

# Construction of Single-line Parallel Slurry Shield Tunnel Passing Directly under Private Constructions

— Kita Osaka Kyuko Line Extension Project —

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## Outline

To construct a single-line parallel railway tunnel directly under private building with small clearance (minimum clearance of 1.46m (about 0.2D)), shield tunneling has been done while strictly managing the face stability and back-fill grouting in order to prevent impacting on buildings (Figure 1).

## 1. Impact Analysis and Shield Tunneling Management

The behaviors of existing buildings to which the shield gets closer have been understood by 2D FEM analysis, and based on the results, managers had discussed and set the measurement control values. The standard values provided by "Recommendations for Design of Building Foundations" (Architectural Institute of Japan) were applied to the limit values for buildings other than high-rise condominiums. For the high-rise condominiums, a 3D FEM analysis was performed, and structural calculations were performed using the ground displacements obtained from the analysis as input values.

The structural details were entrusted to a high-rise condominiums design firm, and it was confirmed that the design criteria were satisfied. The ground displacement at that time was managed as the limits of the control values. During the implementation of the shield tunneling, face pressure and back-fill grouting pressure were changed in a planned way just before reaching the intermediate shaft and just after re-launching to monitor ground surface and ground displacement in the soil, and optimal control values for tunneling were set for each aboveground structure. In addition, in order to promptly feedback the measurement

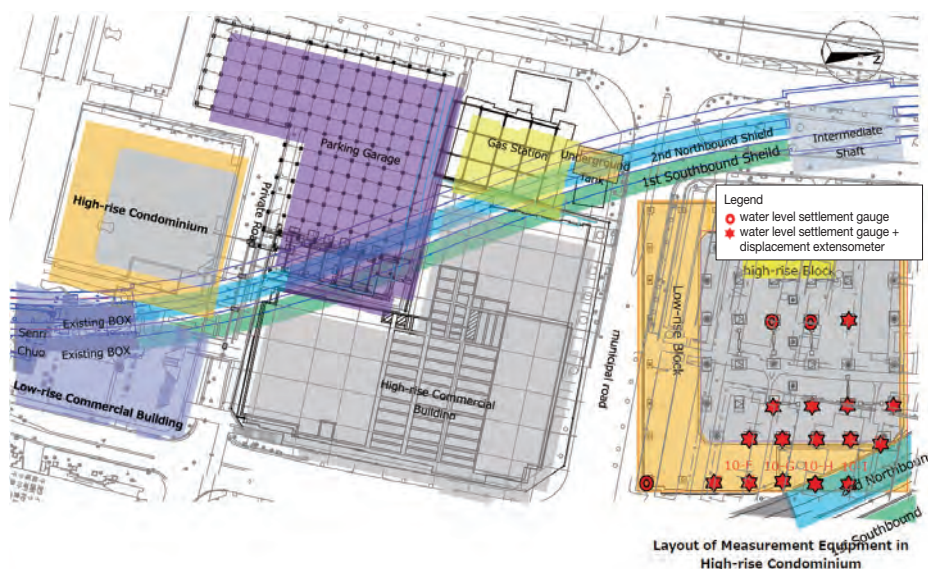
values to tunnelling management, automatic measurements were mainly taken in buildings above the shield passage area, while level surveys and 3D measurements were used where the passage crosses a road. Further, by injecting intermediate filling and using back-fill material that develops strength fast, ground settlement upon shield passage including the period of pausing tunneling and tail void settlement were controlled. When excavating near low-rise commercial buildings and high-rise condominiums in the vicinity of the arrival area, even small changes in face soil pressure or back-fill grouting pressure could affect the buildings due to the small soil cover. Therefore, the target grouting pressure was changed according to the earth cover, and grouting limits and upper and lower limits were set for strict construction management.

## 2. Result

Through those efforts described above, the shield tunneling was completed (Photo-1) without exceeding the displacement or control values predicted based on preliminary analyses (Table-1).

**Table 1** Table of Measured Foundation Displacement for High-rise Condominium

Measurement Point	10 Types of Low-rise Block				
	Max. Value	Min. Value	Primary Control Value	Secondary Control Value	Analysis Value
10-I	0.14mm	-1.78mm	+0.6mm -2.4mm	+0.8mm -3.4mm	+1.02mm -4.79mm
10-H	0.24mm	-0.47mm	+1.7mm -2.8mm	+2.4mm -3.9mm	+3.39mm -5.47mm
10-G	0.36mm	-0.42mm	+2.8mm -2.8mm	+3.9mm -3.9mm	+5.57mm -5.57mm
10-F	-0.07mm	-0.71mm	+0.6mm -1.2mm	+0.8mm -1.7mm	+1.06mm -2.32mm



**Fig. 1** Northern Part of Senri Chuo after Completion of Construction (new tunnel in the foreground, existing tunnel in the background)