
International Standard



4355

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Bases for design of structures — Determination of snow loads on roofs

Bases du calcul des constructions — Détermination de la charge de neige sur les toitures

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4355 was developed by Technical Committee ISO/TC 98, *Bases for design of structures*, and was circulated to the member bodies in November 1978.

It has been approved by the member bodies of the following countries :

Australia	Hungary	Poland
Austria	India	Portugal
Belgium	Ireland	South Africa, Rep. of
Canada	Israel	Spain
China	Italy	Sweden
Czechoslovakia	Japan	Turkey
Denmark	Korea, Rep. of	United Kingdom
Egypt, Arab Rep. of	Netherlands	USSR
France	New Zealand	Yugoslavia
Germany, F.R.	Norway	

The member body of the following country expressed disapproval of the document on technical grounds :

Switzerland

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Bases for design of structures — Determination of snow loads on roofs

0 Introduction

The intensity and distribution of snow load on roofs may be described as functions of climate, topography, shape of building, roof surface material, heat flow through the roof and time. Since sufficient data describing these functions are not available, it is not possible at present to treat the problem by the theory of probability. As a consequence, for this International Standard, it has been decided to treat the problem in a semi-probabilistic way.

The characteristic snow load on a roof area, or any other area above ground which is subject to snow accumulation, is in this International Standard defined as the product of the characteristic snow load on the ground¹⁾, s_0 , specified for the region considered and the nominal shape coefficient, μ , applicable to the particular roof area considered. Other methods for estimating snow load on roofs will not be treated here.

In order to apply this International Standard, each country will have to establish maps and/or other information concerning the geographical distribution of ground snow load in that country. Procedures for a statistical treatment of meteorological data are described in annexes A and B.

The shape coefficients will depend on climate (especially duration of snow season), wind, local topography, geometry of the building and surrounding buildings, roof surface material, building insulation, etc. The snow can be redistributed as a result of wind action; melted water can flow into local areas and refreeze, and snow can slide or can be removed.

1 Scope and field of application

This International Standard specifies methods for the determination of snow load on roofs.

It is intended to serve as a basis for the development of national codes for the determination of snow load on roofs.

National codes may supply statistical data of the ground snow load in the form of zone maps or tables.

The shape coefficients presented in this International Standard are prepared for design application, and may thus be directly adopted for use in national codes, unless justification for other values is available.

For examining the effect of the wind on the distribution of snow loads on roofs of unusual shapes or shapes not dealt with in this International Standard or in national standards, suitable tests carried out in a wind tunnel especially equipped for reproducing accumulation phenomena may give significant results.

Specification of standard procedures and instrumentation for measurements will not be dealt with in this International Standard.

2 Definitions and symbols

2.1 characteristic snow load on the ground, s_0 (in pascals²⁾): The load which is not to be exceeded towards unfavourable values on the average once in T_r years, (i.e. extreme load of T_r years return period).

NOTE — A return period is the average interval, in years, between events which equal or exceed a given magnitude.

2.2 value of snow load on roofs, s (in pascals): The product of the characteristic snow load on the ground and an appropriate shape coefficient.

It refers to a horizontal projection of the area of the roof.

2.3 μ_i (dimensionless): Nominal values of the shape coefficient, taking into account snow drift, sliding snow, etc., with subscripts if necessary.

2.4 l_i (in metres): Horizontal dimensions (see 5.2), with numerical subscripts if necessary.

2.5 h_i (in metres): Vertical dimensions (see 5.2), with numerical subscripts if necessary.

2.6 β_i (in degrees): Angular dimensions (see 5.2), with numerical subscripts if necessary.

1) In meteorology the term "weight of the ground snow cover" is also used.

2) 1 Pa = 1 N/m².

3 Snow load on roofs (s)

3.1 Methods for the determination of the snow load on roofs

In this International Standard, the snow load on roofs is calculated by the formula :

$$s = \mu s_0$$

in which the characteristic snow load on the ground, s_0 , is determined as described in clause 4, and the shape coefficient, μ , is given in clause 5.

