TRANSVERSE LOAD DISTRIBUTION

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Our Current Practice

BS 8110: Part 1: 1997

Clause 5.2.2.2

Concentrated loads on slabs
without reinforced topping

“The width of slab assumed to contribute to the support of concentrated loads (including partitions in the direction of span) should not exceed the width of three precast units and joints plus the width of the loaded area or extend more than a quarter of the span on either side of the loaded area.”

The Future

Not so simple ?

EN 1168

Annex C
(informative)

Transverse load distribution

C.1 Calculation method

The following two methods can be distinguished:

1) Load distribution according to the theory of elasticity

The elements should be regarded as isotropic or anisotropic slabs and the longitudinal joints as hinges.
The percentage of the load on the directly loaded element as obtained by the calculation, should in ultimate limit state be multiplied with 1,25 ; the total percentage share carried by the indirectly loaded elements may be decreased by the same amount according to the ratio of their loading percentages.

Instead of a calculation the load distribution may be determined by means of graphs based on the theory of elasticity. In C.4 and C.5 such graphs are given for elements with a width b = 1,20 m. For any other width such graphs may be elaborated.

The requirements of 4.3.3.2.5 shall be met.

2) No load distribution

Every element should be designed with all loads acting directly on that element and assuming zero shear forces in the transverse joints. In this case, the transverse load distribution and the allied torsional moments may be ignored in ultimate limit state. In serviceability limit state, however, the requirements according to 4.3.3.2.5 and 4.3.3.2.6 should be met. The effective width shall be limited according to C.2.

The first method is only allowed if lateral displacements will be limited according to C.3 and, in the absence of a structural topping, the joints are provided with longitudinal grooves according to Figure B.1.

If this condition is not met, the load distribution should be ignored and the design should be based on the second method.

Line loads parallel to the span of the elements and not greater than 5 kN/m may be replaced by a uniformly distributed load over a width equal to a quarter of the span at both sides of the load. If the available width next to the load is smaller than a quarter of the span, the load should then be distributed over a width equal to the available width at one side plus a width equal to one quarter of the span at the other side.

C.2 Limitation of effective width

If the design analysis in ultimate limit state is based on the second method of C.1 for point loads, and for line loads with a characteristic value greater than 5 kN/m, the maximum effective width should be limited to the width of the load enlarged by:

— in the case of loads within the floorfield, twice the distance between the centre of the load and the support, but not greater than the width of the loaded element;

— in the case of loads on free longitudinal edges, once the distance between the centre of the load and the support, but not greater than half the width of the loaded element.

C3. Limitation of lateral displacements

If the design is based on method 1 of C.1, lateral displacements should be limited by any of the following:

a) the surrounding parts of the structure;
b) the friction at the supports;
c) the reinforcement in the transverse joints;
d) the peripheral ties;
e) a reinforced topping.

Relying on friction at the supports is only allowed in non-seismic situations, if it can be proven that sufficient friction can be developed. Calculating the resistant friction forces the actual bearing method should be taken in consideration.

The required resistance should be at least equal to the total vertical shear forces which have to be transmitted across the longitudinal joints.

C.4 Load distribution factors for centre and edge loads

a) In Figures C.1, C.2 and C.3, the loading percentages for a centre and an edge load have been given. A load may be considered as a centre load if the distance from the load to the edge of the floor area is at least 3 m (2,5 b). For loads between edge and centre the loading percentages may be derived from linear interpolation;

b) In Figures C.2 and C.3, the distribution factors for point loads at midspan ($\ell/x = 2$) have been given. For loads near to the support, $\ell/x \geq 20$, the loading percentages of the actual loaded slab should be taken 100 % and of the non-loaded slabs 0 %. For ℓ/x values between 2 and 20, the loading percentages may be derived from linear interpolation;

c) Determining the loading percentages, linear loads with a length greater than half of the span should be considered as linear loads. Linear loads with a length smaller than half of the span should be considered as linear loads if the centre of the load is at midspan, and as point loads in the centre of the load if the centre is not at midspan;

d) In floors without a topping, the percentages of the loading, determined by the graphs, should in ultimate limit state be modified as follows:

- the percentage of the load on the directly loaded element should be multiplied by 1,25;

- the total percentages of the not directly loaded elements may be decreased by the same amount according to the ratio of their loading percentages;

e) The shear forces in the joints should be calculated from the loading percentages and should be considered as being linearly distributed;

— for point loads not at midspan and linear loads which, according to c), have to be considered as point loads, the effective length of the joint transmitting the shear force should be chosen equal to two times the distance from the centre of the load to the nearest support (see Figure C.4);

f) from the loading percentages, given in the graphs, the longitudinal shear forces in every joint and from that values the torsional moments in every element can be derived.

