	Project details				
mpa The Concrete Centre	**G2.2 Actions for a continuous beam in a mixed-use structure**	Calculated by	**MM**	Job no.	**G2**
		Checked by	**CIEG**	Sheet no.	**1/5**
		Client	**TCC**	Date	**Nov 2026**

Example

Determine the worst case arrangement of actions for ultimate limit state (ULS) design of a continuous beam of four 6 m spans supporting a 200 mm slab at 6 m centres. The slab is simply supported between the beams. Note that the variable actions are from two sources, as defined in Figure G2.2.1.

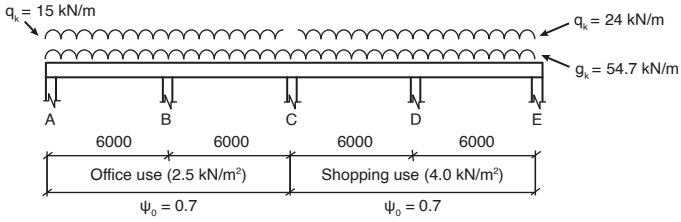


Figure G2.2.1: Continuous beam in a mixed-use structure

General notes:

This calculation is intended to show pattern loading on a continuous beam in a mixed-use building. It also refers to Worked Example G2.1 for actions.

All calculations are carried out in a spreadsheet format where the outcome is not rounded and it is the unrounded value that is used in any further calculation.

This worked example is based on the versions of the codes of practice, guidance documents and publications as noted in the List of References. The user is responsible for ensuring that they use the latest version of the documents.

Abbreviations

General:	Cl.	Clause
	F.	Formula
	Fig.	Figure
	WE	Worked example
Codes of practice:	EC0-1	BS EN 1990-1:2023+A1:2026 [1]
	EC1-1-1	BS EN 1991-1-1:2025 [2]
	EC2-1-1	BS EN 1992-1-1:2023 [3]
	NA EC0-1	NA to BS EN 1990-1:2023+A1:2026 [4]
	NA EC1-1-1	NA to BS EN 1991-1-1:2025 [5]
	PD 6687	PD 6687:2026 [6]
Guidance documents:	G2. How to	G2 - How to: Actions (2026) [7]
	WE G2.1	Actions for a continuous beam in a domestic structure [8]

mpa The Concrete Centre	Project details **G2.2 Actions for a continuous beam in a mixed-use structure**	Calculated by **MM**	Job no. **G2**
		Checked by **CIEG**	Sheet no. **2/5**
		Client **TCC**	Date **Nov 2026**

G2.2.1 Actions

Permanent action, g_k:

As before (from Section G2.1.1):		g_k =	**54.7 kN/m**	WE G2.1

Variable action, q_k:

Office (sub-category B1.1)	= 2.5 x 6	q_k =	**15.0 kN/m**	NA EC1-1-1: Table NA.1
Shopping (sub-category D1 or D2)	= 4.0 x 6	q_k =	**24.0 kN/m**	NA EC1-1-1: Table NA.1

G2.2.2 Load combinations

> *Note:*
>
> *EC0-1 F. (8.12) with verification case VC1 is used in this WE for load combinations. However, there may be benefits in using the more adverse of the upper and lower part of F. (8.13), as shown in WE G2.1.*

Assuming consequence class CC2b (normal upper class),			NA EC0-1: Table NA.1
Consequence factor, k_F	=	1.0	NA EC0-1: Table NA.4
ψ_0 for category B: office areas	=	0.7	NA EC0-1: Table NA.2
ψ_0 for category D: shopping areas	=	0.7	NA EC0-1: Table NA.2

Using EC0-1 F. (8.12) with verification case VC1:

$n = \gamma_G g_k + \gamma_{Q,1} q_{k,1} + \gamma_{Q,2} \psi_{0,2} q_{k,2}$ — EC0-1: Table A.1.3

$n = 1.35 k_F g_k + 1.5 k_F q_{k,1} + 1.5 k_F \psi_{0,2} q_{k,2}$ — NA EC0-1: Table NA.3

(Alternatively, use How to look-up table) — G2. How to: Table G2.8

> *Note:*
>
> *As the variable actions arise from different sources, one is a leading variable action, $q_{k,1}$, and the other is an accompanying variable action, $q_{k,2}$. However, the two variable actions act on different spans and as such, they are not added – refer to Section G2.2.3.*

G2.2.3 Arrangement of ultimate loads

a) Actions

i) Permanent

$1.35 k_F g_k$			EC0-1: Table A.1.3 &
= 1.35 x 1 x 54.7	=	**73.9 kN/m**	NA EC0-1: Table NA.3

ii) Variable

Office use:

as leading action, $1.5 k_F q_{k,1}$			EC0-1: Table A.1.3 &
= 1.5 x 1 x 15	=	**22.5 kN/m**	NA EC0-1: Table NA.3
as accompanying action, $1.5 k_F \psi_{0,2} q_{k,2}$			EC0-1: Table A.1.3 &
= 1.5 x 1 x 0.7 x 15	=	**15.8 kN/m**	NA EC0-1: Table NA.3

