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SUMMARY OF DISCUSSION - SESSION 1

The discussion of the contributions to Session 1 turned in the main about several distinct topics and will be summarized under corresponding headings:

1. Relation between Plasticity Theory and Concrete Behaviour

A. Sawczuk stressed the desirability of following a continuum mechanics approach in formulating failure criteria for concrete, and indicated difficulties arising from cracking, stress histories, etc. He also indicated the need for a stress-strain law at yielding. Z. Sobotka elaborated along similar lines, showing interaction formulae for yielding of orthotropic slabs which include the effects of compressibility.

An exchange between D.H. Clyde and W.F. Chen concerned the effect of assumed tensile concrete strength on the rigour of plasticity theory for concrete.

H. Exner's paper elicited several comments. Clark questioned the applicability of the "effectiveness factor" to narrow plastic shear zones. P. Marti pointed out the inability of the formulation to consider local unloading. He also explained the effectiveness factor as a means of obtaining the average failure stress in a particular strain range. In responding, H. Exner agreed as to the importance of the actual stress- or strain history of the problem.

2. Relation between Plain and Reinforced Concrete Behaviour

S.M. Uzumeri pointed out the difficulty of using plain concrete laws as models for actual situations in reinforced concrete members, such as the effect of confinement. M.P. Collins also observed that the strain field in the vicinity of reinforcement could not easily be represented in tests on plain concrete. W.F. Chen responded that before going on to more complicated problems, we need to know the behaviour of the concrete alone.

3. Tensile Strength

M. Virlogeux enquired into our knowledge of tensile behaviour and was answered by T. Bröndum-Nielsen that tensile stress-strain curves had been obtained in Copenhagen.

K.H. Gerstle commented on the inconsistency of a zero-tension strength assumption for zones of high shear. M.W. Braestrup and M.P. Collins pointed out that even in such cases shear strength without tension strength was possible due to confinement effects.

M.D. Kotsovos, on the other hand, observed that cracking should not only be associated with applied tensile stress but also with internal stress concentrations.

## 4. Shear Transfer Across Cracks

C.T. Morley and R.P. Johnson (in reference to S.I. Sörensen's paper) enquired into shear strength and stiffness across cracks; R.P. Johnson pointed out that the shear stiffness depended on crack width, and therefore crack spacing. S.I. Sörensen explained that in the absence of test data, he had assumed crack widths between 0.0 and 0.5 mm. G. Mehlhorn cited analyses which indicated incompatibility of results with the actual assumed value, other than zero, of the shear stiffness across cracks.

## 5. Endochronic Theory

Great interest was shown in S.I. Sörensen's comparison of results of plasticity and endochronic analyses. J. Blaauwendraad questioned whether equal care had been used in formulating both approaches; S.I. Sörensen's reply indicated that his endochronic model was more refined than his plasticity model. Computer time requirements also played a role in assessing relative merits; at present, work was under way in Trondheim to improve the efficiency of the endochronic analysis.

K.H. Gerstle pointed out that Darwin and Pecknold had obtained results similar to Sörensen's using a simpler approach, whereupon V. Cervenka suggested care in such comparisons; his analysis (on which these comparisons were based) had neglected one important crack mode, which might have made his panel too stiff. M.D. Kotsovos, finally, commented favorably on the fundamental rigour of the endochronic theory compared to the other analyses.

K.H. GERSTLE