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EMBRACING OUR SMART WORLD WHERE THE CONTINENTS CONNECT:

ENHANCING THE GEOSPATIAL MATURITY OF SOCIETIES

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# Control Survey for a 6.7km Immersed Tunnel in Chinese Lingding Ocean

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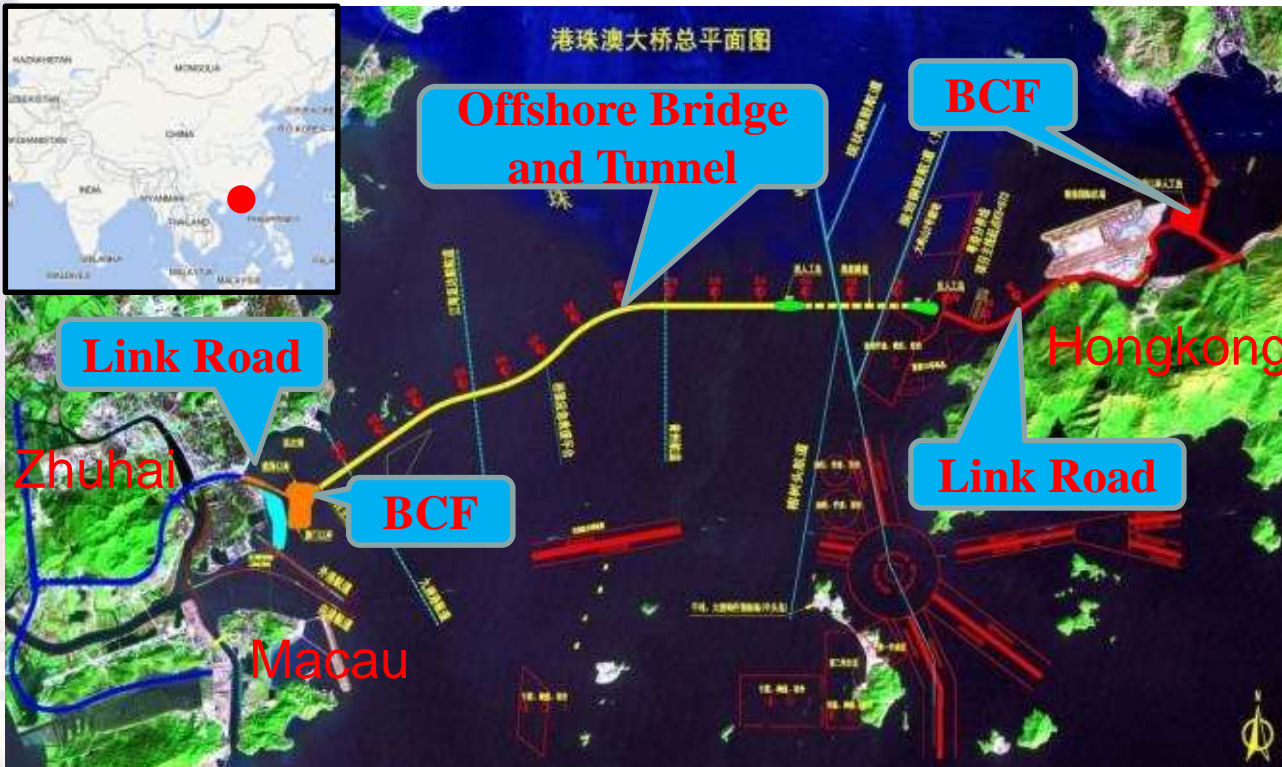
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## Introduction

