TABLE 1. TEST PROGRAMME FOR THE CONSTANT AMPLITUDE TESTS

Load levels		ND65	ND95	LWA75
S_{max}	S_{min}			
0.95	0.05		2	
0.90	0.05		2	
0.85	0.05		2	3
0.75	0.05	2	3	2
0.70	0.05	3	2	3
0.65	0.05		3	2
0.60	0.05	1	2	2
0.55	0.05	2		
0.75	0.20	2	2	3
0.70	0.20	3		
0.75	0.30	2	1	4
0.85	0.40	1	2	3
0.80	0.40	1	3	3
0.75	0.40	1	2	2
0.70	0.40	1		
0.95	0.60		1	
0.90	0.60		2	
0.85	0.60		3	2
0.80	0.60		3	

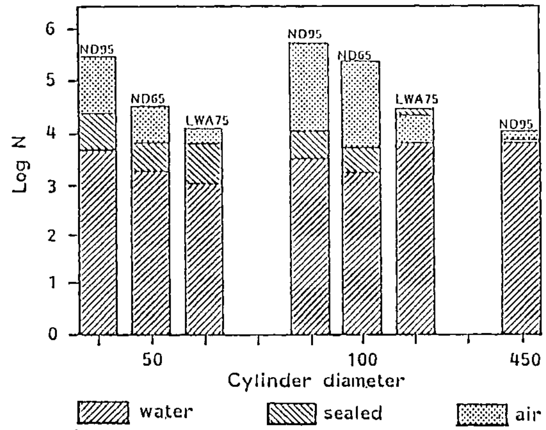

Fig. 1--Mean results of the environmental tests

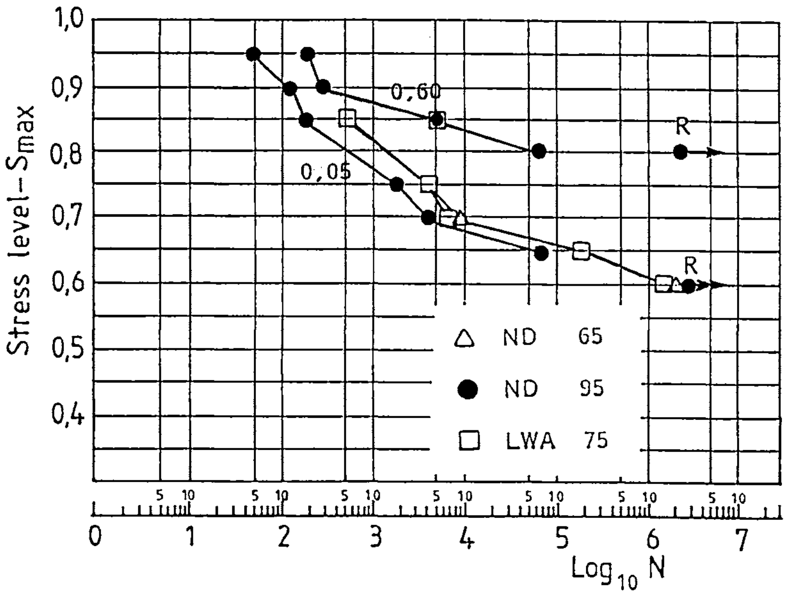

Fig. 2--Results of constant amplitude tests on ND65, ND95 and LWA75 for S_{min}=0.05 and S_{min}=0.60 (R = specimen not failed)