Shopping use:

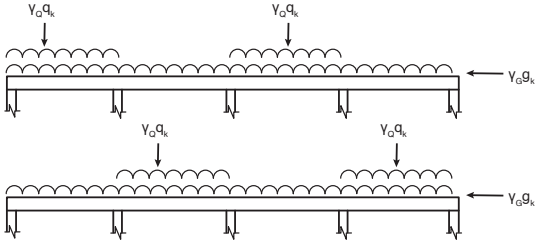
as leading action, $1.5 k_F q_{k,1}$			EC0-1: Table A.1.3 &
= 1.5 x 1 x 24	=	**36.0 kN/m**	NA EC0-1: Table NA.3
as accompanying action, $1.5 k_F \psi_{0,2} q_{k,2}$			EC0-1: Table A.1.3 &
= 1.5 x 1 x 0.7 x 24	=	**25.2 kN/m**	NA EC0-1: Table NA.3

b) Load arrangements

Note:

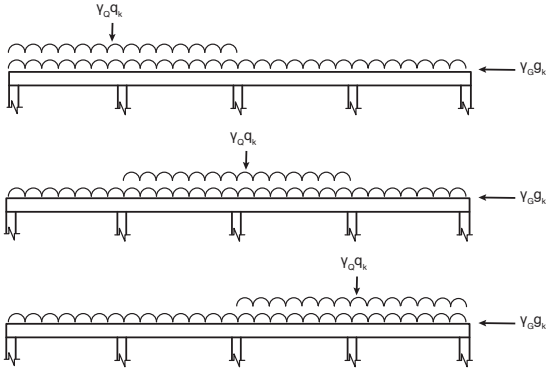
EC2-1-1 does not provide guidance on load arrangements and pattern loading for analysis. The background document to the National Annex, PD 6687 , provides two options for load arrangements in beams. This WE adopts analysis to option a), which involves designing to the more onerous of the two arrangements shown in Fig. G2.2.2 (i.e. alternate spans loaded arrangement) and Fig. G2.2.3 (i.e. adjacent spans loaded arrangement).*

PD 6687: Cl. 4.3



G2. How to: Fig. G2.6

Figure G2.2.2: Alternate spans loaded arrangement



G2. How to: Fig. G2.7

Figure G2.2.3: Adjacent spans loaded arrangement

i) For maximum bending moment in span AB

The arrangement** and magnitude of actions of loads are shown in Fig. G2.2.4. The variable action in span AB assumes the value as leading action and that in span CD takes the value as an accompanying action.

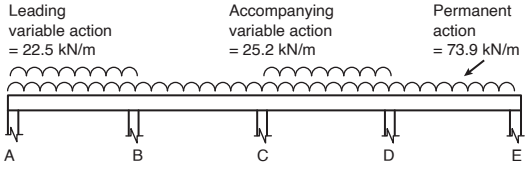


Figure G2.2.4: For maximum bending moment in span AB

* Alternatively, one may design to option b), which involves designing to the more onerous of all spans loaded and alternate spans loaded. Option b) may be easier to analyse.

** The alternate spans loaded arrangement is more onerous than the adjacent spans loaded arrangement for the maximum bending moment in span AB.

ii) For maximum bending moment in span CD

The load arrangement* is similar to that in Fig. G2.2.4, but now the variable load in span AB takes its value as an accompanying action and that in span CD assumes the value as leading action.

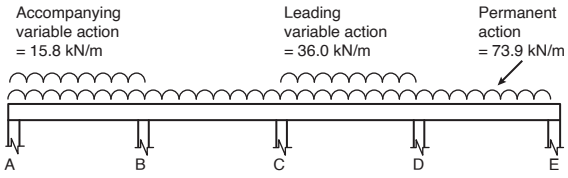


Figure G2.2.5: For maximum bending moment in span CD

iii) For maximum bending moment at support B

The load arrangement** is shown in Fig. G2.2.6. As both spans AB and BC receive load from the same source, no reduction is possible (other than that for large area†).

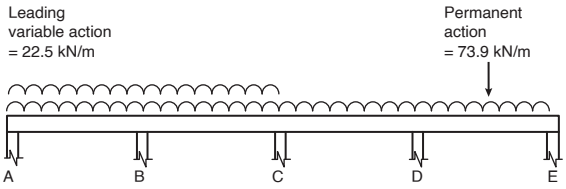


Figure G2.2.6: For maximum bending moment in support B

iv) For maximum bending moment at support D

The relevant arrangement of loads is shown in Fig. G2.2.7. Comments made in G2.2.3 b) iii) also apply here.

