

## CHAPTER 2 LOADS AND LOAD COMBINATIONS

**2.1 Loads**

The following loads are to be considered in structural design.

- Dead load (  $G$  )
- Live load (  $Q$  )
- Snow load (  $S$  )
- Wind load (  $W$  )
- Earthquake load (  $E$  )
- Temperature load (  $T$  )
- Earth or hydraulic pressure (  $H$  )
- Other loads

**2.2 Basic Load Values**

The following basic load values, which represent the characteristic intensity of loads, are to be determined.

- The basic dead load (G) is the nominal dead load, or is determined according to actual conditions.
- The basic live load (Q) is the 99 percentile non-exceedance live load under normal conditions, or is a corresponding value if it is difficult to statistically evaluate.
- The basic snow load (S) is the 100-year-return-period snow load, based on ground snow depth.
- The basic wind load (W) is the 100-year-return-period wind load, based on mean wind speed.
- The basic earthquake load (E) is the 100-year-return-period earthquake load, based on the horizontal peak ground acceleration on the engineering bed rock.
- The basic temperature load (T) is the 100-year-return-period wind load under normal conditions, or is a corresponding value if it is difficult to statistically evaluate.
- The basic earth pressure and hydraulic pressure (H) is the 99 percentile non-exceedance values in normal conditions or a corresponding.
- The basic values of other loads are the ones evaluated as in the above.

## 2.3 Load combinations and load factors

### 2.3.1 Basis of Load combinations

- (1) Load combinations for design and assessment of buildings or parts are to be selected based on the required performance level of the buildings or the parts.
- (2) The required performance level of buildings or parts must be determined by designers based on importance, sociality, economy, relevance to existing design codes, etc.
- (3) Loading states to be considered are, according to actual conditions, as follows,
  - Normal states
  - State of live loading
  - State of snow load
  - State of strong wind
  - State of earthquake
  - State of temperature change

### 2.3.2 Load combination for Limit State Design (LSD) format

- (1) When designing a building and/or a structural member, the following limit state shall be considered appropriately for each load combination.
  - Safety limit state
  - Serviceability limit state
- (2) A target performance level shall be defined using a target reliability index considering the predetermined reference period.
- (3) Load combinations shall be considered as the sum of the products of the load effect corresponding to the basic value of each load and the load factor as,

$$\gamma_p S_{pn} + \sum_k \gamma_k S_{kn} \quad (2.1)$$

in which  $S_{pn}$ ,  $S_{kn}$  are the load effects due to the basic value of the principal load and the  $k$ -th secondary load, respectively, and  $\gamma_p$ ,  $\gamma_k$  are the load factors for the respective loads.

Load factors shall be determined appropriately considering the limit state, the target reliability index, the variability in the load effect of each load and resistance, the probability of load coincidence, etc.

### 2.3.3 Load combination for allowable stress design and ultimate strength design

Combinations of loads used for allowable stress design and ultimate strength design are to be taken based on service life, importance, failure consequence of buildings and properties of each load such as variability, occurrence frequency and duration time, and design loads factored by the return period conversion factor are used. Subsection 2.3.2 may also be applied for ultimate strength design.

(1) Loading states to be considered

Loading states to be considered in allowable stress design are to be categorized into either long-term or short term loading state according to loading period and are based on 2.3.1(3). Snow load during strong wind or earthquakes are to be taken according to actual conditions. Loading states to be considered in ultimate strength design are also based on 2.3.1(3).

(2) Return period conversion factor

The return period conversion factors below are to be used the design return period  $r$  different from 100 year period. The return period conversion factors for dead, live, and temperature loads are to be calculated according to actual conditions.

a. Case of snow load

For the case of non-controlled roof snow, the return period conversion factor  $k_{rS}$  equals the following.

$$k_{rS} = \begin{cases} 0.36 + 0.14 \ln(r) & : \text{heavy snowy area} \\ 0.08 + 0.20 \ln(r) & : \text{other area} \end{cases} \quad (2.2)$$

b. Case of wind load

For calculation of wind load, the return period conversion factor  $k_{rW}$  is the following

$$k_{rW} = 0.63 (\lambda_U - 1) \ln(r) - 2.9 \lambda_U + 3.9 \quad (2.3)$$

where  $\lambda_U = U_{500}/U_0$  is a ratio of the 10 minute mean wind speed corresponding to 500 year return period to the basic wind speed (refer to Appendix 6.1.7).

c. Case of earthquake load

For calculation of earthquake load, the return period conversion factor for peak ground acceleration  $k_{rE}$  equals to the following.

$$k_{rE} = \left( \frac{r}{100} \right)^{1/k} \quad (2.4)$$

where  $k$  represents regional statistical characteristics of seismic hazard (refer to 7.2.2).