VANCOUVER SKYTRAIN - SURREY EXTENSION
SEISMIC ANALYSIS

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1. INTRODUCTION

The seismic analysis of the 1 km section of elevated guideway located on the south side of the Fraser River presented a unique soils - structure interaction design problem.

The structure consists of a series of two and three span guideway sections, plus a single four-span cross-over section. The inbound and outbound guideways are independently supported on separate columns, which share common rectangular foundation footings supported on 50m long steel pipe piles.

2. DESIGN RESPONSE SPECTRUM AND SITE CONDITIONS

The suggested acceleration response spectrum supplied by B.C. Transit indicated somewhat higher response coefficients than the equivalent NBC spectrum, and a preliminary "inverted pendulum" analysis of the structures indicated natural periods close to the "corner" of the response spectrum at 0.5 seconds.

Soils investigation revealed approximately 10 -12 m of fine fibrous peat and very soft organic silty clays overlying increasingly more competent materials. Becker hammer drill logs showed zero blow counts in the peaty material with pressuremeter tests indicating shear modulus values in the order of 1 - 2 MPa. This information gave concern that significant relative movement could be expected between the piles and soft peat layer in the event of a seismic occurrence; in effect creating an additional flexible "storey" in the structure.

On the basis of the foregoing it was decided that a dynamic analysis was required to more accurately determine seismic design forces on the structure.

3. DYNAMIC MODELLING

A lumped mass model was developed to simulate the behaviour of the structure under seismic loading. The computer program used for analysis was IMAGES 3D, a micro-based three dimensional structural analysis program with modal seismic response capabilities. Design ground motion was input in the form of a response spectrum. In addition to the usual beam end releases the program simulates spring/mass elements at nodes as well as spring-to-ground elements.

The "peat" lumped masses were arbitrarily set to be much larger than the foundation mass such that varying the peat mass did not affect the results. Peat-peat and ground-peat spring stiffnesses were determined from the shear value of the peat and the layer depth. The foundation peat spring stiffness was determined from the usual expressions for foundation slab on a half space, while translatory and rotatory spring stiffnesses of the foundation slab were derived from structural properties of the piles.

4. RESULTS OF ANALYSES

Analysis was carried out for a range of soil parameters and variations in structural configuration. Predicted displacements were compared with the results of "SHAKE" analyses performed on the same general soil column with approximately the same base accelerations.

Results indicated that seismic deflections would control the pile design and that the piles should be framed into the foundation slab to ensure full development of the column overstrength moments. The columns themselves were designed for ductile behaviour and detailed to confine the concrete core in regions of plastic hinging during an earthquake.