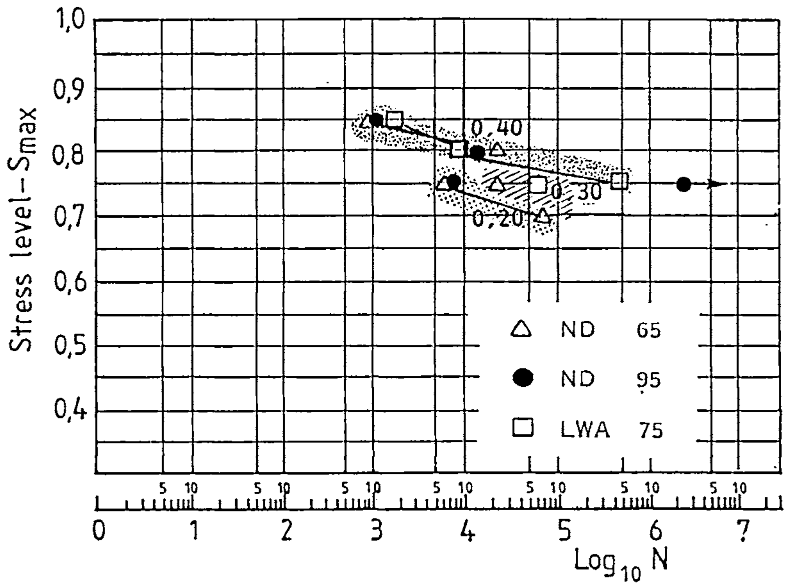

Fig. 3--Results of constant amplitude tests on ND65, ND95 and LWA75 for S_{min}=0.20, S_{min}=0.30 and S_{min}=0.40 (R = specimen not failed)