If lateral displacements are limited according to C.3, the torsional moments may be divided by a factor 2.

Figure C.1 - Load distribution factors for linear loads

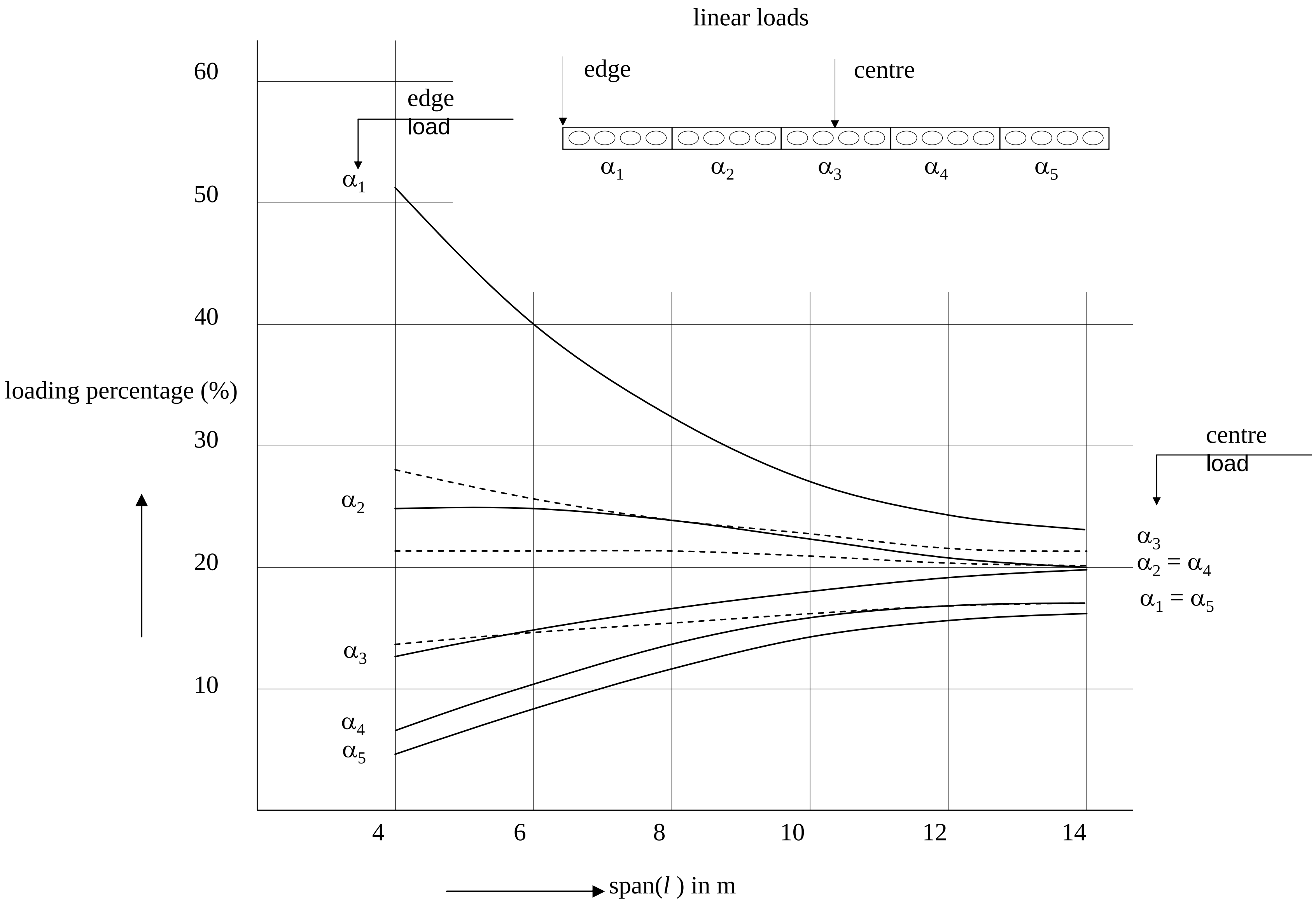


Figure C.2 - Load distribution factors for point loads in centre

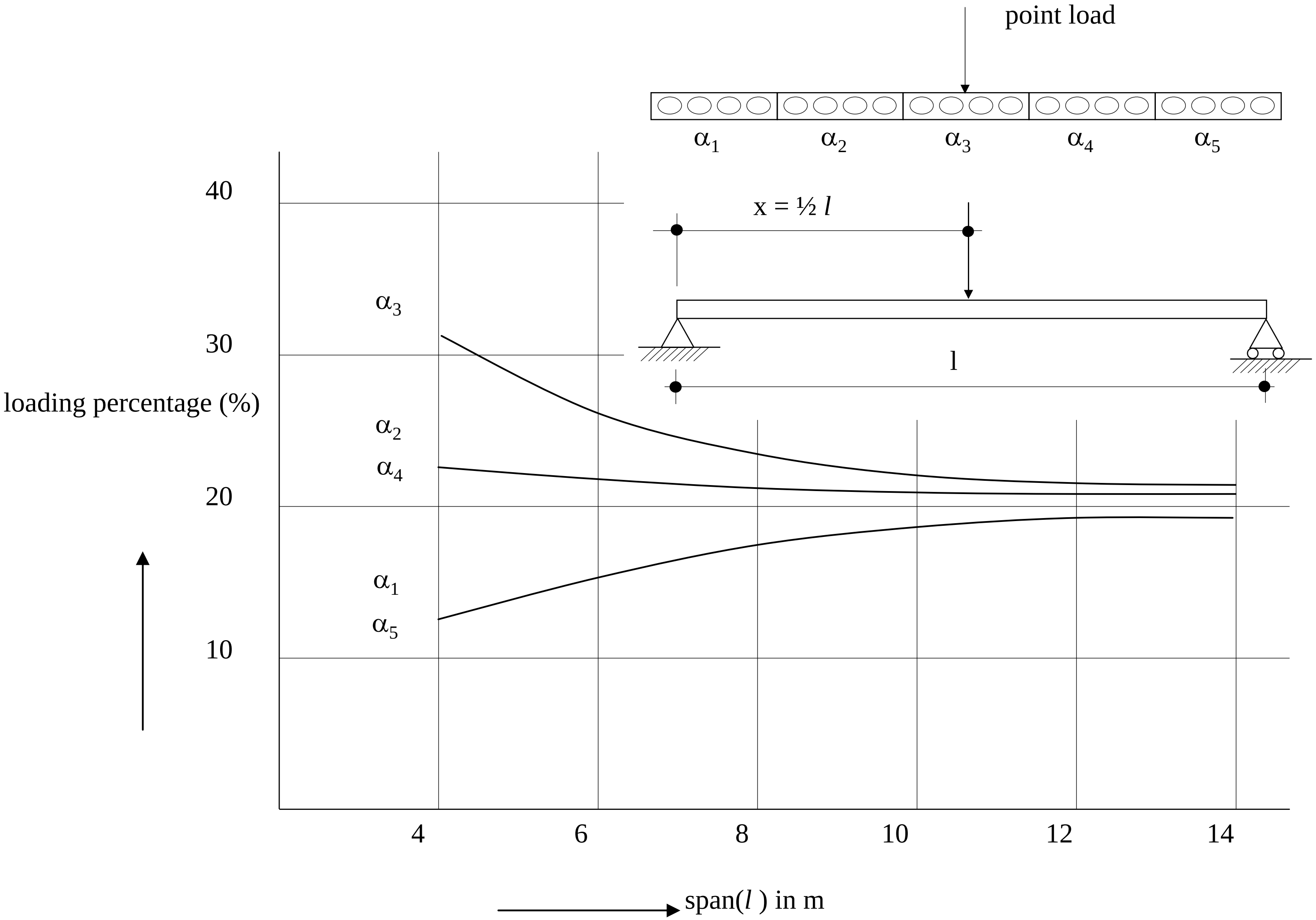


