JCSS PROBABILISTIC MODEL CODE
PART 2 - LOAD MODELS

2.1 SELF WEIGHT

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List of symbols:

d   = correlation length
V   = volume described by the boundary of the structural part

γ = weight density of the material.
γ_{av} = average weight density for a structural part
ρ_o = correlation between two far away points in one member
Δr = distance between two points within a member

2.1.1 Introduction

The self weight concerns the weight of structural and non-structural components. The main characteristics of the self weight can be described as follows:

- The probability of occurrence at an arbitrary point-in-time is close to one
- The variability with time is normally negligible
- The uncertainties of the magnitude is normally small in comparison with other kinds of loads.

Concerning the uncertainties one can distinguish between (hierarchical model):

- variability **within** a structural part
- variability **between** different structural parts of the same structure
- variability **between** various structures

The variability within a structural part is normally small and can often be neglected. However, for some types of problem (c.g. static equilibrium) it may be important.

2.1.2 Basic model

The self weight, G, of a structural part is determined by the relation

$$G = \int_{Vol} \gamma \, dV \qquad (1)$$

where:

V is the volume described by the boundary of the structural part. The volume of V is Vol.
γ is the weight density of the material.

For a part where the material can be assumed to be reasonably homogeneous eq. (1) can be written

$$G = \gamma_{av} V \qquad (2)$$

where

γ_{av} is an average weight density for the part (see further section 2.1.4).

2.1.3 Probability density distribution functions

The weight density and the dimensions of a structural part are assumed to have Gaussian distributions. To simplify the calculations the self weight, G, may as an approximation be assumed to have a Gaussian distribution.

2.1.4 Weight density

Total variability

Mean values, μ_γ, and coefficients of variation, V_γ, for the total variability of the weight density of some common building materials are given in table 2.1.1.

Table 2.1.1. Mean value and coefficient of variation for weight density [1]

Material	Mean value [kN/m^3]	Coefficient of variation
Steel	77	< 0.01
Concrete		
Ordinary concrete [2]	24	0.04
High strength concrete	24-26 [4]	0.03
Lightweight aggregate concrete	[4]	0.04-0.08
Cellular concrete	[4]	0.05-0.10
Heavy concrete for special purposes	[4]	0.01-0.02
Masonry	-	≈ 0.05
Timber [3]		
Spruce, fir (Picea)	4.4	0.10
Pine (Pinus)	5.1	0.10
Larch (Larix)	6.6	0.10
Beech (Fagus)	6.8	0.10
Oak (Quercus)	6.5	0.10

[1] The values refer to large populations. They are based on data from various sources.

[2] The values are valid for concrete without reinforcement and with stable moisture content. In case of continuous drying under elevated temperature the stable volume weight after 50 days is 1.0-1.5 kN/m^3 lower.

[3] Moisture content 12%. An increase in moisture content from 12% to 22% causes a 10% rise in weight density.

[4] Depends on mix, composition and treatment

Spatial correlations

Between densities of two points within one member, the following correlation can considered to be present:

$$\rho(\Delta r) = \rho_o + (1-\rho_o) \exp \{-(\Delta r/d)^2\} \tag{3}$$

where

d   is a so called correlation length which characterises the correlation structures
Δr is the distance between two points within a member
ρ_o correlation between two far away points in one member

Only correlation in the length dimensions of a structural part are of importance. For beams the weight density over the cross section and for plates over the height may be considered as fully correlated.

Between points in two different members, but within one building, a constant correlation ρ_m is assumed to be present.

In the absence of more detailed information the following values can be used:

d	10 m (beam/column)
	6 m (plate)
	3 m (volume)
ρ_o	0.85
ρ_m	0.70

Note: For large members the variability of the weight density may be taken as $V \rho_o$; for a whole structure consisting out of many members the variability may be taken as $V \rho_m$, where V is the total variability according to table 2.1.1.

2.1.5 Volume

In most cases it may be assumed that the mean values of the dimensions are equal to the nominal values i.e. the dimensions given on drawings, in descriptions etc. The mean value of the volume, V, of the structural parts is calculated directly from the mean values of the dimensions.

The standard deviation of the volume, V, is calculated directly from the values of the standard deviation for the dimensions. Standard deviations for cross section dimensions are given in table 2.1.2 for some common building materials and types of structural elements.

Table 2.1.2. Mean values and standard deviations for deviations of cross-section dimensions from their nominal values.

Structure or structural member	Mean value	Standard deviation
Rolled steel		
steel profiles, area A	$0.01 A_{nom}$	$0.04 A_{nom}$
steel plates, thickness t	$0.01 t_{nom}$	$0.02 t_{nom}$
Concrete members [2]		
$a_{nom} \leq 1000$ mm	$0.003 a_{nom}$	$4 + 0.006 a_{nom}$
$a_{nom} \geq 1000$ mm	3 mm	10 mm
Masonry members		
unplastered	$0.02 a_{nom}$	$0.04 a_{nom}$
plastered	$0.02 a_{nom}$	$0.02 a_{nom}$
Structural timber		
sawn beam or strut	$0.05 a_{nom}$	2 mm
laminated beam, planed	≈ 0	1 mm

[1] The values refer to large populations. They are based on data from various sources and they concern members with currency acceptation dimension accuracy.
[2] The values are valid for concrete members cast in situ. For concrete members produced in a factory the deviations may be considerably smaller.

The variability within a component (e.g. the variability of the cross section area along a beam) may be treated according to the same principles that is presented for the weight density in section 2.1.4.

Reference

CIB W81, Actions on Stuctures, Self weight, Report no. 115, Rotterdam