EARTHQUAKE ANALYSIS OF A TV TOWER STRUCTURE

by

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SYNOPSIS

The paper presents results of modal earthquake analysis of a TV Tower structure consisting of a stiff concrete lower shaft and a slender upper steel portion. From the mode shapes, it can be seen that for such composite structures, the addition of a light slender top portion degenerates each mode of vibration of the stiff shaft into two modes. This fact should be recognized before one uses only the first few modes for calculating design forces.

All India Radio is constructing a 200 m high TV Tower at Jullunder about 200 miles from New Delhi. This is the first concrete TV tower in India. Dynamic (modal) analysis of the tower structure was carried out to assess its response to earthquake forces.

The tower consists of a 127 m high hollow concrete tapered shaft and a steel space truss structure for the upper 73 metres. Inside the concrete portion, there is a seperate concrete lift shaft which is connected to the main tower at intervals. There is also a viewing gallery and restaurant near the top of the concrete portion.

The full tower (including the steel portion and the lift shaft) was idealized as a 25 degrees of freedom system and its natural frequencies and mode shapes were obtained. Using the average spectrum of the Indian Code[1], the forces in each mode and the most probable design forces were obtained.

An interesting feature of the study was the behaviour of this special structure which consists of a very stiff and heavier lower concrete shaft topped by a very slender and light upper steel tower. From figure 1 it is seen that in the first two modes, the lower shaft by itself is vibrating only in its first mode. In the 3rd and 4th modes the lower shaft is vibrating in its second mode and so on. Thus due to addition of the slender and lightweight upper steel portion, it can be said that each mode of vibration of the lower shaft is degenerated into 2 modes. Since a major contribution to the lateral forces will come from the heavy lower shaft, the contribution of the first two modes of the composite structure will be equivalent to the first mode contribution of a regular structure and so on.

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Thus, for calculating lateral forces for design if one were to use only the first three modes (as recommended by the Indian Code) results would not be correct for such composite structures. In the present structure, we should use at least the first six modes. Similar behavior has also been observed by the authors from modal analysis of other structures such as composite silos, Preheater Towers of cement plants etc. where the mass and stiffness distribution is irregular with wide variations.

It is therefore recommended that for all structures including multistoreyed buildings with irregular mass and stiffness distribution, the various mode shapes should be studied before determining the number of modes to be used for calculating design lateral loads.

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1 "Criteria for Earthquake Resistant Design of Structures" IS 1893-1970, Indian Standards Institution, New Delhi.

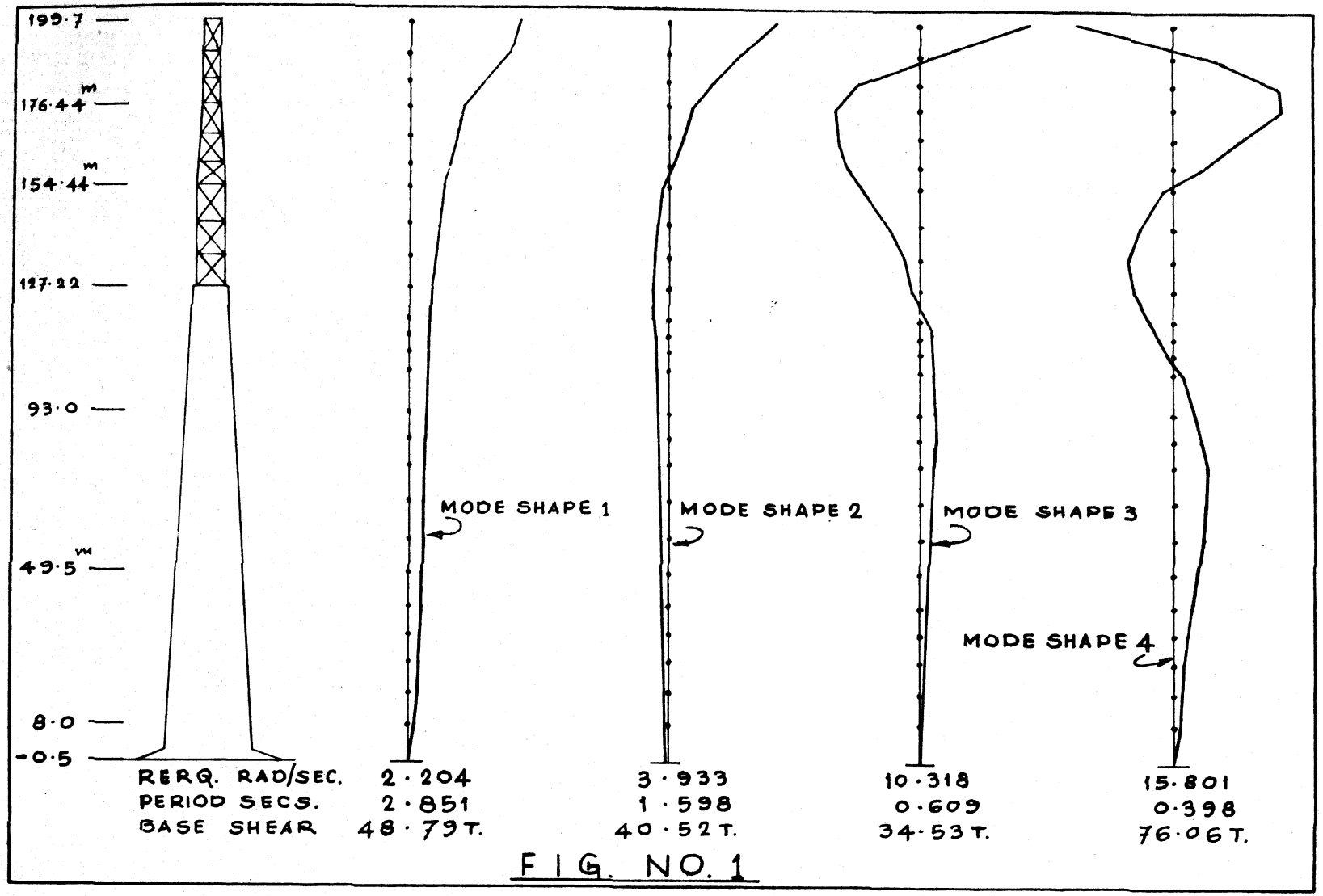
199·7
176·44 m
154·44 m
127·22
93·0
49·5 m
8·0
-0·5
MODE SHAPE 1
MODE SHAPE 2
MODE SHAPE 3
MODE SHAPE 4
RERQ. RAD/SEC. 2·204 3·933 10·318 15·801
PERIOD SECS. 2·851 1·598 0·609 0·398
BASE SHEAR 48·79T. 40·52T. 34·53T. 76·06T.

FIG. NO. 1