Prestress losses

CSI Software calculates prestress loss according to the friction and anchorage loss parameters specified. Losses from elastic shortening and long-term effects, including creep, shrinkage, and relaxation, are computed for tendons which are modeled as objects, and may be specified for those modeled as loads.

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Overview

The prestress losses which may be accounted for within SAP2000 include the following:

- Immediate losses which occur before and during transfer:
  - Anchorage set (slip)
  - Elastic shortening
  - Friction loss due to length (wobble) and curvature effects
- Long-term losses:
  - Concrete creep
  - Concrete shrinkage
  - Steel relaxation

Short-term losses

Short-term losses are described as follows:

Anchorage set

Slip from anchorage setting is a user-defined parameter. This loss is not uniformly distributed along the length of the tendon. Instead, the affected length is calculated as a function of friction loss as follows:

\[ L_{\text{set}} = \left( \frac{A_{PS} E_P}{P_{0}} \right) \]

where:

- \( L_{\text{set}} \) = anchorage set
- \( A_{PS} \) = tendon cross-sectional area
- \( E_P \) = tendon elastic modulus
- \( P_0 \) = frictional loss as a change in force per unit length, calculated from a tendon-force variation diagram

Elastic shortening

Losses from elastic shortening are automatically computed for tendons which are modeled as objects.

Friction losses

Tendon force is greatest at the jacking end, and decreases with distance from the end because of the friction which occurs during jacking between the tendon and the duct. Friction loss has two components, including the length or wobble effect and the curvature effect. Tendon force \( P_x \) at the distance \( x \) from the jacking end can be expressed as follows:

\[ P_x = P_0 e^{(\mu + K x)} \]

where:

- \( P_0 \) = tendon force at the jacking end
- \( \mu \) = curvature friction coefficient
- \( K \) = wobble friction coefficient
- \( x \) = position along tendon from jacking end

Long-term losses
To evaluate long-term losses, **staged construction** must be run with dependent material properties. Based on the material model selected for the time-dependent behaviors associated with creep, shrinkage, and steel relaxation, long-term losses are automatically calculated.

### Concrete creep

The material model available to *creep* behavior is as follows:

- Ceb-Fip Model Code 1990

### Concrete shrinkage

The material model available to *shrinkage* behavior is as follows:

- Ceb-Fip Model Code 1990

### Steel relaxation

The material model available to steel relaxation is as follows:

- Ceb-Fip Model Code 1990

### References