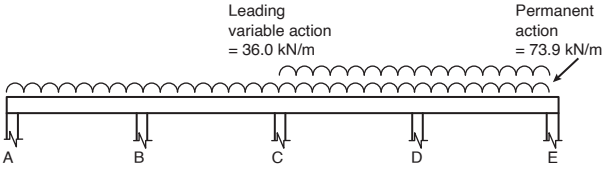


Figure G2.2.7: For maximum bending moment in support D

---

* Similar to Section G2.2 b) i), the alternate spans loaded arrangement shown in Fig. G2.2.5 is more critical than the adjacent spans loaded arrangement for the worse bending moment in span CD.

** In this scenario, the adjacent spans loaded arrangement (with spans AB and BC fully loaded as shown) is more critical than the alternate spans loaded arrangement.

† NA to EC1-1-1 Cl. NA.2.13 allows variable actions to be subjected to a reduction factor, α_A, according to the tributary area, A in m^2. The reduction factor is defined in F. (NA.1) as $\alpha_A = 1.0 - A/1000 \geq 0.75$. Note that the NA to EC1-1-1 Cl. NA.2.12 does not allow combining the reduction factor relevant to imposed loads on horizontal elements i.e. α_A with the reduction factor relevant to vertical elements in multi-storey buildings i.e. α_n.

v) For critical curtailment and hogging in span CD

The relevant arrangement of loads is shown in Fig. G2.2.8.

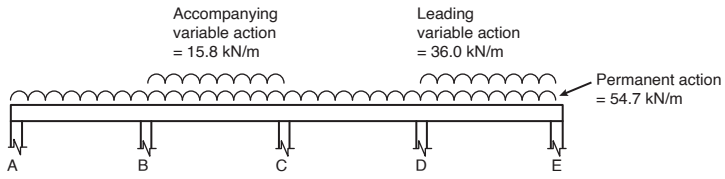


Figure G2.2.8: For curtailment and hogging in span CD

Note:

For load arrangements, PD 6687 Cl. 4.3 requires that the same partial factor for the permanent load is used in all spans. The partial factors for permanent loads for the structural resistance verification case VC1 are defined in Table NA.3 of NA EC0-1 and can be either γ_G for unfavourable resulting effects or $\gamma_{G,fav}$ for favourable resulting effects. As illustrated in Fig. G2.2.8 , using $\gamma_{G,fav}$ = 1.0 for verification case VC1 favourable condition might be critical for curtailment and hogging in spans.

PD 6687: Cl. 4.3
NA EC0-1: Table NA.3

In this case, the permanent action is found as follows:

$\gamma_{G,fav} g_k$ = 1.0 x 54.7 = **54.7 kN/m**

EC0-1: Table A.1.3 & NA EC0-1: Table NA.3

List of references

[1] British Standards Institution. (2026) BS EN 1990-1:2023+A1:2026 Eurocode – Basis of structural and geotechnical design. Part 1: New structures. London, BSI.

[2] British Standards Institution. (2025) BS EN 1991-1-1:2025 Eurocode 1 – Actions on structures. Part 1-1: Specific weight of materials, self-weight of construction works and imposed loads for buildings. London, BSI.

[3] British Standards Institution. (2023) BS EN 1992-1-1:2023 Eurocode 2 – Design of concrete structures. Part 1-1: General rules and rules for buildings, bridges and civil engineering structures. London, BSI.

[4] British Standards Institution. (2026) NA to BS EN 1990-1:2023+A1:2026 UK National Annex to Eurocode – Basis of structural and geotechnical design – Part 1: New structures. London, BSI.

[5] British Standards Institution. (2026) NA to BS EN 1991-1-1:2025 UK National Annex to Eurocode 1 – Actions on structures. Part 1-1: Specific weight of materials, self-weight of construction works and imposed loads for buildings. London, BSI. London, BSI.

[6] British Standards Institution. (2026) PD 6687:2026 Background paper to the National Annexes to BS EN 1992-1-1:2023, BS EN 1992-1-2:2023 and BS EN 1992-4:2018. London, BSI.

[7] MPA The Concrete Centre. (2026) How to design concrete structures using Eurocode 2 (second generation). G2 – Actions. London, TCC.

[8] MPA The Concrete Centre. (2026) Worked examples to Eurocode 2 (second generation). WE G2.1 – Actions for a continuous beam in a domestic structure. London, TCC.

Revision number	Revision date	Notes
1.0	Nov 2026	First publication

At the time of publication, work on the second generation of Eurocodes and supporting documents is ongoing. Where possible, this worked example has been developed based on the standards that have been published to date, but in some instances, the relevant documents have not yet been finalised and so anticipated values are included and clearly noted as such. Amendments are planned for all of the Eurocodes ahead of the March 2028 date of adoption and users are advised to ensure they are referring to the latest version of a standard or publication.

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