## Hongkong-Zhuhai-Macau link

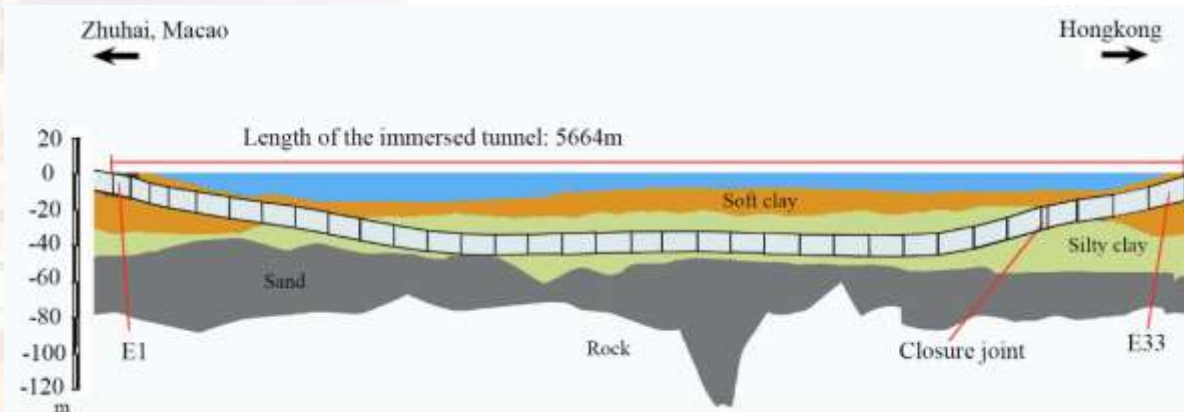
Located in south China;  
Bridge and tunnel combination;  
55 km;  
The island and tunnel section;  
7.4 km.



## Introduction

### The immersed tunnel

- Being offshore
- Connecting to small islands
- Immersed from the opposite directions
- Owning narrow inner space



**Tolerance error  
70 mm**



## Methods

### The breakthrough error

- The sum of two separate influences:  
surface and underground network

### Surface network

- Primary and densified network

### Underground network

- Configuration and gyro check

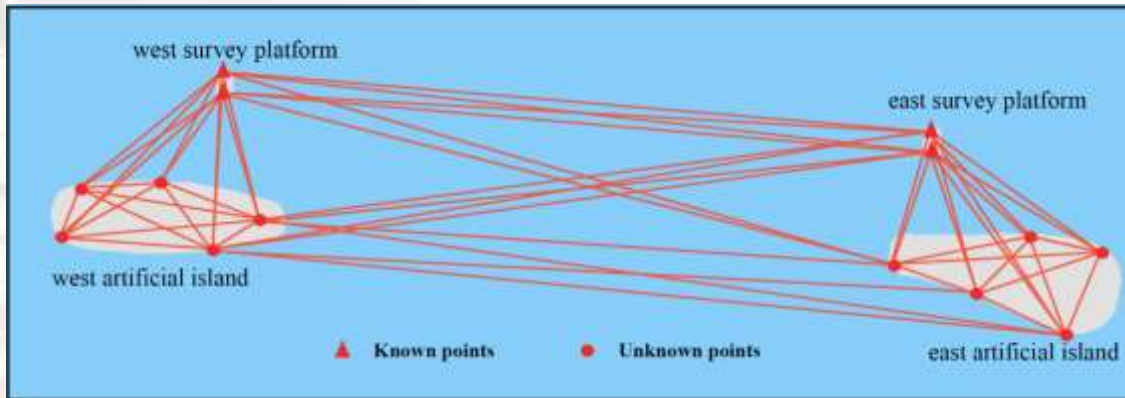


## Methods

### Densified network

- In artificial islands
- Significant settlement and displacement
- Point location changes

