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Commentaries

Key Issues on the Seismic Design of Roadway and Railway Viaduct Structures

Hajime Ohuchi*

Keywords: Displacement Ductility, Multi Directional Loading Effect, P-Δ Effect, Eccentric Axial Load Effect, Beam Column Joint, Footing

1. Introduction

Key Issues are described on the seismic design of Roadway and Railway viaduct structures focusing on following topics; 1)displacement ductility as seismic capacity index, 2)multi directional loading effect, 3)P-Δ effect, 4)eccentric axial load effect, and shear design of 5)beam column joint and of 6)footing.

2. Displacement Ductility as Seismic Capacity Index

Displacement ductility evaluation method is comparatively introduced based on curvature ductility in the roadway design, while on rotational capacity in the railway design. Relationship between curvature and displacement ductility is discussed dependent on plastic hinge length.

3. Multi Directional Loading Effect

In the current design standard, seismic performance is evaluated independently in the transverse and in the longitudinal directions. This chapter discusses load capacity and hysteretic characteristics dependent on bi directional loading history.

4. Eccentric Axial Load Effect

C type column bent as illustrated in Fig.1 is occasionally utilized in the urban area. Eccentricity provides torsional action in addition to horizontal loading. Torsional moment may deteriorate hysteretic characteristic in the more eccentricity case because of shear failure combined as illustrated in Fig.2.

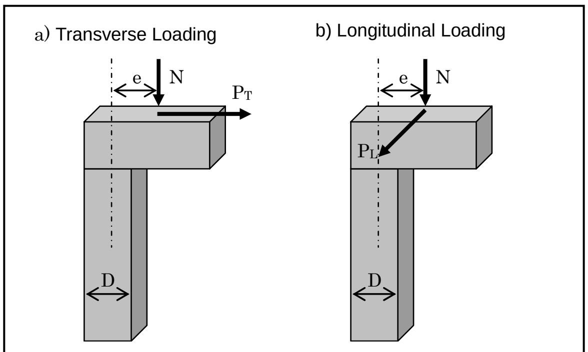

Fig.1 Flexural and Torsional Loading on to C Type Column Bent

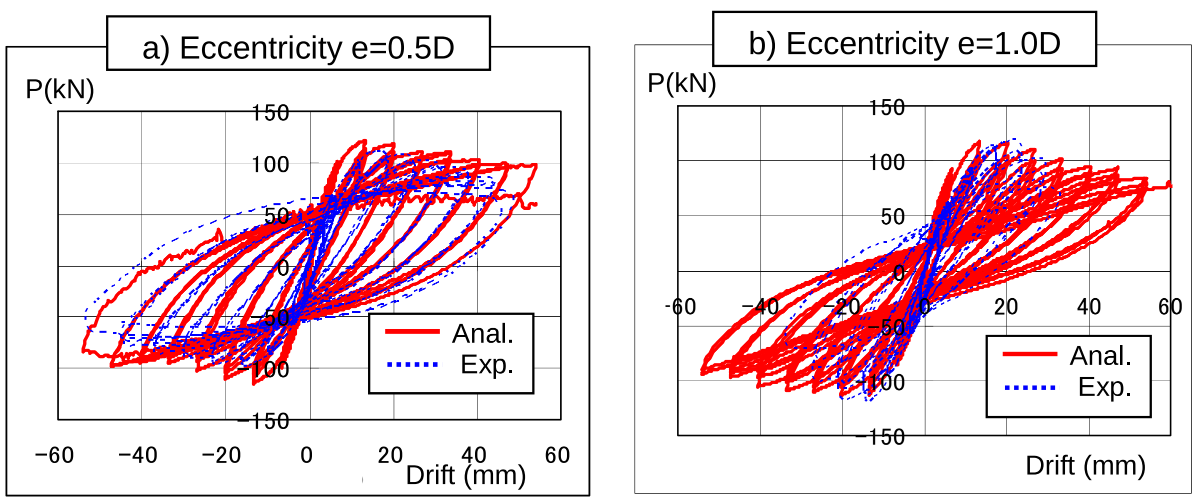

Fig.2 Load-Drift Relationship Dependent on Eccentricity with 1/5 Scale Model Specimen

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Technical reports

Evaluation of the filling of PC grout using nondestructive inspection techniques

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Keywords: PC grout, nondestructive inspection, impact elastic-wave method, impact-echo method

Abstract: When voids are left ungrouted, steel tendons in prestressing cables tend to be corroded by the water, salt or other matters penetrating into the sheath, ultimately being fractured. Fracture of tendons results in a reduced load bearing performance of the members as well as may cause a danger of accident to a third party as concrete debris falls due to the impact of fracture. Accurate evaluation of the filling of PC grout is therefore extremely important for the maintenance of prestressed concrete structures. Nondestructive inspection techniques are preferable for the PC grout evaluation due to no damage to the structures being inspected. Various methods have been developed in many fields and applied to investigations on existing bridges in recent years. This is a technical report on nondestructive inspection techniques for concrete based on elastic-wave methods, with a specific focus placed on impact elastic-wave method for transverse prestressing cables of concrete slabs and impact-echo method which is applicable to internal cables in the post-tensioning system.

