

Safety Factors γ_{M0} and γ_{M1} in Metal Eurocodes

Ivan Baláž^{1,a*}, Yvona Koleková^{2,b}

¹KKDK Stavebná fakulta STU v Bratislave, Radlinského 11, 810 05 Bratislava, Slovakia

²KSM Stavebná fakulta STU v Bratislave, Radlinského 11, 810 05 Bratislava, Slovakia

^aivan.balaz@stuba.sk, ^byvona.kolekova@stuba.sk

Keywords: partial safety factors, recommended values, definitions, applications, Eurocodes.

Abstract: Overview of values and definitions of γ_{M0} and γ_{M1} safety factors used in all 20 parts of Eurocodes EN 1993 Design of steel structures [1] and in all 5 parts of EN 1999 Design of aluminium structures [2]. Applications of the γ_{M0} and γ_{M1} safety factors values and definitions in all clauses of EN 1993. Comparison of safety levels of former Czechoslovak standards with current Eurocodes. Proposals for correction of definitions and applications of γ_{M0} and γ_{M1} safety factors in all clauses of EN 1993. The overview and corrections enable to do better choice from several official options aiming to change current value $\gamma_{M1} = 1,0$ valid in EN 1993-1-1 for buildings, which were presented at CEN/TC250 SC3 meetings in October 24th 2014 and in March 19th 2015 in Berlin

Analysis of safety factors recommended values and definitions

20 parts of Eurocode 1993 Design of steel structures may be divided into two groups: a) servants (containing theoretical procedures), b) masters (application parts). Part 1 EN 1993-1 consists from twelve subparts: EN 1993-1-1 to EN 1993-1-12. They are all servants except EN 1993-1-1 which contains general rules and rules for design of buildings as well. The group of masters consists from 6 application parts: EN 1993-2 bridges, EN 1993-3 tall structures, EN 1993-4 storage structures, EN 1993-5 pilings, EN 1993-6 crane runway girders. Overview of recommended numerical values of partial safety factors γ_{M0} and γ_{M1} in all 20 parts of EN 1993 is given in the Table 1.

Tab. 1: Recommended values of partial safety factors γ_{M0} and γ_{M1} in all 20 parts of EN 1993

EN 1993	-1-1	-1-2	-1-3	-1-4	-1-5	-1-6
γ_{M0}	1,0	ref. to -1-1	1,0	1,1	A.P.	A.P.
γ_{M1}	1,0	ref. to -1-1	1,0	1,1	A.P.	A.P.
EN 1993	-1-7	-1-8	-1-9	-1-10	-1-11	-1-12
γ_{M0}	A.P.	ref. to -1-1	-	-	-	-
γ_{M1}	A.P.	ref. to -1-1	-	-	-	-
EN 1993	-2	-3-1	-3-2	-4-1	-4-2	-4-3
γ_{M0}	1,0	1,0	1,0	1,0	1,0	-
γ_{M1}	1,1	1,0	1,1	1,1	1,1	-
EN 1993	-5	-6	Key:			
γ_{M0}	ref. to -1-1	1,0	ref. to -1-1 = refers to EN 1993-1-1			
γ_{M1}	ref. to -1-1	1,0	A.P. = as in relevant application part of EN 1993			

Overview of safety factors definitions and their applications in all clauses containing partial safety factors γ_{M0} and γ_{M1} in all 20 parts of EN 1993 is given in the Table 2.

In the prestandard ENV 1999 and standard EN 1999 for design of aluminium structures there is only one recommended value $\gamma_{M1} = 1,1$. Partial safety factor γ_{M0} is not used in these Eurocodes.

In prestandard ENV 1993 there are recommended values $\gamma_{M0} = \gamma_{M1} = 1,1$.

Tab. 2: Definitions of partial safety factors γ_{M0} and γ_{M1} in all 20 parts of EN 1993

EN 1993-1-1: γ_{M0} : resistance of cross-sections whatever the class is γ_{M1} : resistance of members to instability assessed by member checks
EN 1993-1-2: No γ_{Mi} definitions. Only γ_{M0} is used in part -1-2, which refers only to 1993-1-1
EN 1993-1-3: γ_{M0} : resistance of cross-sections to excessive yielding including local and distortional buckling γ_{M1} : resistance of members and sheeting where failure is caused by global buckling
EN 1993-1-4: γ_{M0} : resistance of cross-sections to excessive yielding including local buckling γ_{M1} : resistance of members to instability assessed by member checks
EN 1993-1-5: No γ_{Mi} definitions.
EN 1993-1-6: No γ_{Mi} definitions. This part is intended for use in conjunction with EN 1993-1-1,-1-3, -1-4, -1-9 and the relevant application parts of EN 1993, which include -3-1 for towers and masts, -3-2 for chimneys, -4-4 for silos, -4-2 for tanks, -4-3 for pipelines
EN 1993-1-7: No γ_{Mi} definitions. Recommended γ_{M0} and γ_{M1} values are given in the relevant application standards
EN 1993-1-8: No γ_{Mi} definitions. γ_{Mi} for resistance of members and cross-sections see in -1-1
EN 1993-1-9, -1-10, -1-11, -1-12: γ_{M0} and γ_{M1} are not used in these standards
EN 1993-2: γ_{M0} : resistance of cross-sections to excessive yielding including local buckling γ_{M1} : resistance of members to instability assessed by member checks
EN 1993-3-1: γ_{M0} : resistance of member to yielding γ_{M1} : resistance of member buckling
EN 1993-3-2: γ_{M0} : resistance of structural elements or members related to the yield strength f_y , when no global or local buckling occurs γ_{M1} : resistance of structural elements or members related to the yield strength f_y , where global or local buckling is considered
EN 1993-4-1: γ_{M0} : resistance of welded or bolted shell wall to plastic limit state γ_{M1} : resistance of shell wall to stability
EN 1993-4-2: γ_{M0} : resistance of welded or bolted shell wall to plastic limit state, cross-sectional resistance γ_{M1} : resistance of shell wall to stability
EN 1993-4-3: γ_{M0} and γ_{M1} are not used in this standard
EN 1993-5: No γ_{Mi} definitions. For the partial factors to be applied to resistance see EN 1993-1-1
EN 1993-6: γ_{M0} : resistance of cross-sections to excessive yielding including local buckling γ_{M1} : resistance of members to instability assessed by member checks

In prestandard ENV 1993 there are different safety factors definitions comparing with EN 1993.

Summary

The definitions of safety factors used in EN 1993 should be unified, the cross-references among its parts improved and applications of safety factors in some clauses corrected. These measurements enable to make change of recommended value $\gamma_{M1} = 1,0$ used in EN 1993-1-1 easier.

Acknowledgement: Project No. 1/0748/13 was supported by the Slovak Grant Agency VEGA.

References

- [1] EN 1993 Eurocode 3. Design of steel structures. Set of 20 standards. CEN Brussels. 2005-2007.
- [2] EN 1999 Eurocode 9. Design of aluminium structures. Set of 5 standards. CEN Brussels. 2007.