



*Analysis of Wide Plate Tests
using SINTAP Failure
Assessment Diagrams*



UNIVERSITY OF CANTABRIA

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J. Ruiz Ocejo
F. Gutiérrez-Solana

Departamento de Ciencia e Ingeniería del Terreno y de los Materiales
E.T.S. de Ingenieros de Caminos, Canales y Puertos
Universidad de Cantabria
Avda de los Castros s/n
39005, Santander (Spain)
Tel. 34-942-201819, Fax 34-942-201818

1. MATERIALS

Plate	1	2	3	4	5	6	7
Material	S275J0	355EMZ	450EMZ	S690Q	ABR.400	S690Q	S690Q
Thickness (mm)	25	25	25	25	25	12	40
LYS or 0.2%PS (MPa)	303	436	471	713	991	820	746
UTS (MPa)	467	548	565	792	1408	864	859
LYS/UTS	0.649	0.796	0.834	0.900	0.704	0.949	0.868
Type of curve	Discont.	Discont.	Discont.	Contin.	Contin.	Discont.	Contin.
N (measured)	0.231	0.282	0.151	0.092	0.157	0.071	0.068
Charpy T27J (°C)	-65	-115	-115	-50	-45	-85	-85
Charpy at -20°C (J)	70	220	>250	100	35	180	170
CTOD at -20°C (mm)	0.974	0.765	1.450	0.083	0.022	0.140	0.235
CTOD R-curve (mm)	$1.03\Delta a^{0.50}$	$1.04\Delta a^{0.63}$	$1.31\Delta a^{0.71}$	-	-	-	$0.44\Delta a^{0.62}$

2. CALCULATIONS TO DERIVE THE DIFFERENT FAILURE ASSESSMENT LINES

Plate	1	2	3	4	5	6	7
FS (MPa)	385	492	518	752.5	1199.5	842	802.5
Cut-off	1.271	1.128	1.100	1.055	1.210	1.027	1.076
$\Delta\epsilon$	0.0261	0.0212	0.0198	-	-	0.0068	-
μ	-	-	-	0.295	0.212	-	0.282
λ	19.12	11.19	9.84	-	-	2.73	-
N	0.105	0.061	0.050	0.030	0.089	0.015	0.040
$L_{r\max}^{\text{est}}$	-	-	-	1.020	1.009	-	1.018

Three different Failure Assessment Lines have been drawn for each material (Default, Basic and SS in SINTAP Procedure Rev 5 and noted herein as FAD 0, 1 and 3 respectively).

3. TOUGHNESSES CONSIDERED

From the Charpy values, different toughnesses can be taken into account depending upon the test temperature (-20°C for all plates) whether this is higher than the transition one or not, thus depending if the material is either on the lower or transition regime or on the upper shelf.

If the material is above or near the transition temperature (T_{27J}), two different equations from Section CH can be used (Eq. 2 -lower bound- and Eq. 3 -Master curve- of SINTAP Revision 5). Only Plate 5 can be said that behaves on the lower shelf. If the material is on the upper shelf, Equation 11 from Section CH should be used instead the previous ones.

These three options have been noted as Toughness 1*, 1** and 1 respectively in the following tables and figures.

On the other hand, if CTOD-values are considered, these can be translated into K-values by means of Equations 5 and 6 in the mentioned Section CH. Factors 1.5 and 1.3 have been used for yield and flow stress respectively and plane strain has been supposed ($E=210\text{ GPa}$, $\nu=0.3$).

Plate	1	2	3	4	5	6	7
$l \approx B$	135	135	135	135	135	135	135
K_{mat25}	-	-	-	-	71.0	-	-
P_f	-	-	-	-	0.05	-	-
$K_{mat} (1^*) (\text{MPam}^{1/2})$	-	-	-	-	53.5	-	-
$K_{mat} (1^{**}) (\text{MPam}^{1/2})$	-	-	-	-	59.9	-	-
$K_{mat} (1) (\text{MPam}^{1/2})$	106.5	189.8	201.9	128.1	-	172.1	167.3
$K_{mat} (2) (\text{MPam}^{1/2})$	319.6	336.0	474.7	136.9	86.9	188.1	237.9

4. CRACKS CONSIDERED

All the flaws analysed within this work have been considered as Finite surface crack in a plate. For some plates two different crack sizes have been studied; the real one and a nominal one of 5 mm.