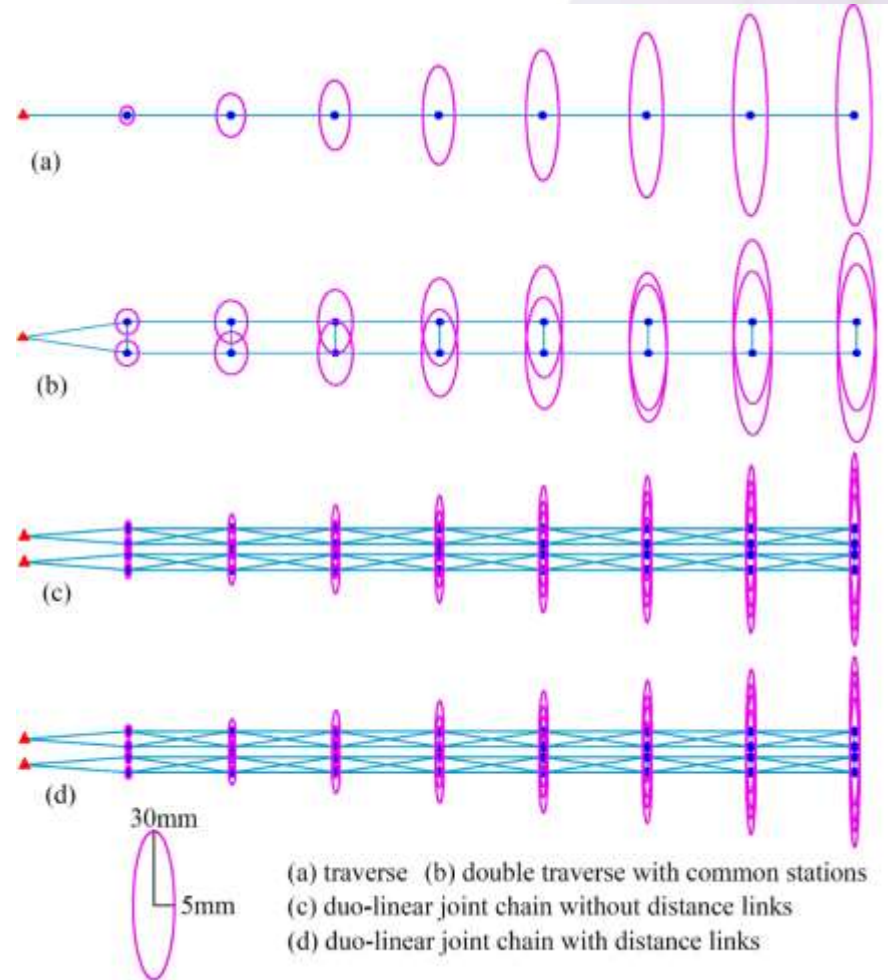
Relative horizontal positional:  
less than  $\pm 2\text{mm}$   
99% level of confidence



