# JCSS PROBABILISTIC MODEL CODE
# PART 3: RESISTANCE MODELS

## 3.11 EXCENTRICITIES

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**List of symbols:**

| | |
|---|---|
| $\rho(i,j)$ | = coefficient of correlation for two columns i and j |
| e | = average eccentricities |
| f | = central eccentricity due to curvature |
| $\phi$ | = out of plumbness |
| $\mu$ | = mean |
| $\sigma$ | = standard deviation |

### 3.11.1 Introduction

The bearing capacity of slender elements depends to some extend on the difference between the actual and theoretical lining, the so called excentricity. In this section we will present the models for the excentrities of columns in braced and unbraced frameworks.

### 3.11.2 Basic model

In the analysis three types of eccentricities can be distinguished (see figure 3.11.1)

- the average excentricity
- the initial curvature
- the out of plumbness $\phi$

For the braced frame the out of plumpness is only relevant for the bracing system, but not for the column under consideration; for the unbraced frame especially the out of plumpness is usually dominant over the end point eccentricity and the curvature.

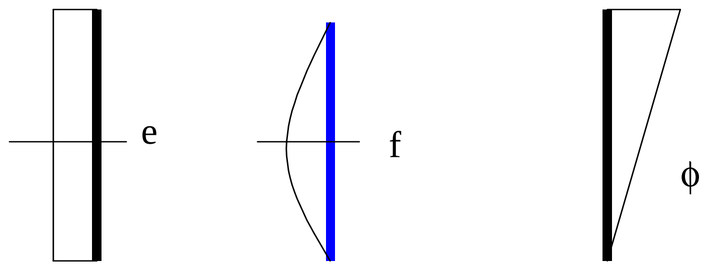


Figure 3.11.1: The three basic excentiricties e, f and $\phi$

### 3.11.3 Probabilistic models

*Distribution type, mean and scatter*

The probabilistic model for the three basic parameters are presented in Table 3.11.1. For all three cases it is assumed that the distribution is symmetrical around zero and that small eccentricities are more likely than large ones, although large ones are more dangerous. Note that in special cases non-symmetrical cross sections may have $\mu(f) \neq 0$ due to the fabrication process.

In many cases only the absolute values of the excentricities are important. From the table it can be derived that these absolute values are distributed with a truncated normal distribution, the truncation point being the mean of the untruncated distribution. The absolute value has a mean of about 0.80 times the standard deviation of the untruncated distribution; the coefficient of variation is 0.75.

| X | description | type | $\mu$ | $\sigma$ |
|---|---|---|---|---|
| | | | | |
| e | average excentricity | normal | 0 m | L/1000 |
| f | out of straightness | normal | 0 m | L/1000 |
| $\phi$ | the out of plumbness | normal | 0 rad | 0.0015 rad |

Table 3.11.1 statistical properties for excentricities (for steel and concrete columns)

All eccentricity parameters e, f and $\phi$ shall be regarded as independent variables.

*Time and spatial dependency*

In general eccentricities may be treated as being time independent. An exception might be timber where in particular the initial curvature may depend on the moisture content.

For the spatial fluctuation the dependency between various columns in one building is important. In this code the average eccentricity e as well as the out of straightness f will be considered as being uncorrelated for all members. For $\phi$ the following correlation pattern is recommended:

$\rho(\phi_i,\phi_j) = 0,5$ for two columns on the same floor
$\rho(\phi_i,\phi_j) = 0$ for columns on different floors

In this model some possible negative correlation between columns in vertical direction, resulting from (over) corrections for out of plumbness on lower storeys is not considered. This is a conservative assumption.

**Note on applications**

The limit state function for a simple slender column, clamped at the bottom and free at the top, may be presented as:

$$Z = M_p - \frac{P_E}{P_E - P} P\phi h$$

$M_p$ = plastic moment
P = vertical load
$P_E$ = Euler buckling load
h = height of the column

### 3.11.4. References

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