AN APPROACH TO MODEL REINFORCED CONCRETE CHIMNEYS FOR CALCULATING INELASTIC DYNAMIC RESPONSE

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SYNOPSIS

Inelastic response of a reinforced concrete chimney is obtained by representing the complex hysteresis behavior by two conventional elasto-plastic types.

DISCUSSION OF ANALYSIS AND RESULTS

In a recent investigation Sun(1) studied the moment-curvature behavior of hollow circular sections of reinforced concrete chimneys under reversed cyclic loading. The results showed that the hysteresis behavior can be quite complex and it is influenced by a number of variables most important being the material stress-strain properties, the relative amount of reinforcement and the magnitude of axial force.

An actual 1200 ft. tall chimney is divided into ten equal segments. Each segment is represented by two bending elements following a conventional elasto-plastic hysteresis behavior. The properties of these elements are selected such that the resultant hysteresis loops in moment-curvature terms at the eleven nodal sections are close to those predicted by using Sun's approximate formulas(1). The masses are lumped at the nodal points. The response of this model is then computed by using DRAIN-2D program developed at the University of California, Berkeley. Horizontal ground accelerations of NS component of the El Centro 1940 earthquake multiplied by factors of one and two are used to compute the response of the chimney.

Elastic response of the chimney as computed by the above procedure was very close to that in which the chimney is treated as a continuum and nodal superposition is used. The inelastic response due to one times El Centro motion produced a maximum horizontal displacement of 4.1 ft. at the top and slight inelastic deformation in the upper portion. Due to double the ground acceleration, however, there were considerable inelastic deformations over the entire height of the chimney. Also, the top of the chimney drifted laterally by more than 50 ft. with yielding at the base occurring as early as 2 seconds in the response. Nevertheless, the strains in concrete did not exceed the ultimate value of .003. It should be mentioned that the model as used in this study is a first attempt at the suggested approach and does not represent deterioration of the hysteresis loops. More sophisticated elements will have to be used to model the observed hysteresis loops more accurately.

REFERENCE

1. Sun, Ru-T., "Inelastic Behavior of Reinforced Concrete Chimneys," Ph.D. Thesis, The University of Michigan, Ann Arbor, Michigan, 1974.

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