NOTES

1 Other methods for the determination of the nominal snow load on roofs, for example long-term direct measurements, will not be treated here. Although such methods may prove to be more reliable, sufficient data are not yet available to such an extent that standardization would be of practical use.

2 The possibility of eventual impact loading on multi-level roofs due to slide should be considered by the designer.

3.2 Partial loading due to melting, sliding and snow removal

If more severe imbalances may be expected from snow removal, sliding, melting, etc. than those given in clause 5 and if other information is not available, the nominal snow load shall be applied with the load intensities according to clause 5 on any given portion of the roof area and zero load on the remainder of the area.

4 Characteristic snow load on the ground (s_0)

4.1 Method for the determination of the characteristic snow load on the ground

The characteristic snow load on the ground, s_0 , is determined by statistical treatment of either directly measured snow load on the ground or, more usually, other meteorological data in the area in question.

Snow load measurements on the ground should be taken in a well sheltered area, e.g. in a deciduous forest.

Methods for the determination of the characteristic snow load on the ground, s_0 , are described in annexes A and B.

For practical application, the characteristic snow load on the ground will be defined in standard step values, which will yield

basic values for the preparation of zone maps as described in 4.2.

4.2 Snow zones and maps

The methods described in annexes A and B yield basic values for a subdivision of a country into zones with constant s_0 -values. It should be noted that on a small scale, a map cannot show local differences in climate even where these are known to exist. This should be noted particularly for mountainous areas, where snow load on the ground is known to increase with elevation. Observations from meteorological stations at different altitudes may serve as a guide.

When drawing a map for a standardized value of T_r , isolines or zones should be constructed to include the following set of values for the characteristic snow load on the ground (in kilopascals) :

$$0,3 - 0,5 - 0,7 - 1,0 - 1,5 - 2,0 - 2,5 - \dots$$

5 Shape coefficients

5.1 General principles

In perfectly calm weather, falling snow would cover roofs and the ground with a uniform blanket of snow, and the design snow load could be considered as a uniformly distributed load. Truly uniform loading conditions, however, are rare and have usually only been observed in areas that are sheltered on all sides by high trees, buildings, etc. In such a case the shape coefficient would be equal to unity.

In most regions, snowfalls are accompanied or followed by winds. The winds will redistribute the snow, and on some roofs, especially multilevel roofs, the accumulated drift load may reach a multiple of the ground load. Roofs which are sheltered by other buildings, vegetation, etc., may collect more snow load than the ground load. This phenomenon is of the same nature as that illustrated for multilevel roofs in 5.2.4.

Additionally, one has to consider the sliding effect on pitched roofs. Sliding of snow depends on the thermal conditions in the roof, surface roughness, the roof angle and existing obstructions.

So far sufficient data are not available to determine the shape coefficient on a statistical basis. Therefore, a nominal value is given. A representative sample of roofs is shown in 5.2. However, special cases such as strip loading, cleaning of the roof periodically by deliberate heating of the roof, etc., have to be treated separately (see 3.2).

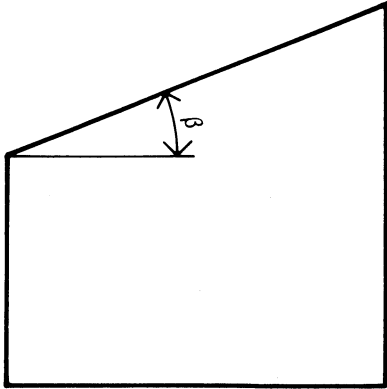
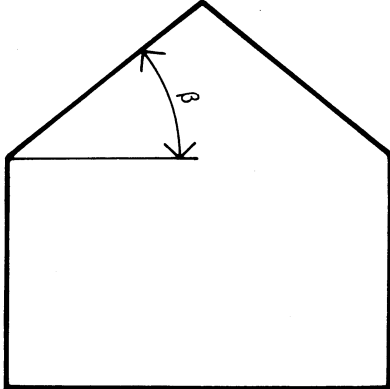

