2/ Slenderness effects on comprehensive strength of masonry test pieces according to EC 6 (1104)

Titel 1. Datei

Abstract

The verification algorithm in EC 6 (EN 1996-1-1) for centric and eccentric compression is based on the assumption of a masonry strength corresponding to a specimen with zeroslenderness in order to determine the bearing resistance of the building material. This represents a general modification as compared to the design according to the German Code DIN 1053-1. Conversions of test results have been referred so far to different slenderness values (e.g. *hlt* = 5 or 10) by means of the buckling theory of *Mann.* This theory does not however consider the real stress-strain relationships of the typical masonry types. Moreover, the verification of the ultimate limit state is carried out being on the safe side. The simplifications which are used to derive the respective reduction factor, lead however by the conversion of the test results to an overestimation of the compressive strength, as for this purpose the reciprocal value is needed. The test results are thus overestimated and this represents a safety risk.

The actual influence of the slenderness of the test specimens on the compressive strength of masonry structures is first of all analyzed based on theoretical assumptions. The solution of the differential equation serves therein as a basis for the determination of the conversion factor from the existing test member slenderness to the theoretical zeroslenderness. Based on the equilibrium of the analysis model and in consideration of the realistic material characteristics, appropriate conversion factors for different masonry types may be determined. By this method very exact numerical values are obtained, that are partly smaller than the ones assumed so far, which does confirm the aforementioned assumption of the existence of a safety risk.

Moreover, the influence of the loading and the support conditions of the test member is taken into consideration by means of a numerical model. Two cases are numerically simulated to this end: the ideal theoretical case with artificially eliminated influence of the restricted lateral strain and the actual case including the numerical simulation of the loading region. The numerical model is calibrated and developed in close connection with the experimental tests. No influence of the pressure plates can be detected. Therefore, a noticeable increase by the conversion of the compressive strength between experiment and theory cannot be assumed. Consequently, the thesis given by *Mann,* i.e. that the pressure plates at the end points of the test members do not have an influence on the test result and therefore on the determination of the compressive strength, can be confirmed.

In addition the effects of accidental eccentricities during the tests are analyzed. The separate test program implies standard masonry test members, where 3 different types and sizes of stones are used. First, straight after their fabrication, the test members are put under photogrammetric survey in order to be able to detect possible deflections of the vertical and to quantify them. Here, especially the misalignment of the masonry stones has to be investigated. The test members are measured for the second time just before the beginning of the experiment in order to determine their strength. There, the picture of the test facility will be effected in order to be able to detect possible deviations to the planned exact centric loading. The eccentricity caused by the fabrication of the test members or rather by their installation in the test facility partly turn out to be very small and has moreover only a small influence on the size of the conversion factor for the consideration of the slenderness of the test members.

In general, looking at the results of the analyses, it can be reasoned that up to a test member slenderness of h/t = 5 no conversions should be made, with respect the test member slenderness, the additional eccentricity, or the influence of the pressure plates. Up to a slenderness ration of h/t = 5 the eccentricities that have been determined during the tests did not show any noteworthy influence on the magnitude of the converted compressive strength of masonry. Only at a slenderness of $h/t > 5{,}0$ may the influences given by the slenderness of the test members, due to imperfections come into effect at the experimental determination of the compressive strength, which justify a conversion. In general, however, the test member slenderness lies under this limit. Therefore, in most of the applied cases, no great importance is attached to the slenderness of the test members for the size of the compressive strength. Furthermore, with the numeric and experimental investigations the assumption of Mann, i. e. that the pressure plates at the ends of the test members do not influence the estimation of the compressive strength, can be confirmed. An influence of the restricted lateral strain by the pressure plates (steel plate) at the edge of the test member can not be detected, provided that the dimensions of the test members are according to DIN EN 1052-1 or DIN 18554-1 respectively.