difficulties since the start of construction. Before the final acceptance, several hundred meters of tunnel had such deformations that the tubbing had to be strengthened with expensive metal rings. A measurement system providing higher accuracy allowed us to determine precisely the area of problems and thus save costs.

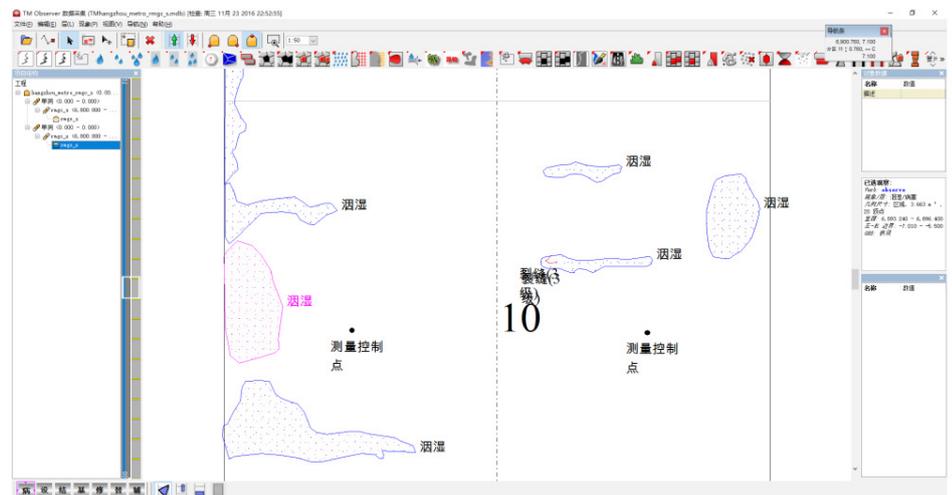
Methods	No. of Tubbing/hour	No. of Operator	Accuracy
Manual distance measuring	180	2	5mm
Total Station	5	2	3mm
GRP 5000	1250	3	3mm

Our evaluation of three methods showed that the GRP 5000 provides the best results with the highest performance.



## Evaluation of tunnel damages

The high performance Amberg Profiler 6012 with a rotation speed of 200 Hz provided us greyscale reflectivity images with 3 mm resolution, regardless of light conditions. Various damages such as concrete spalling, water damage, cracks wider than 0.3 mm etc. were made visible and could be digitized with the software Amberg TunnelMap. Furthermore, it was possible to visualize and compare statistics over certain areas or time periods.



## Conclusion

The kinematic 3D data acquisition with the GRP 5000 system simplified our workflow. It provided all the features we needed such as high accuracy, resolution and reliability regardless of light conditions. The collected data could be analyzed with various software tools for a wide range of applications. One single measurement underground – all data collected. One single manufacturer – all required software solutions for tunnel and railway applications.