when yield occurred a considerable increment of plastic strain was noted. This phenomenon continued right up to failure.

It should be noted that the degree of axiality of loading in the initial stages of the test was probably not high because of the coarse threads on the end of the specimen. Also with two axial extensometers opposite one another it is impossible to estimate the magnitude of the non-axiality. Consequently it is impossible to determine the exact value of the upper yield stress in EN3, and even in material such as Vibrac which has a sharp yield there was significant non-linearity in the curve below the true yield. As a consequence it was decided to quote the 0.1% proof stress. Table 2 gives a summary of the results of torsion and tension tests.

Pressure tests have been carried out on cylinders with various values of diameter ratio K, made from the three steels being investigated, and at various temperatures. It is impossible to present all the graphs of the immense amount of data accumulated, and only those necessary to get the salient feature across are given. Figures 16 and 17 show the pressure/expansion curves at small and large strains for Vibrac specimens

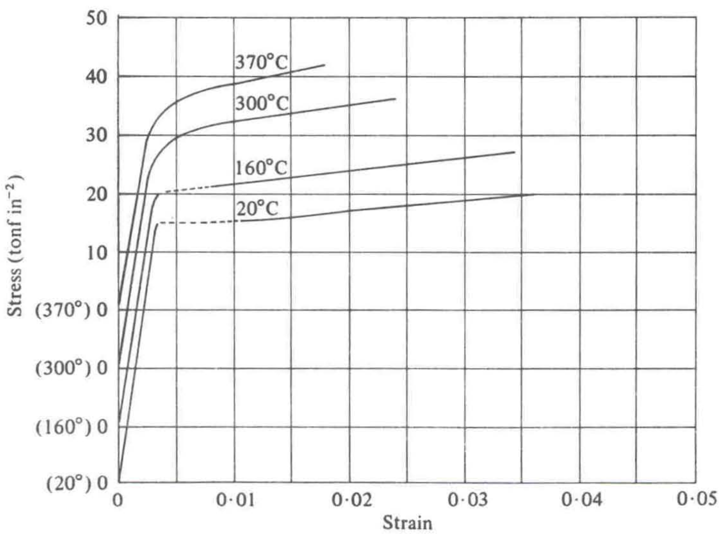

Figure 14. Tension tests on Vibrac.

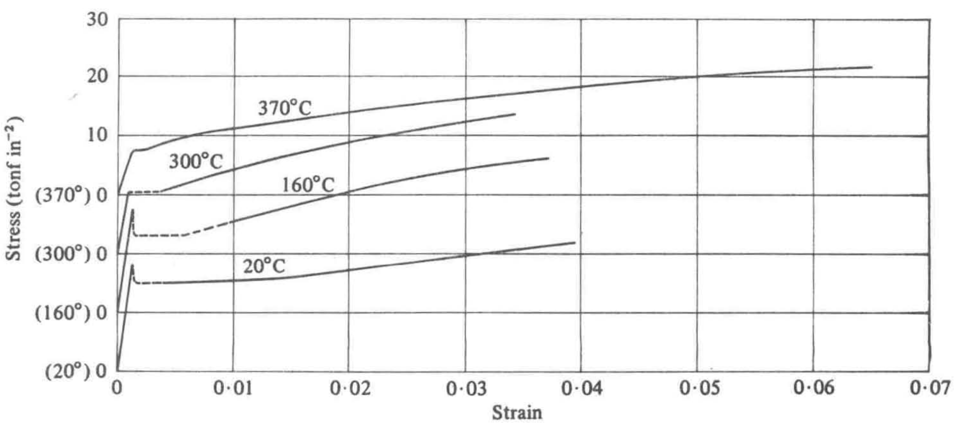

Figure 15. Tension tests on mild steel EN3A.

Table 2. Summary of torsion and tension tests (readings after 3 min delay).