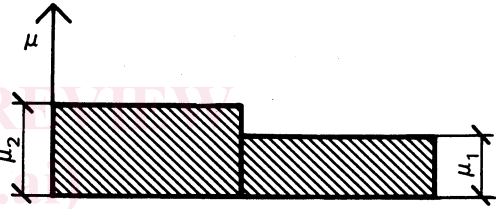
The distribution of snow in the direction parallel to the eaves is assumed to be uniform.

5.2 Shape coefficients for selected types of roofs

5.2.1

Simple flat and monopitch roofs

Simple pitched roofs (positive roof slope)¹⁾

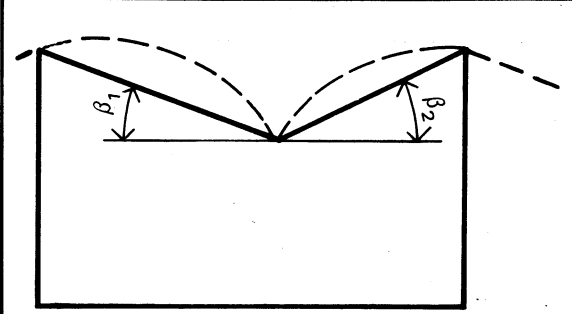
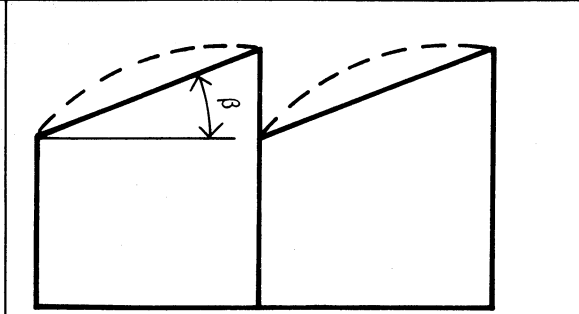
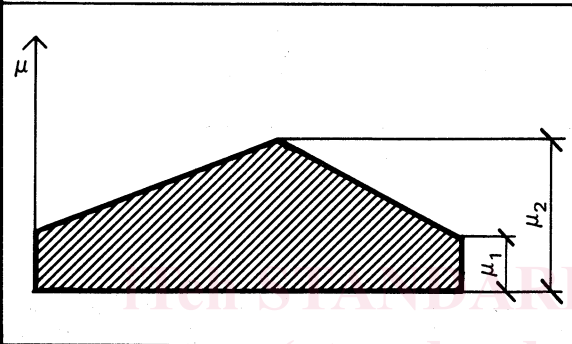
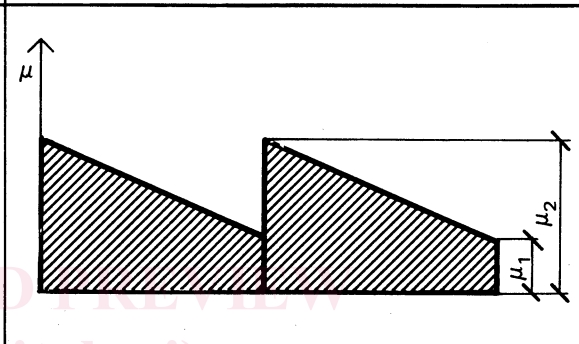
		
		
$0^\circ < \beta < 15^\circ$	$\mu_1 = 0,8$	$\mu_2 = \mu_1 = 0,8$
$15^\circ < \beta < 30^\circ$	$\mu_1 = 0,8$	$\mu_2 = 0,8 + 0,4 \left(\frac{\beta - 15}{15} \right)$ $\mu_1 = 0,8$
$30^\circ < \beta < 60^\circ$	$\mu_1 = 0,8 \left(\frac{60 - \beta}{30} \right)$	$\mu_2 = 1,2 \left(\frac{60 - \beta}{30} \right)$ $\mu_1 = 0,8 \left(\frac{60 - \beta}{30} \right)$
$\beta > 60^\circ$	$\mu_1 = 0$	$\mu_2 = \mu_1 = 0$

1) For asymmetrical simple pitched roofs, each side of the roof shall be treated as one half of corresponding symmetrical roofs.