Figure C.3 - Load distribution factor for point loads at edge

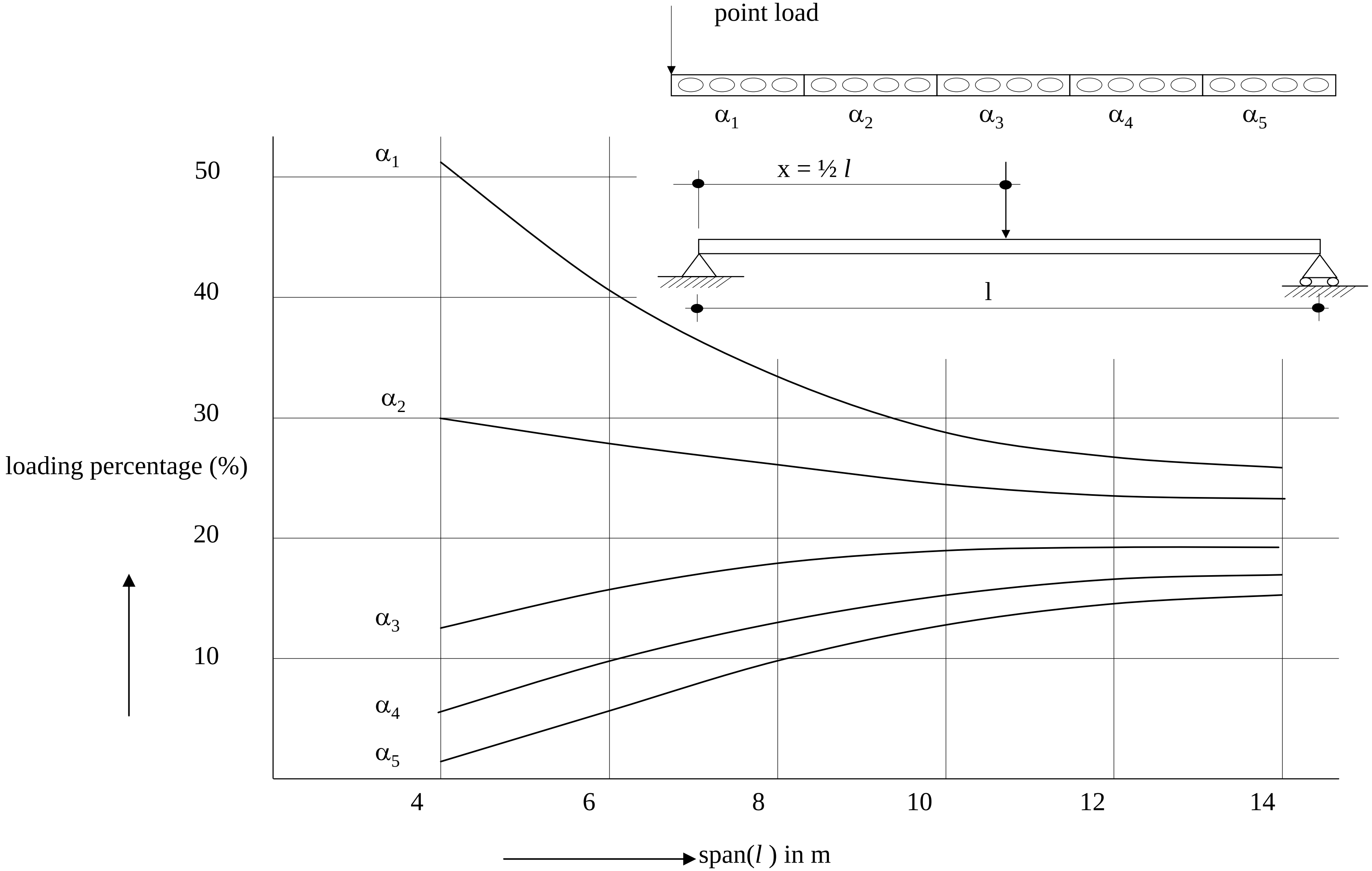
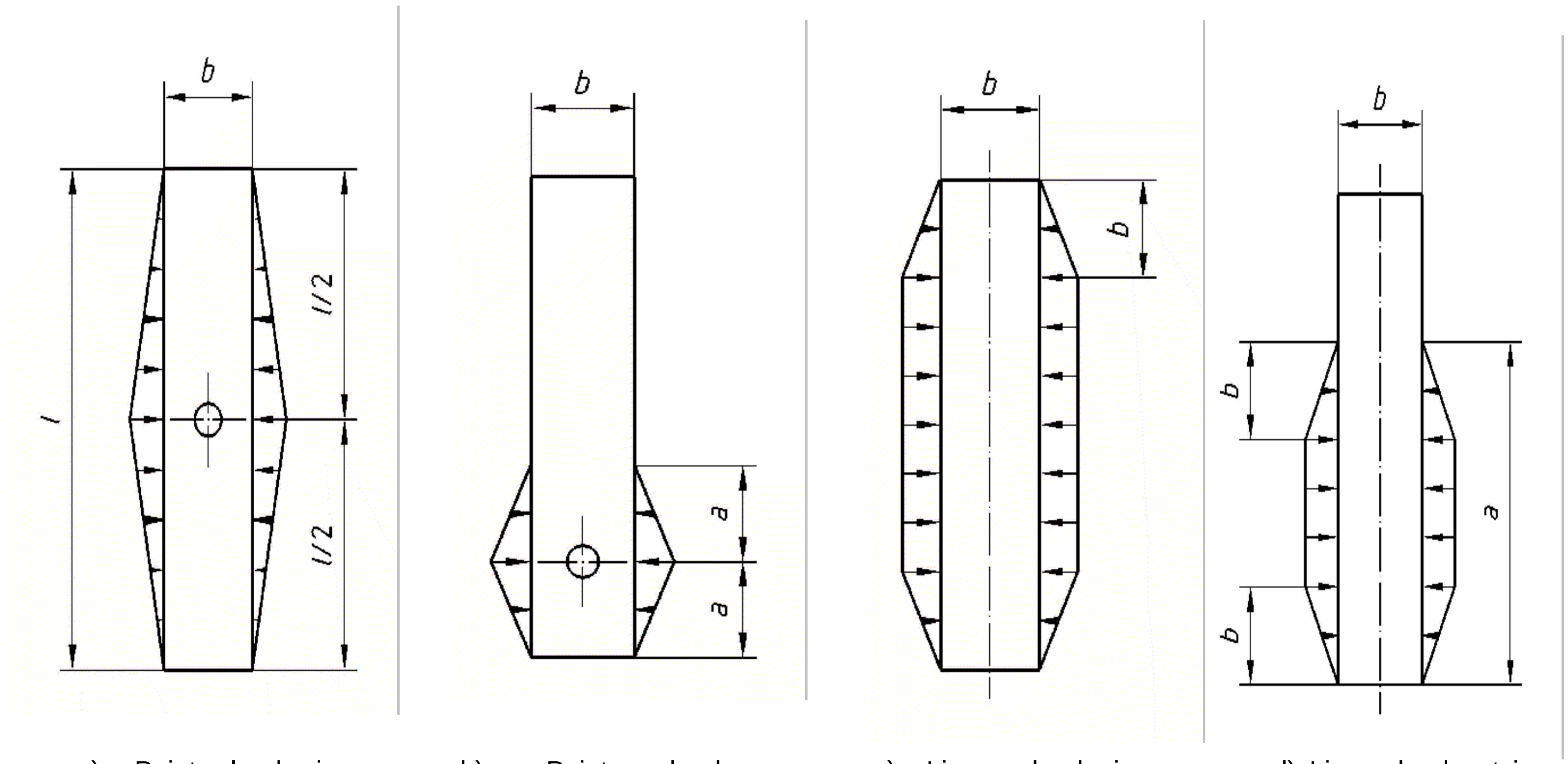