Temperature (°C)	20	90	160	230	300	370
			Hykro (EN40)			
Torsion test						
Number of torsion specimens	4	–	2	–	5	2
Shear strain at failure	4·3	–	4·9	–	3·4	2·0
Modulus of rigidity G (tonf in^{-2})	5350	–	5110	–	4830	4680
Upper yield stress (tonf in^{-2})						
Lower yield stress (tonf in^{-2})	23·2-24·2	–	22·6-23·2	–	21·8	18·6-18·8
Shear stress at failure (tonf in^{-2})	38·2-37·2	–	35·5-35	–	37·2-35·8	31·7-30·2
Tension test						
% Elongation	14·5	–	12·8	–	11·3	12
% Reduction of area	74	–	73·2	–	72·3	70·4
Modulus of elasticity E (tonf in^{-2})	13600	–	12890	–	12300	12000
Upper tensile yield stress (tonf in^{-2})	–					–
Lower tensile yield stress (tonf in^{-2})	42 [d]	–	38·2 [d]	–	36 [d]	34·0 [d]
Ultimate tensile stress (tonf in^{-2})	57·1	–	50·9	–	48·8	49·4
			Vibrac (EN25)			
Torsion test						
Number of torsion specimens	10	–	4	–	5	5
Shear strain at failure	2·51	–	2·0	–	1·34	2·17 [a]
Modulus of rigidity G (tonf in^{-2})	5260	–	4970	–	4770	4590
Upper yield stress (tonf in^{-2})	–	–	–	–	–	–
Lower yield stress (tonf in^{-2})	23·8-25·4	–	21·1-23	–	20·4-21·8	17·1-18
Shear stress at failure (tonf in^{-2})	37·8-36·2	–	38-37	–	32·4	26-25·4
Tension test						
% Elongation	17·2-17·5	–	15·6	–	15·8	17·3
% Reduction of area	66·0-71	–	70·9	–	61·6	66
Modulus of elasticity E (tonf in^{-2})	13250	–	12730	–	12000	11600
Upper tensile yield stress (tonf in^{-2})	–	–	–	–	–	–
Lower tensile yield stress (tonf in^{-2})	44·1 [d]	–	39·2 [d]	–	35·5 [d]	29·0 [d]
Ultimate tensile stress (tonf in^{-2})	55·5-54·3	–	50·2	–	52·5	47·5
			EN3			
Torsion test						
Number of torsion specimens	6	1	3	1	4	2
Shear strain at failure	1·81	1·21	1·1	0·8	0·94	2·3 [a]
Modulus of rigidity G (tonf in^{-2})	5200	5055	5045	4900	4695	4385
Upper yield stress (tonf in^{-2})	9·6-9·1	9·4	9·4-8·9	8·3	5·9	3·6
Lower yield stress (tonf in^{-2})	6·8-6·6	6·6	6·9-6·6	6·0	4·9-4·8	–
Shear stress at failure (tonf in^{-2})	23·8-23·2	24·0	23·8-23·2	21·3	20·8-20·3	16·9-16·5 [b]
Tension test						
% Elongation	33·7	–	14·7-14·9%	–	26·7	24·2-28·6
% Reduction of area	68·6	–	46·5-46·2%	–	47·7	63-59·6
Modulus of elasticity E (tonf in^{-2})	13370	–	13270	–	12360	11600
Upper tensile yield stress (tonf in^{-2})	17·3-18·4 [c]	–	17·4-15·1 [c]	–	small drop	–
Lower tensile yield stress (tonf in^{-2})	15·0	–	13·3-13·1	–	10·3	7·5
Ultimate tensile stress (tonf in^{-2})	29·7	–	32·4-32·1	–	33·3	28·6-29·4

[a] The torque reached a maximum then decreased so that the shear strain is no longer uniform along the gauge length.
[b] The specimen failed at a lower torque than the maximum; maximum shear stress is quoted.
[c] No correction for eccentricity, so upper yield probably much higher; see Crossland and Bones (1958).
[d] 0·1% proof stress as distinct yield was not obtained.