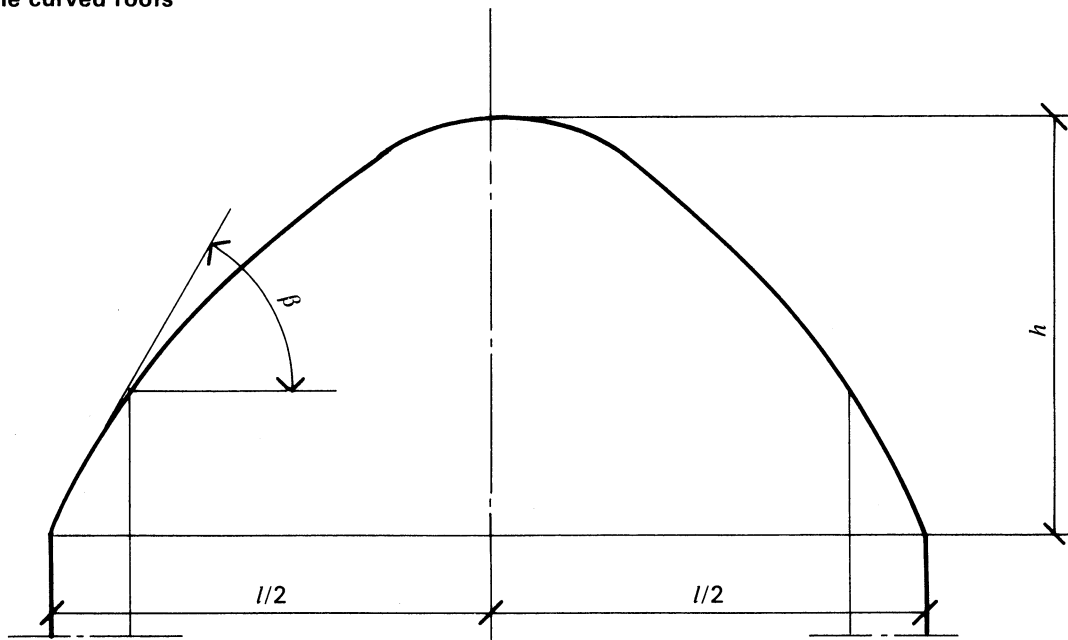
5.2.2

Simple or multiple pitched roofs
(negative roof slope)