Figure C.4 - Assumed shape of vertical shear forces in joints



a) Point load in centre

b) Point load between centre and support

c) Linear load in centre

d) Linear load not in centre

C5. Load distribution factors for three supported edges

a) For linear loads and point loads, the reaction forces may be based on Figures C.5 and C.6.

If the number of elements (*n*) is larger than 5, the reaction force should be multiplied by the factor (see Figures C.5 and C.6):

$$1-\left(\frac{n-5}{50}\times\frac{s}{b}\right)$$

where

s is the distance of the load from the support, in millimetres.

b is the width of the slab in millimetres

In the case of four supported edges, the reaction force of the support nearest to the force should be multiplied by the factor:

$$\frac{nb-s}{nb}$$

b) If the distance between the load and the longitudinal support is greater than 4,5 b, the reaction force may be taken as zero.

c) When determining the reaction forces, linear loads with a length greater than half the span should be considered as linear loads. Linear loads with a length smaller than half the span should be considered as linear loads if the centre of the load is at midspan, and as point loads if the centre of the load is not at midspan.
The reaction force of Figure C.5, may be multiplied by the ratio of the length of the load to the length of the span.

d) For point loads at midspan, $\ell/x = 2$, the reaction forces can be taken from Figure C.6.

For loads near to the support, $\ell/x \geq 20$, the reaction force should be taken zero; for values of ℓ/x between 2 and 20 the reaction force should be calculated by linear interpolation.

The length of the reaction force should be chosen equal to two times the distance between the centre of the load and the nearest support.

The magnitude of the force is the value from Figure C.6 multiplied by $2x/\ell$.

e) The transverse distribution due to the reaction force should be calculated according to C.4 by considering the reaction force as a (negative) edge load.

