Exploring the Effect of Expansion Joints Spacing in Concrete Multistory

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Summary

Temperature and shrinkage effects may cause cracks and additional stresses in the structural components of concrete buildings. In order to limit the undesirable effects of temperature and shrinkage, it is recommended by many building codes to use expansion joints in long buildings. In this study the effect of temperature and shrinkage on multistory buildings was explored. 3D finite element models were constructed for multistory buildings with different lengths and heights, and analyzed using various temperature loads. A factor termed in this study the temperature design ratio was developed to evaluate the maximum spacing between expansion joints that can be used with out including temperature effects in the analysis. This factor was calculated by comparing the design obtained using temperature and vertical loads to that obtained using vertical loads alone. Different factors affecting the response of the structure to temperature strains were also studied.

Keywords: Temperature; shrinkage; concrete; expansion joints; multi-story buildings; thermal load.

1. Introduction

Temperature and shrinkage effects may cause considerable strain changes in concrete buildings. This in turn may cause cracks in the non-structural elements affecting the aesthetics of the building. Temperature and shrinkage effects can also cause additional stresses in the structural components of the building. In order to limit the undesirable effects of temperature and shrinkage, it is recommended by many building codes to use expansion joints in long buildings. Unfortunately, there is a large variation in the recommendations regarding this matter. These recommendations are based on empirical formulas, engineering judgment, and research dating 30 to 40 years back. The National Academy of Sciences report no. 65 [1] provided guidelines for expansion joint spacing based on an unpublished experimental study performed by the structural Engineers in the Public Building Administration which examined the displacement in nine federal buildings in Washington D.C. during a one year period (1943-1944), as well as an analytical study performed on 2D multistory frames. Expansion joint spacing ranging from 60 m to 180 m can be obtained from the guideline provided by the report depending on the expected temperature change, air conditioning, and the connection at the base of the columns. Although the report [1] is easy to use, it doesn't take the effect of the column and beam stiffness into consideration. Martin and Acosta [2] provided two equations for calculating the maximum expansion joint spacing allowed for the structure. The first equation took into consideration the effect of the beam and column stiffness as well as the magnitude of the temperature change. The second equation was based on serviceability requirement limiting the maximum story drift to 1/180 of the column height. The study was based on an analytical study of a series of multi-bay single story 2D frames subjected to gravity and thermal loads. The study was based on the assumption that design loads due to the combined effects of vertical and thermal loads can be taken as 75% of that obtained due to the vertical loads alone. The load factors used in the equation was based on the ACI318-63 code [3]. Varyani and Radhaji [4] studied the effect of temperature on single and multi-story frames to obtain recommendations for expansion joint spacing for multi-story buildings. The study was based on 2D multi-bay frames with fixed supports, subjected to

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