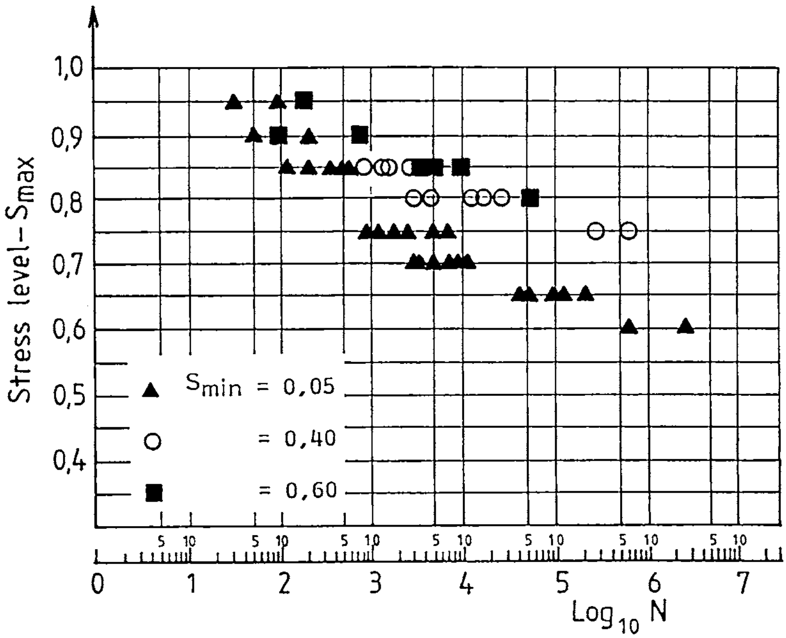

Fig.4-- Results from all three qualities for S_{min}=0.05, 0.40 and 0.60

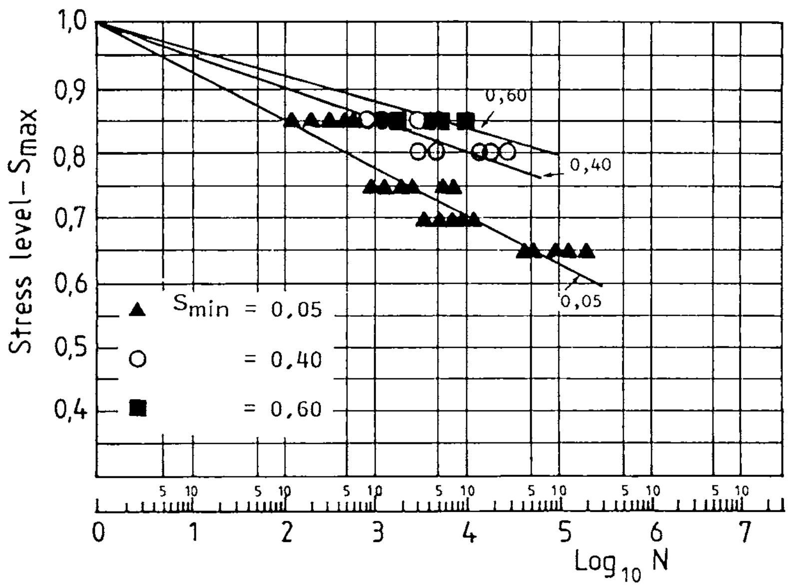

Fig. 5--Regression lines through S_{max}=1.0 based upon the results of all three qualities for S_{min}=0.05, 0.40 and 0.60, and S_{max} between 0.65 and 0.85

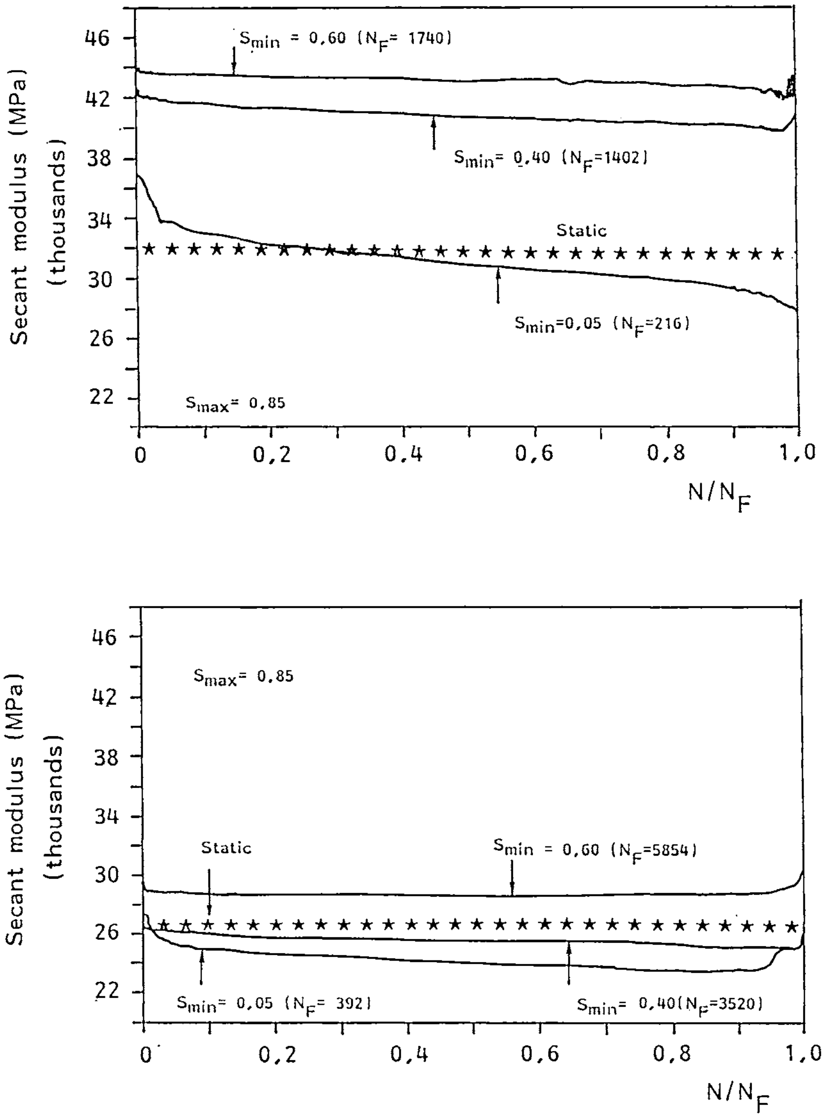

Fig. 6--The secant stiffness as a function of the stress range for ND95 and LWA75, S_{max}=0.85