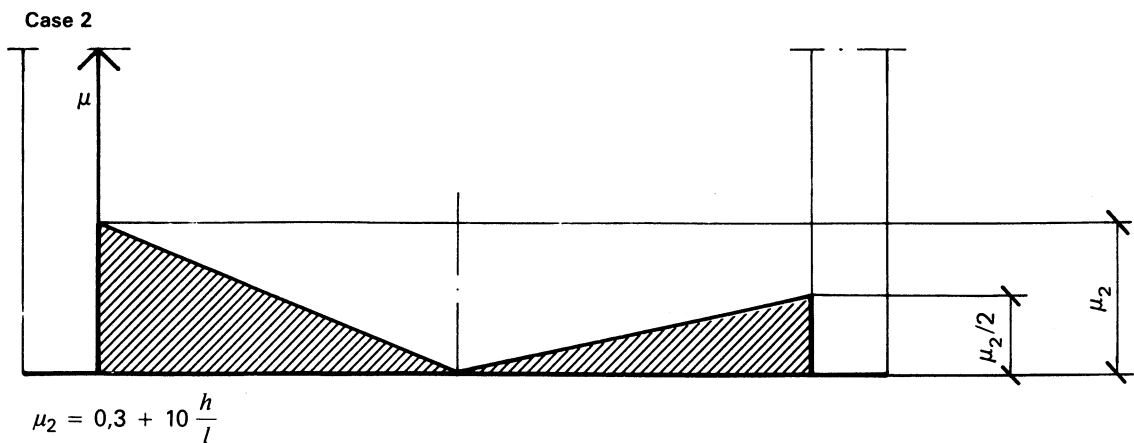
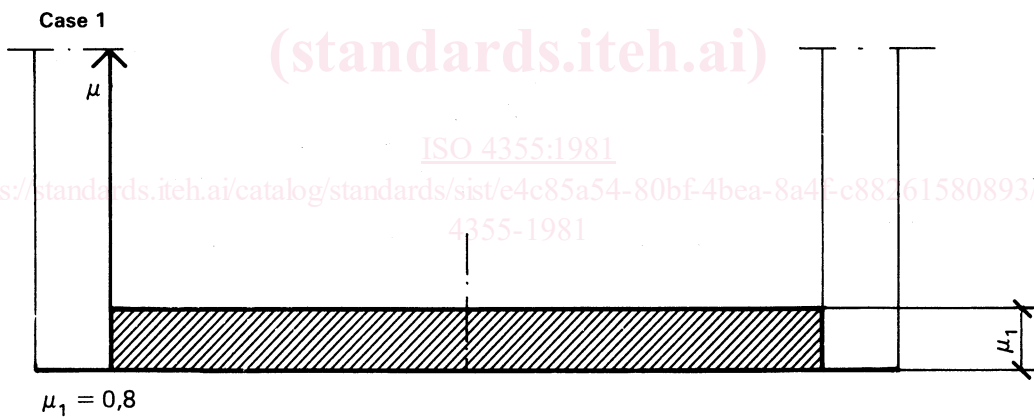
Two-span or multispan roofs

 $\beta = \frac{\beta_1 + \beta_2}{2}$		
		
$0^\circ < \beta < 30^\circ$	$\mu_2 = 0,8 \left(\frac{30 + \beta}{30} \right)$ $\mu_1 = 0,8$	$\mu_2 = 0,8 \left(\frac{30 + \beta}{30} \right)$ $\mu_1 = 0,8$
$30^\circ < \beta < 60^\circ$	$\mu_2 = 1,6$ $\mu_1 = 0,8 \left(\frac{60 - \beta}{30} \right)$	$\mu_2 = 1,6$ $\mu_1 = 0,8 \left(\frac{60 - \beta}{30} \right)$
$\beta > 60^\circ$	$\mu_2 = 1,6$ $\mu_1 = 0$	$\mu_2 = 1,6$ $\mu_1 = 0$

5.2.3 Simple curved roofs



The following cases, 1 and 2, must be examined :