Figure C.5 - Reaction force at longitudinal support due to a linear load

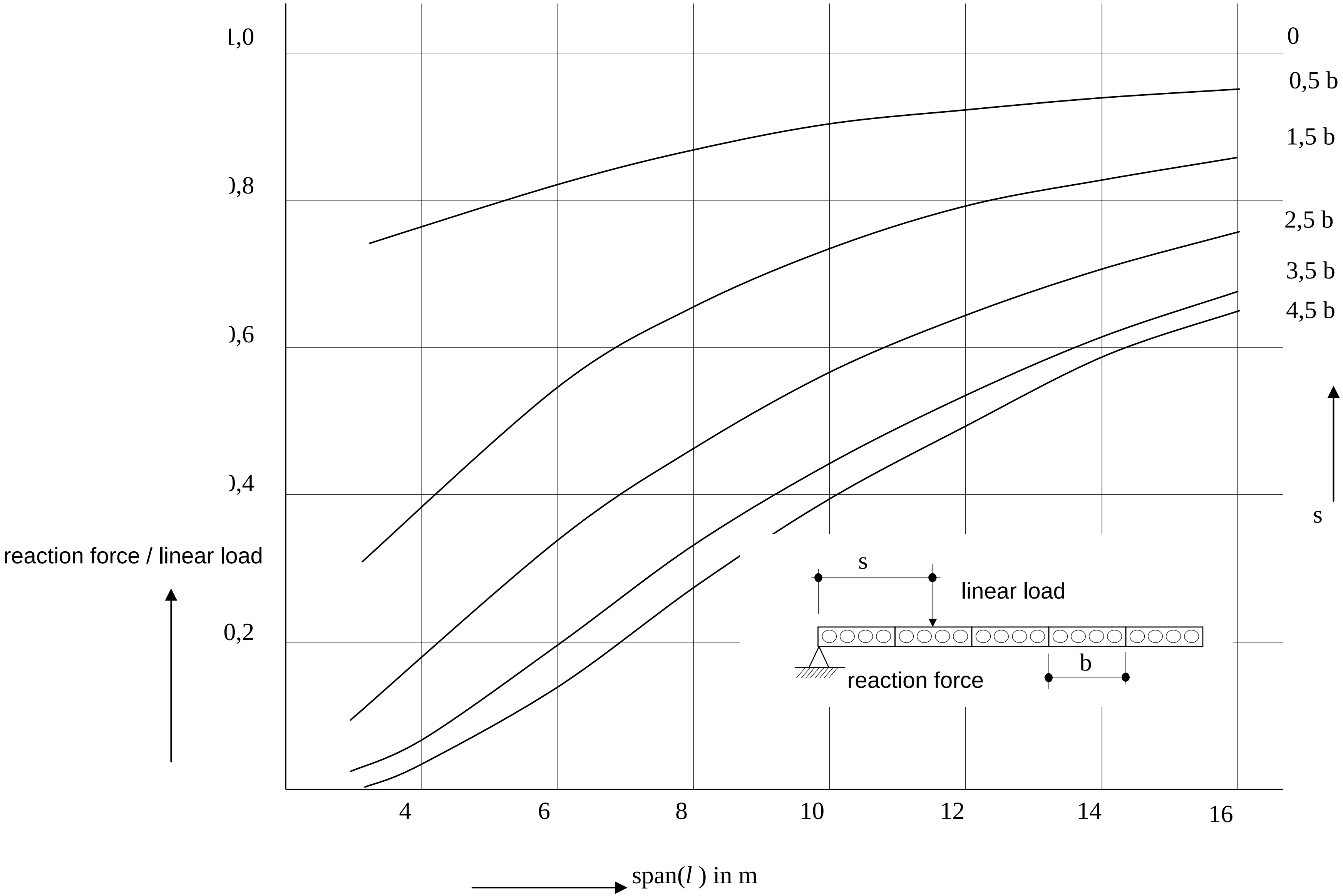
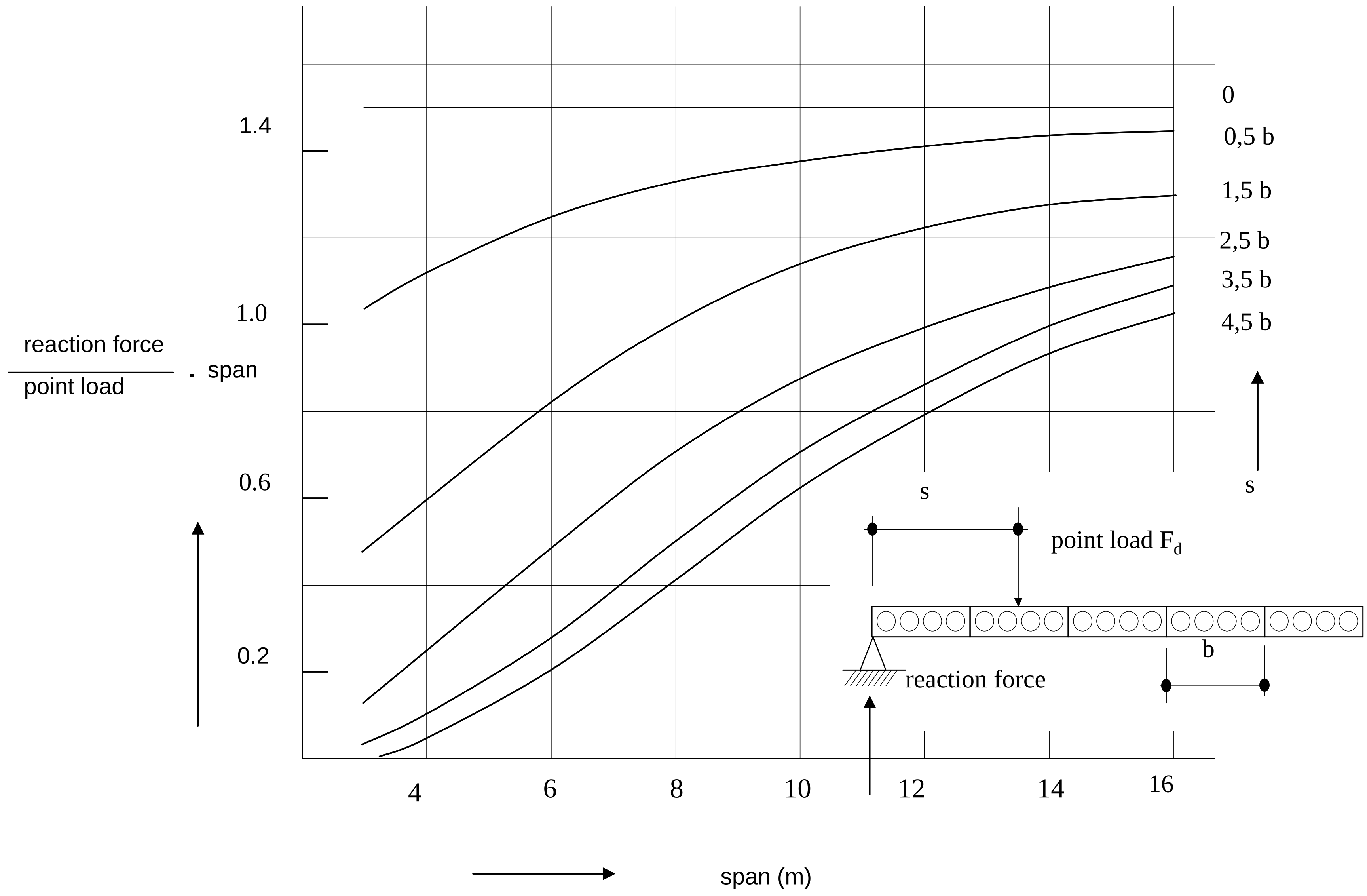


Figure C.6 - Reaction force at longitudinal support due to a point load at midspan



A lot of words and diagrams, but what does it all mean in reality ?