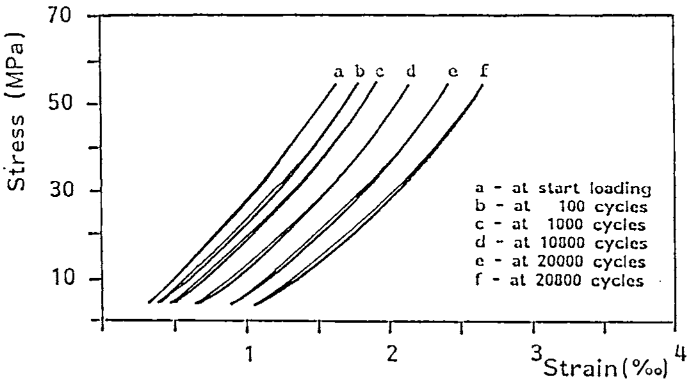

Fig. 7--An example of stress-strain curves for a ND95 cylinder tested in fatigue

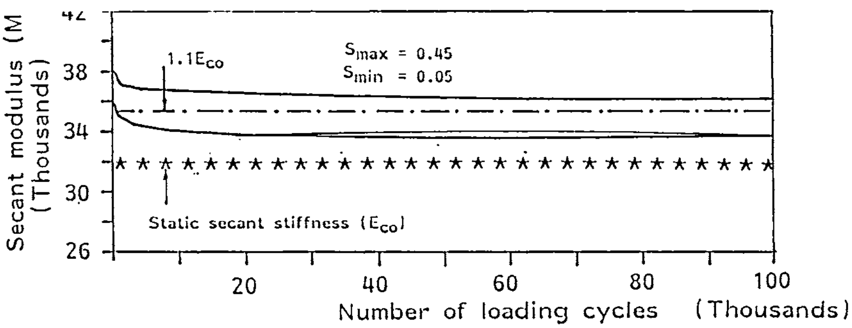

Fig. 8--Stiffness development during the first 100 000 cycles of three ND95 cylinders, S_{max}=0.45

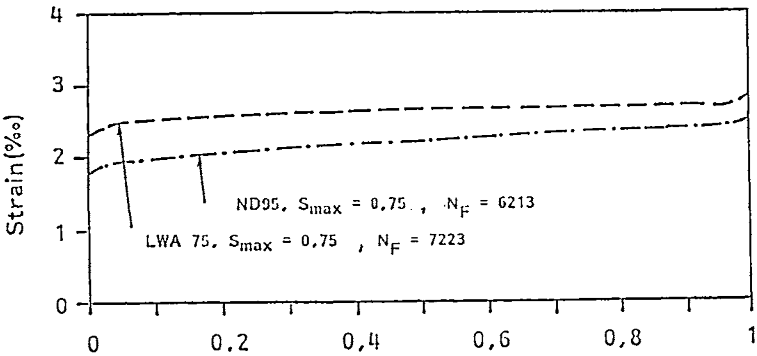

Fig. 9--Typical strain development curves at maximum stress for ND95 and LWA75

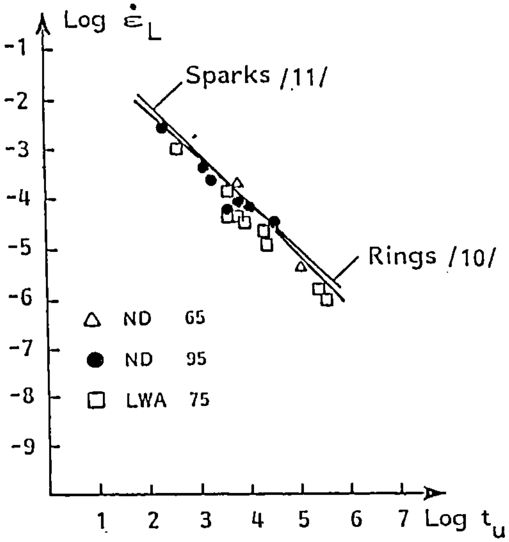

Fig. 10--The relationship between the logarithm of the rate of maximum strain (strain values times 10^3) and the logarithm of time (in seconds) to failure in the longitudinal direction