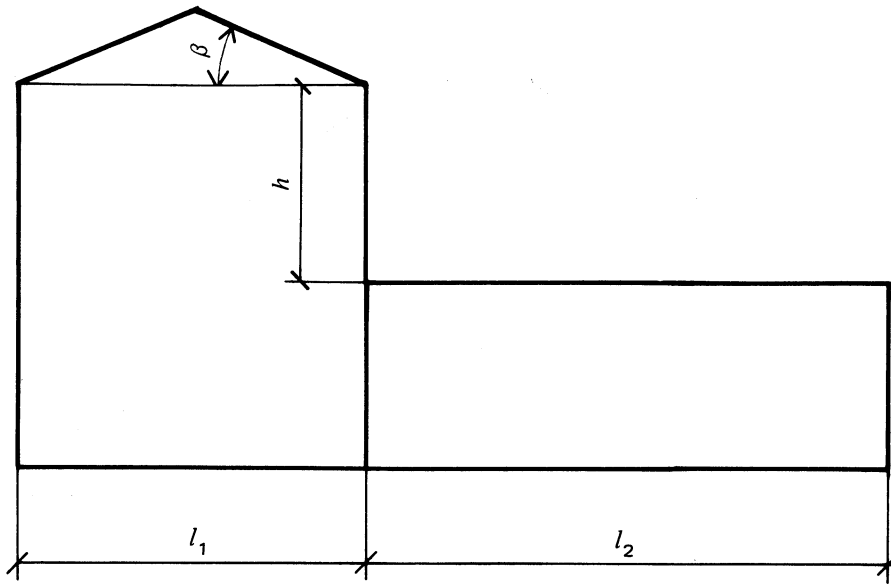


Restriction :

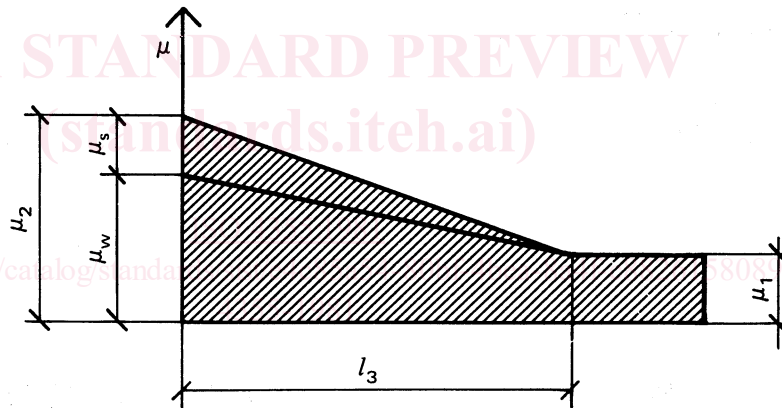
$\mu_2 < 2,3$

$\mu = 0$ if $\beta > 60^\circ$

5.2.4 Multilevel roofs¹⁾



$\mu_1 = 0,8$
 $\mu_2 = \mu_s + \mu_w$
 where
 μ_s : due to sliding
 μ_w : due to wind



$l_3 = 2 h^2$) but is restricted as follows :

