Title: Effects of Column Creep and Shrinkage in Tall Structures-Prediction of Inelastic Column Shortening

Author(s): Mark Fintel and Fazlur R. Khan

Publication: Journal Proceedings

Volume: 66

Issue: 12

Pages: 957-967

Keywords: columns supports) ; creep properties; frames; high-rise buildings; multi-story buildings; loads (forces); reinforced concrete; shrinkage; strains; structural design.

Date: December 1, 1969

Abstract:

A procedure for prediction of the amount of creep and shrinkage strains is outlined based on the present state of the art. Consideration is given to the loading history of columns in multistory buildings which receive their load in as many in-rements as there are stories in the building, thus considerably reducing the creep as compared to a single load application. Also, volume-to-surface ratio of sections and the effect of reinforcement on the creep and shrinkage is considered.

Title: Influence of Column Shortening in Reinforced Concrete and Composite High-Rise Structures

Author(s): M. M. Elnimeiri and M. R. Joglekar

Publication: Special Publication

Volume: 117

Pages: 55-86

Keywords: columns (supports); composite construction (concrete and steel); concrete construction; cracking (fracturing); creep properties; deformation; high-rise buildings; loads (forces); load transfer; measurement; serviceability; structural design; Construction

Date: October 1, 1989

Abstract:

Differential elastic, creep, shrinkage, and thermal deformations of vertical concrete elements, columns, and walls in tall building structures require special attention to insure proper behavior for both strength and serviceability of the structure and the attached nonstructural elements. The long-term serviceability problems include out-of-level floors in both concrete and composite buildings, and cracking and deformations of internal partitions and external cladding elements. A procedure is developed to predict the long-term deformations of reinforced concrete columns, walls, and composite columns. The procedure incorporates the effects of concrete properties, construction sequence, and loading history. For composite columns, the effects of load transfer from the steel erection column to the reinforced concrete column are also included. Methods to minimize differential shortening of columns and walls are discussed. The methods involve corrections during both design and construction phases. Differential shortening effects for three tall buildings, in Chicago, which were designed using the procedure, are discussed. Results from six years of field measurements of column shortening are compared with predicted values.

Title: Shortening of High-Strength Concrete Members

Author(s): Henry G. Russell

Publication: Special Publication
Volume: 121
Pages: 1-20
Keywords: beams (supports); columns (supports); compressive strength; creep properties; deformation; high-strength concretes; modulus of elasticity; shrinkage; strains; Structural Research
Date: November 1, 1990

Abstract:
When high-strength concretes are used in high-rise buildings, long-span bridges, and offshore structures, special attention must be given to the dimensional changes that occur in the concrete members. For design purposes, the length changes are usually considered to consist of instantaneous shortening, shrinkage, and creep. Instantaneous shortening depends on stress level, cross-sectional dimensions of the member, and modulus of elasticity of steel and concrete at the age when the load is applied. Shrinkage deformations generally depend on type and proportions of concrete materials, quantity of water in the mix, size of member, amount of reinforcement, and environmental conditions. Creep deformations depend on concrete stress, size of member, amount of reinforcement, creep properties of concrete at different ages, and environmental conditions. In recent years, questions have been raised about the validity of methods for calculating deformations in high-strength concrete members and the in-place properties of high-strength concrete members. These properties include compressive strength, modulus of elasticity, shrinkage, and creep. This paper reviews existing state-of-the-art technology concerning instantaneous shortening, shrinkage, and creep of high-strength concrete members.

Title: Designing for Effects of Creep and Shrinkage in High-Rise Concrete Buildings

Author(s): D.J. Carreira and T.D. Poulos

Publication: Special Publication
Volume: 246
Pages: 107-132
Keywords: age-adjusted modulus; column shortening; concrete; creep; creep superposition; differential shortening; elevation corrections; high-rise structures; modulus of elasticity; shrinkage
Date: September 1, 2007

Abstract:
Differential shortening caused by creep and shrinkage of reinforced concrete columns and shear walls affects the serviceability of high-rise buildings. For structures up to 30 stories or 400 ft (120 m) high, the effects of creep and shrinkage are usually ignored without serious consequences. For reinforced concrete buildings beyond 30 stories, and for shorter buildings of hybrid or mixed construction, ignoring the effects of creep and shrinkage may create several undesirable conditions in the serviceability of the structure.

Owners of high-rise concrete buildings are aware of the potential for undesirable behaviors in service in both structural and in nonstructural elements from the effects of differential shortening of columns and shear walls. Examples include sloping floors; cracking of structural members and interior partitions; buckled elevator guide rails, misaligned elevator stops relative to floors, and damage to façade elements and plumbing risers. To minimize these behaviors, the structural engineer is challenged to predict, design for, and adjust for differential shortening in each of the structural components during construction, as well as forecast future behaviors.

Title: Creep and Shrinkage and the Design of Supertall Buildings-A Case Study: The Burj Dubai Tower

Author(s): W.F. Baker, D.S. Korista, L.C. Novak, J. Pawlikowski, and B. Young

Publication: Special Publication

Volume: 246

Pages: 133-148

Keywords: Burj Dubai; column shortening; creep; gravity sidesway; high-rise; shrinkage; vertical shortening

Date: September 1, 2007

Abstract:

The Burj Dubai tower, which is currently under construction, will be the world's tallest structure. This paper addresses the structural system utilized for the Burj Dubai tower and the structural design implications of creep and shrinkage of the high performance reinforced concrete vertical load carrying elements.