The dimensions are summarised in the following table:

Plate	1	2	3	4	5	6	7
l (mm)	135	135	135	135	135	135	135
t (mm)	25	25	25	25	25	12	40
a real (mm)	5	6.5	6.8	5.5	5	3.1	8.4
a nominal	-	5	5	5	-	-	-

5. L_r AND K_I SOLUTIONS

From Stress Intensity Factor and Limit Load Handbook, Issue 1, September 1998,

L_r (AII.42):

$$L_r = \frac{\sigma}{(1-\zeta)\sigma_Y}$$

where

$$\zeta = \frac{al}{t(1+2t)}$$

K_I (AI.3) -deepest point of the crack-:

$$K_I = \sigma f_0 \sqrt{\pi a}$$

(Linear interpolation has been used for f_0 determination)

The following table details the corresponding factor ζ and f_0 values for the plates.

Plate	1	2	3	4	5	6	7
ζ (real a)	0.1459	0.1897	0.1985	0.1605	0.1459	0.2193	0.1319
f_0 (real a)	1.2151	1.2904	1.3026	1.2421	1.2151	1.3991	1.1753
ζ (nominal a)	-	0.1459	0.1459	0.1459	-	-	-
f_0 (nominal a)	-	1.2151	1.2151	1.2151	-	-	-

6. RESULTS

The maximum acceptable applied stress for each plate, crack, toughness and FAD considered are pointed out in the table where the results are in MPa.

Plate	Crack size	Toughness	FAD 0	FAD 1	FAD 3
1	5	1	259	259	259
		2	259	291	329
2	5	1	372	372	419
		2	372	398	420
	6.5	1	353	353	398
		2	353	371	398
3	5	1	402	404	412
		2	402	438	441
	6.8	1	378	378	378
		2	378	405	413
4	5	1	558	589	604
		2	572	606	610
	5.5	1	537	566	589
		2	551	583	595
5	5	1*	337	338	-
		1**	374	375	-

		2	513	519	-
6	3.1	1	640	647	629
		2	640	651	633
7	8.4	1	589	623	639, 658
		2	659	661	672

7. ANNEX

The following pages present all the assessment graphics needed to perform the calculations.