$5 \text{ m} < l_3 < 15 \text{ m}$

$$\mu_w = \frac{l_1 + l_2}{2 h} < \frac{kh}{s_0}$$

with the restriction $0,8 < \mu_w < 4,0$

where

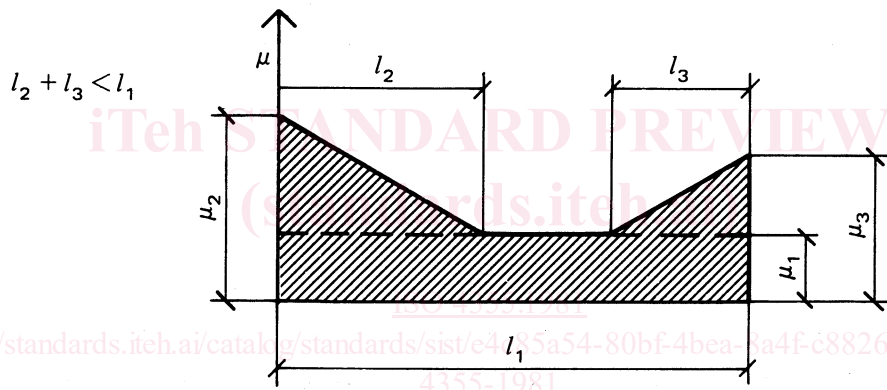
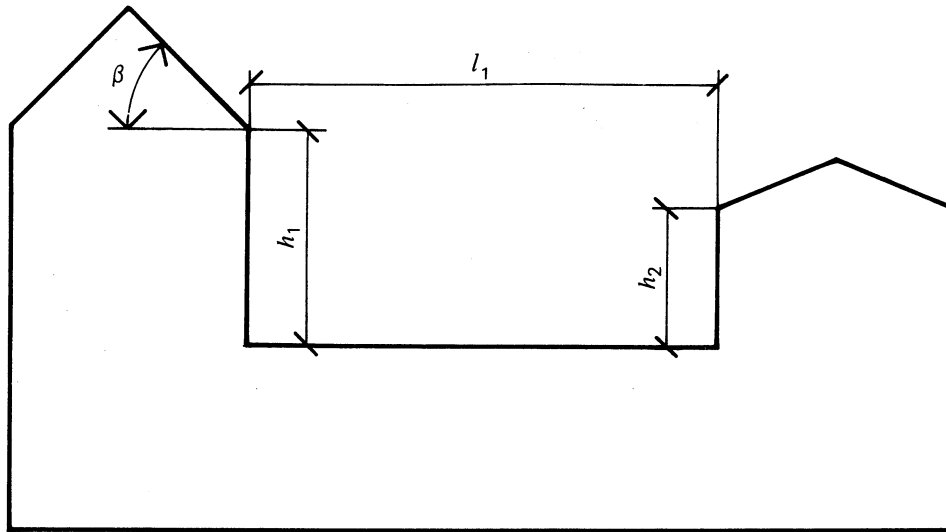
- h is in metres
- s_0 is in kilopascals (kilonewtons per square metre)
- $k = 2 \text{ kN/m}^3$

$\beta > 15^\circ$: μ_s is determined from an additional load amounting to 50 % of the maximum total load on the adjacent slope of the upper roof³⁾, and is distributed linearly as shown on the figure.

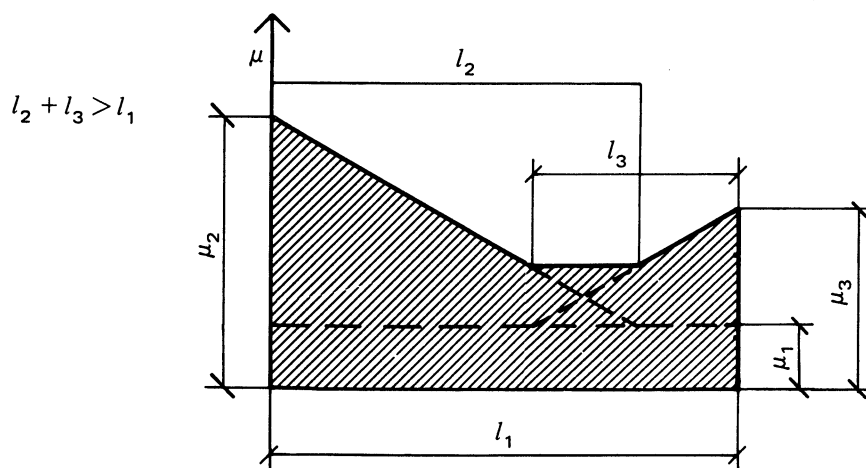
$\beta < 15^\circ$: $\mu_s = 0$

1) A more extensive formula for μ_w is described in annex C.
 2) If $l_2 < l_3$ the coefficient μ is determined by interpolation between μ_1 and μ_2 .
 3) The load on the upper roof is calculated according to 5.2.1 or 5.2.2.

5.2.5 Complex multilevel roofs



$l_2 = 2 h_1; l_3 = 2 h_2; \mu_1 = 0,8$



$l_2 = 2 h_1; l_3 = 2 h_2; \mu_1 = 0,8$

Restriction :

$5 \text{ m} < l_2 < 15 \text{ m};$

$5 \text{ m} < l_3 < 15 \text{ m}$

μ_2 and μ_3 , ($\mu_s + \mu_w$), are calculated according to 5.2.1, 5.2.2 and 5.2.4.