Impact elastic-wave method: Impact elastic-wave method is a nondestructive inspection technique in which an elastic wave is generated by hitting the concrete surface with a hammer or spring pointer near an anchorage region of a steel tendon and the input wave and its output propagating to the other end are detected with acoustic emission (AE) sensors. This method takes advantage of the changes in elastic wave propagation behavior with the filling condition of grout and is applicable to checking the filling of grout for the full length of a transverse prestressing cable (Fig. 1).

Impact-echo method: Impact-echo method is a nondestructive inspection technique in which an elastic wave is generated by hitting the concrete surface with a small steel ball where a steel tendon is located and the reflected waves, or echoes, are detected with a sensor. Since echoes vary with presence or absence of air voids inside the sheath, ungrouted voids can be detected from the relationship between the echo frequency and the spectrum intensity (Fig. 2). This method allows checking the filling of grout for a specific portion inside a cable and is therefore suitable for the application to longitudinal and transverse prestressing cables.

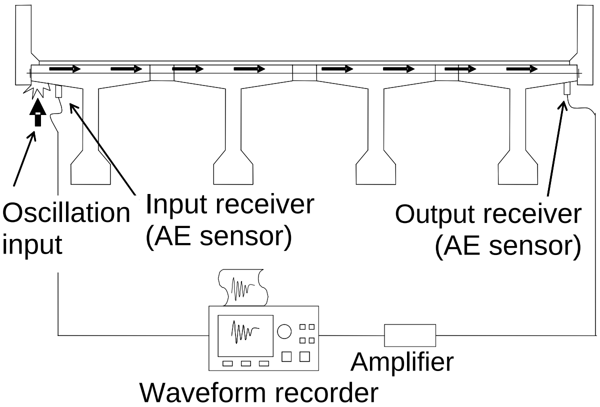

Fig. 1 Impact elastic-wave method

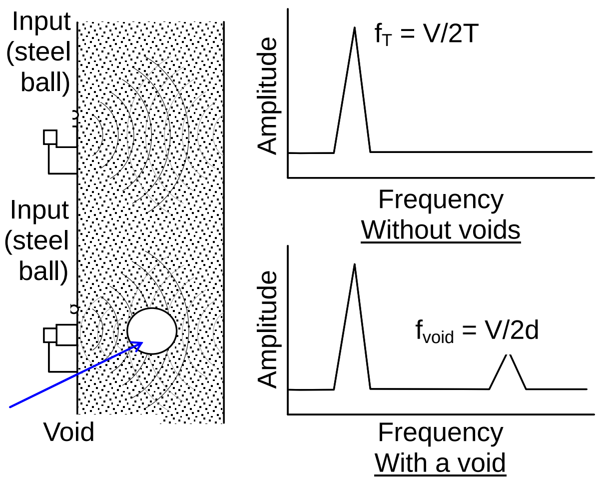

Fig. 2 Frequency response characteristics with and without voids

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Construction records

Efficient Structure Construction Using Unitized Precast Concrete Members and Three-dimensional CAD Technology

— Relocation and New Construction of Yamada Red Cross Hospital —

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Keywords: workability improvement, three-dimensional CAD, mechanical joint, rebar detailing study, column-beam connection, unitized, use of precast concrete

This project is featured by the five-story low-rise building that blends in with the townscape of Ise. The shape of the first and second level floor plans is a regular square measuring 134 meters each side, while the third and upper level floor plans are diamond-shaped, formed by rotating the lower floor plan shape 45 degrees, which all together makes the plan shape of the whole building complicated.

To construct this uniquely shaped building, we used three-dimensional CAD and other brand-new technologies and considered workability in our study during the design stage in order to ensure the structure quality. Specifically, our efforts during the design stage included the study of rebar detailing at the column-beam connections, and use of precast concrete members, prefabricated rebars and mechanical joint and anchorage methods. Other various techniques employed in the construction phase also contributed to ensuring the structure quality.

Fig.1 Perspective rendering: building appearance

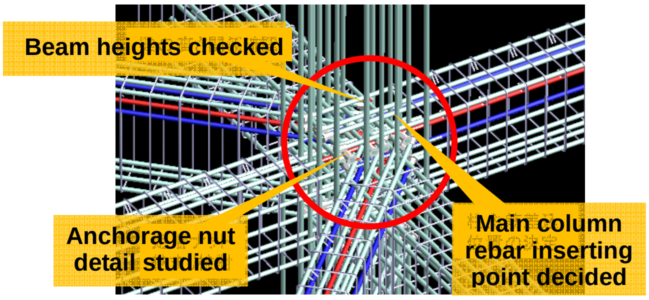

Fig.2 Rebar detailing study: Connection of diagonal beams to PC sub-beams

Placement of column rebar unit

Placement of cross beam unit (diagonal)

Mechanical joint installation

Placement of PC sub-beam

Installation of Ferro (reinforced) deck plate unit

Installation of PC balcony floor panel

Fig.3 Unitized and/or PC member construction process

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