Plate 1. S275J0

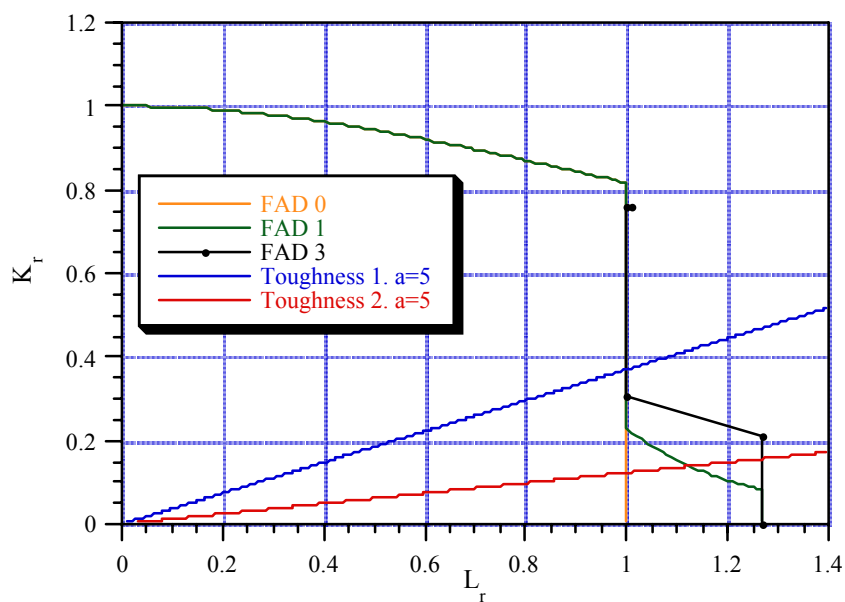


Plate 2. 355EMZ

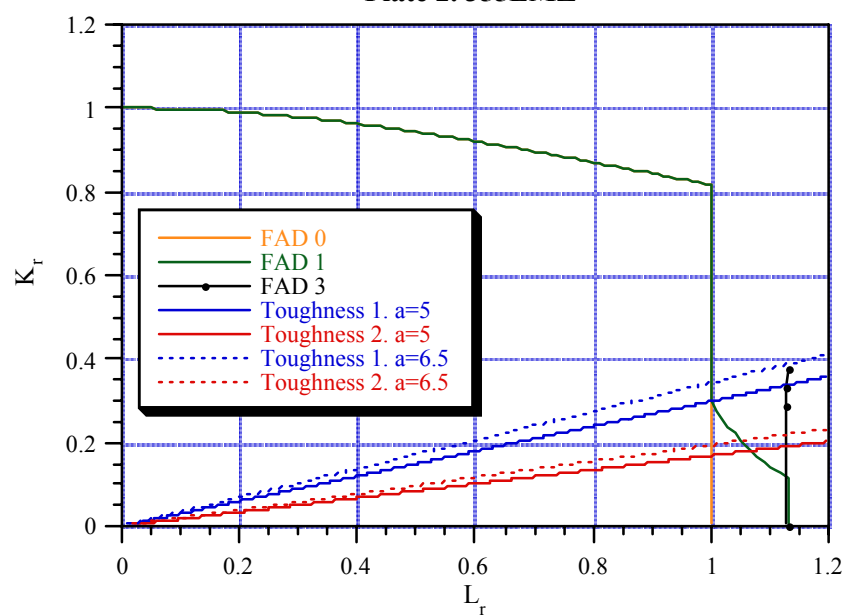


Plate 3. 450EMZ

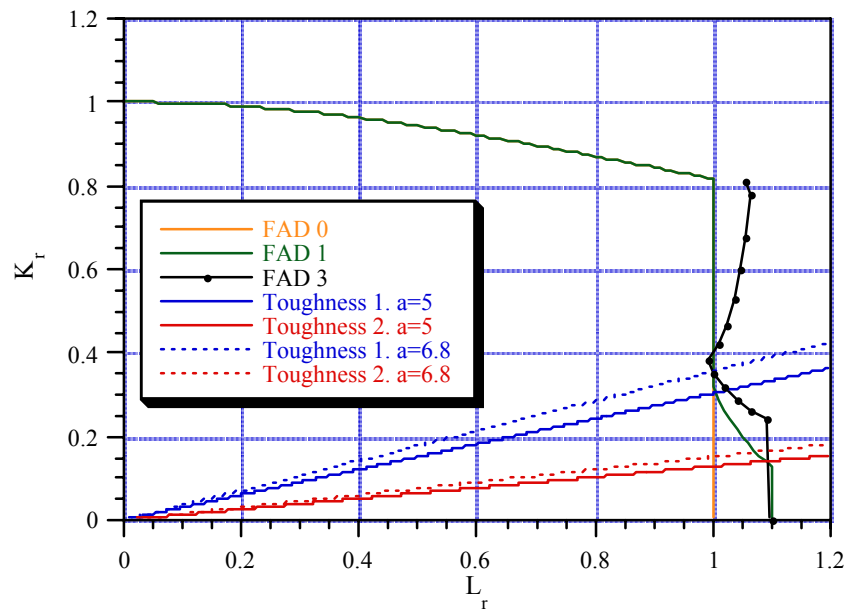


Plate 4. S690Q