## Methods

### Underground network

- Simulations
- Duo-linear joint chain
- West leg length 720 m





## Methods

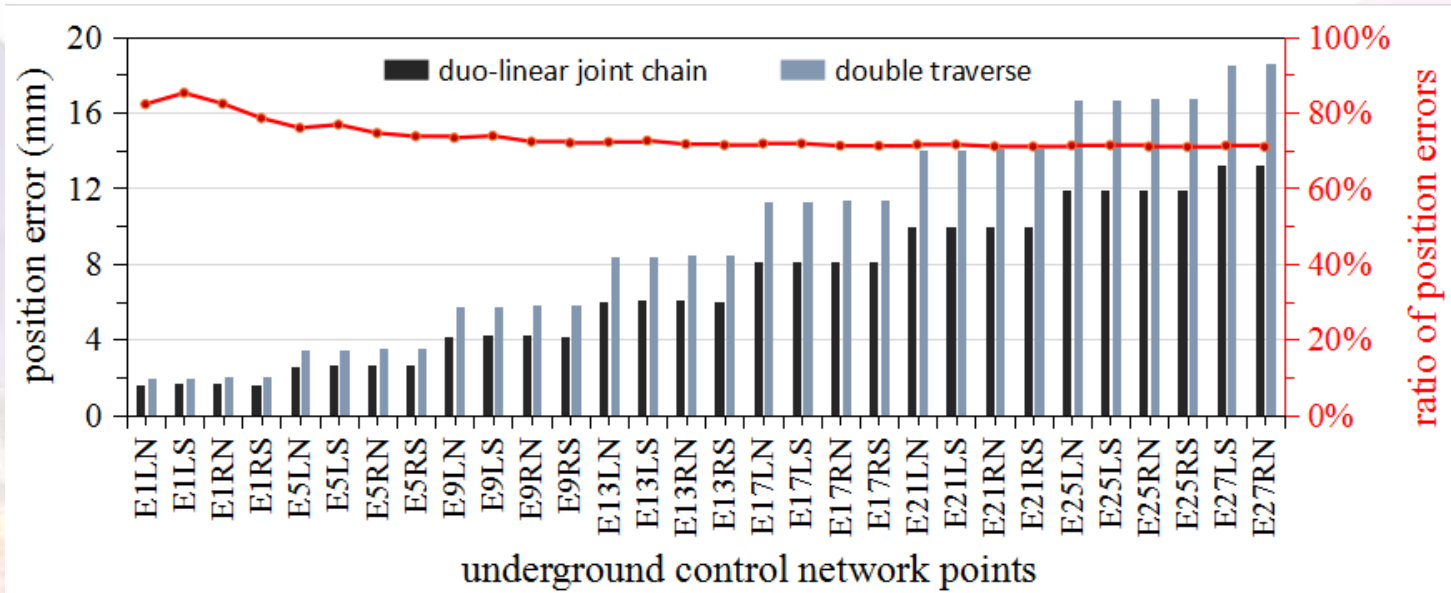
### Gyro check campaign

- Nominal accuracy  $\pm 3''$
- Three azimuths in the two bores
- Reciprocal observations
- In December 2015



From	To	Diff. of bearings (")	Length of network (Km)
E5LS	E9LN	0.07	2.16
E17RS	E20RN	0.09	4.14
E17LS	E20LS	0.11	4.14

## Measured Data Analysis



$$\text{ratio} = \frac{m_c}{m_t}$$

- ✓ The ratio is smaller than 85%;
- ✓ The ratio becomes smaller as the network length increases;
- ✓ The measured positional error of the last point is only 13 mm.





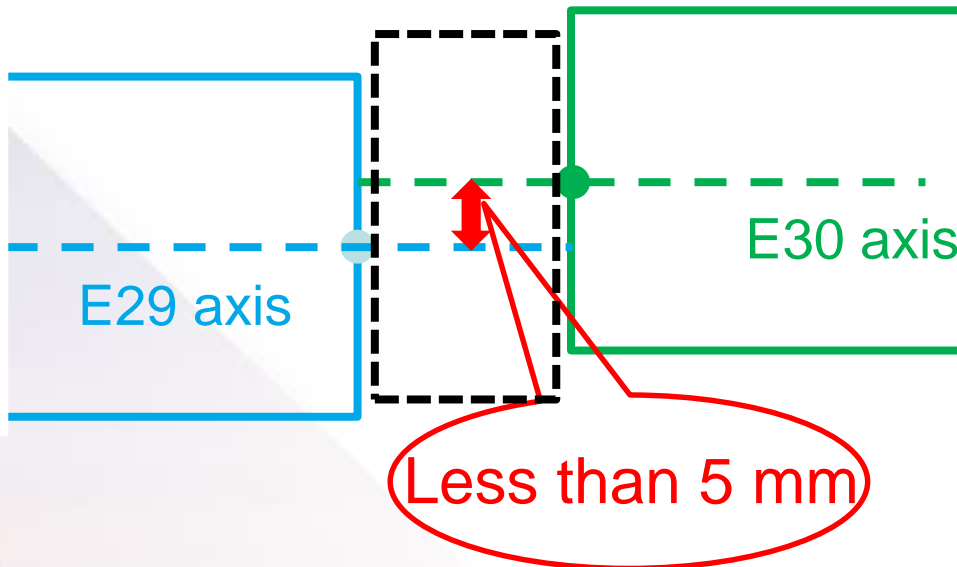
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## Results and Conclusions



Final breakthrough error: 12 mm!

Own higher precision; Be expanded to other precise engineering projects.

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# Thank You

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