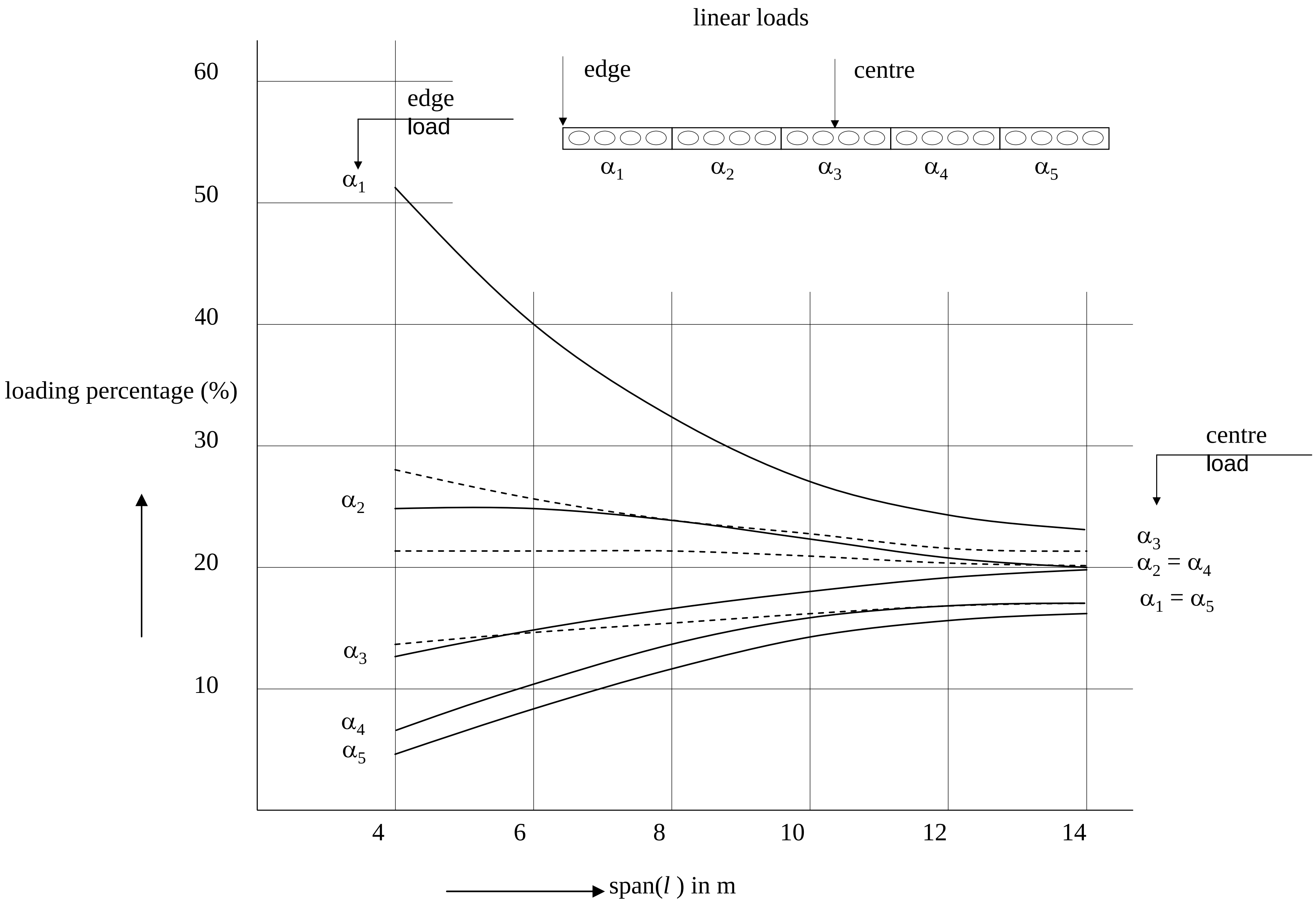
If the line loads are 5kN/m or less, the simple approach of using a UDL can be taken in accordance with C.1

For Point Loads and Line Loads greater than 5kN/m, you have 3 basic options:

1) Calculate the percentage of the load on the directly loaded element and the percentage on the adjacent elements taking into consideration the limits on effective width;

2) Use the graphs to determine load percentages on each element, taking into consideration the limits on effective width;

Figure C.1 - Load distribution factors for linear loads



3) No load distribution – every element designed to fully support all loads applied to it.

The Future

Not so complicated ?

Thanks for your attention