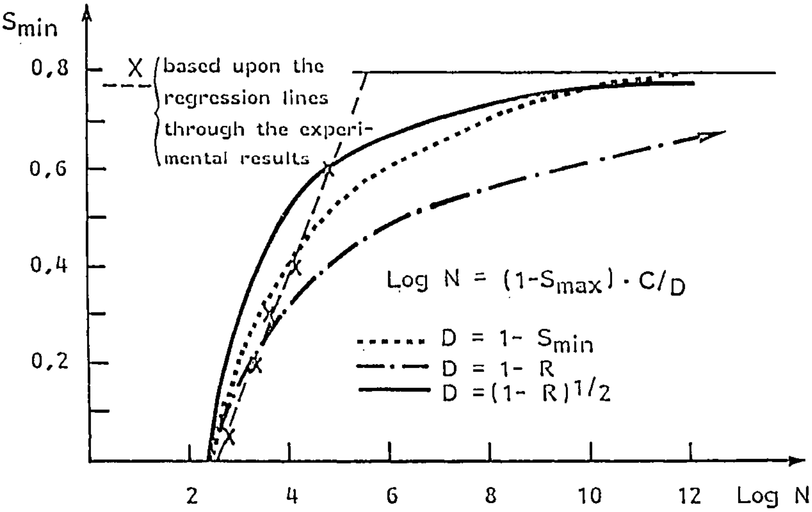

Fig. 11--Comparison of different design formulations with the experimental results regarding the influence of S_{min}. The constant C-12 and S_{max}-0.80 in this comparison.

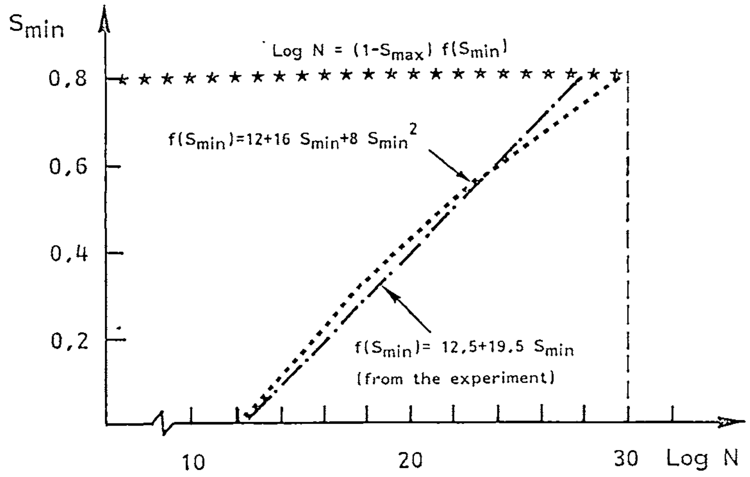

Fig. 12--Comparison of the proposed S_{min}-Log N relationship with the experimental results (values for S_{max}=0)

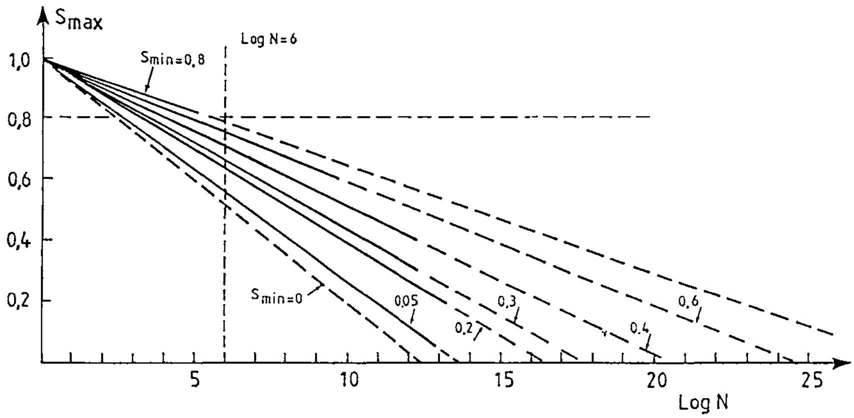

Fig. 13--Regression lines through S_{max}=1.0 for different stress levels obtained in this investigation

