DISCUSSION SECTION

"SOME ASPECTS OF SHEAR WALL DESIGN" BY T.A. PAULAY

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O. A. GLOGAU:

Dr. Paulay is to be congratuled on another notable contribution to the subject of shear wall design. The writer would like to discuss the question of laminar ductility factors (Fig. 15).

If, hysteritic energy dissipation is the criterium of seismic performance then the yield points selected for 15(a) and 15(b) do not appear to give a comparable picture for the two systems. If, for instance, in system 15(a) the load had been reversed at Stage 3, almost no hysteritic loop would be formed but a ductility factor of 1.5 would be assigned. On the other hand, in system 15(b), deflections beyond Stage 3 result in significant yielding. Thus, if in 15(a) Stage 3 had been selected as the yield point then, Stage 6 would have to be made to correspond to a deflection of 32" resulting in much larger distortions of coupling beam at $x/_H = 0.6$.

REPLY BY T. A. PAULAY:

The comments of Mr. Glogau expose the prevelant difficulties associated with the definition and interpretation of "ductility" in real structures. To allow the comparison of the elasto-plastic behaviour of similar structures to be made in the paper the author adopted the following definition:

"The ductility factor, related to a shear wall structure, is the ratio of the lateral deflection at the top, Δ, and that deflection, Δ_y, which occurs at the same level when first yield occurs in any part of the structure. "

In suitably designed coupled shear wall yield should first occur in the coupling beams. The interpretation of this definition, and in particular its relevance to the two coupled shear wall structures represented in Fig. 15 of the paper, are further discussed with the aid of Fig. 19.

The "equal displacement concept" was the adopted criterion for the structures analysed in Fig. 15a and 15b. Accordingly the design rested on the premise that for a given seismic excitation the lateral deflection of the elasto-plastic structure is the same as the corresponding deflection of the same structure responding in a perfectly elastic manner. A commonly accepted ductility factor is 4. This implies then that the strength of the structure with respect to lateral load need only be 1/4 of that associated with perfect elastic response. The structure needs to be ductile enough to sustain this load while the imposed plastic displacement is at least three times as much as the displacement at first yield.

The idealised elasto-plastic response, the theoretical response of the two coupled shear walls of Fig. 15 and the perfect elastic response to equivalent lateral static loading are compared in Fig. 19. The common basis for both structures was a minimum strength corresponding with a base shear of 800 K. This implies that a base shear of 4 x 800 = 3200^K would have been generated in the fully elastic structure with a lateral deflection at the top of approximately 21 in. Accordingly the critically situated coupling beams were designed to yield when the base shear reached 800 K. Fig. 15a shows that at this "Stage 2" only 71% (800/1130 = 0.71) of the full strength of the structure is utilised. In Shear Wall A the yield commenced in one coupling beam only. On the other hand, in Shear Wall B (Fig. 15b) the base shear represents 92% (800/870 = 0.92) of its full strength. In this case all coupling beams commence yielding at the same time.

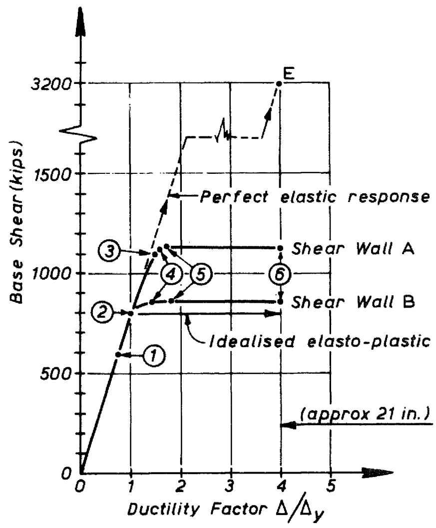

FIG. 19

A comparison of the responses of two coupled shear walls.

Fig. 19 shows that both structures are satisfactory if they can sustain the respective loads at a lateral deflection (21 in) corresponding with a ductility factor of 4. As stated earlier this was the considered criterion for seismic performance and not overall hysteretic energy dissipation. Shear Wall A will obviously require more reinforcement because of the larger forces invited at full plastification. The load-displacement relationship for all but the simplest reinforced concrete structures will always differ from the idealised bilinear elasto-plastic response. In such situations it will be for the designer to decide where the point of first yield, such as "Stage 2" of the example structures, should be.