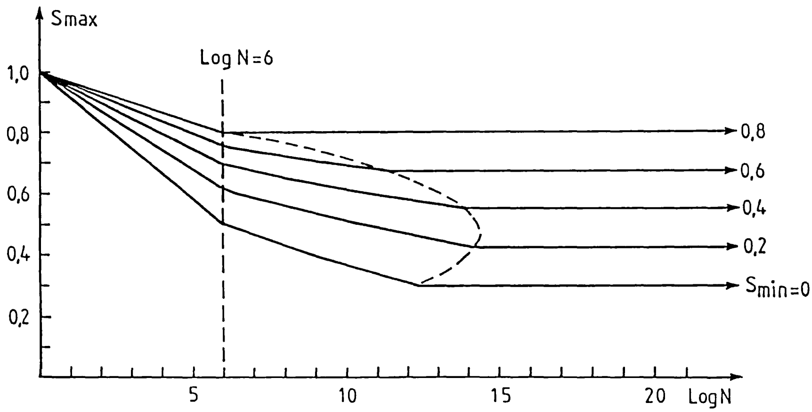

Fig. 14--The final S-N diagram for fatigue of concrete in compression

SP 121-26

Strength Development Characteristics of High-Strength Concrete Incorporating Supplementary Cementing Materials

by P. Read, G. G. Carette, and V. M. Malhotra

Synopsis: This paper presents data at ages up to one year on the strength development characteristics of high-strength concrete (>80 MPa) incorporating blast-furnace slag and/or silica fume or high volumes of ASTM Class F fly ash.

Six concrete mixtures of various compositions were investigated in this study. Five of these mixtures had the same cementitious materials content of 485 kg/m^3 of concrete, and the sixth mixture was typical of high-volume fly ash concrete incorporating a cement content of 150 kg/m^3 of concrete and large volumes of fly ash. The concrete was obtained from a commercial ready-mixed concrete plant. For each mixture, three types of structural elements simulating a thick wall, a thin wall and a thick column were fabricated for testing under field curing conditions. Cores, 100 x 200 mm in size, were drilled at ages up to one year for determining the in-situ compressive strength of the various concrete elements. In addition, a number of 150 x 300-mm cylinders were cast from each mixture for long-term strength testing.

The test results indicate that compressive strengths approaching 100 MPa at one year can be achieved using a superplasticizer, with or without the use of supplementary cementing materials.

The moist-cured test cylinders and the drilled cores from the various concrete elements indicate continued gain in strength of concrete at ages at least up to 365 days.

The use of silica fume is generally required if high early-age strengths are to be achieved in structural elements. However, if high early-age strength is not a critical factor, then the high-volume fly ash concrete seems to be the most promising system.

Keywords: blast-furnace slag; compressive strength; concrete cores; curing; cylinders; fly ash; high-strength concretes; plasticizers; silica fume; strength; tests

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INTRODUCTION

In recent years concrete mixtures incorporating supplementary cementing materials have been successfully supplied by ready-mixed concrete producers to meet compressive strengths in excess of 80 MPa at 56 or 90 days (1-7). Among the supplementary cementing materials used to produce high-strength concrete, silica fume is being utilized increasingly because of its role in decreasing permeability and its contribution to increase in strength at relatively early stages of hydration. Furthermore, because of its very small particle size (average size 0.1 mm) and spherical nature of the particles, silica fume, in combination with superplasticizers, helps to produce concrete of increased workability at very low water-to-cementitious materials ratios.

To date, there is little information available concerning the long-term properties of high-strength concretes made with mineral admixtures, particularly those containing silica fume. Limited laboratory investigations at the Canadian Centre for Mineral and Energy Technology (CANMET) have indicated that the long-term strength development of silica fume concrete test specimens could be somewhat adversely affected when cured in a continuously dry environment (8). Since the main reason for the success of this type of concrete is the high strengths that can be achieved, this phenomenon is obviously of particular concern to designers.