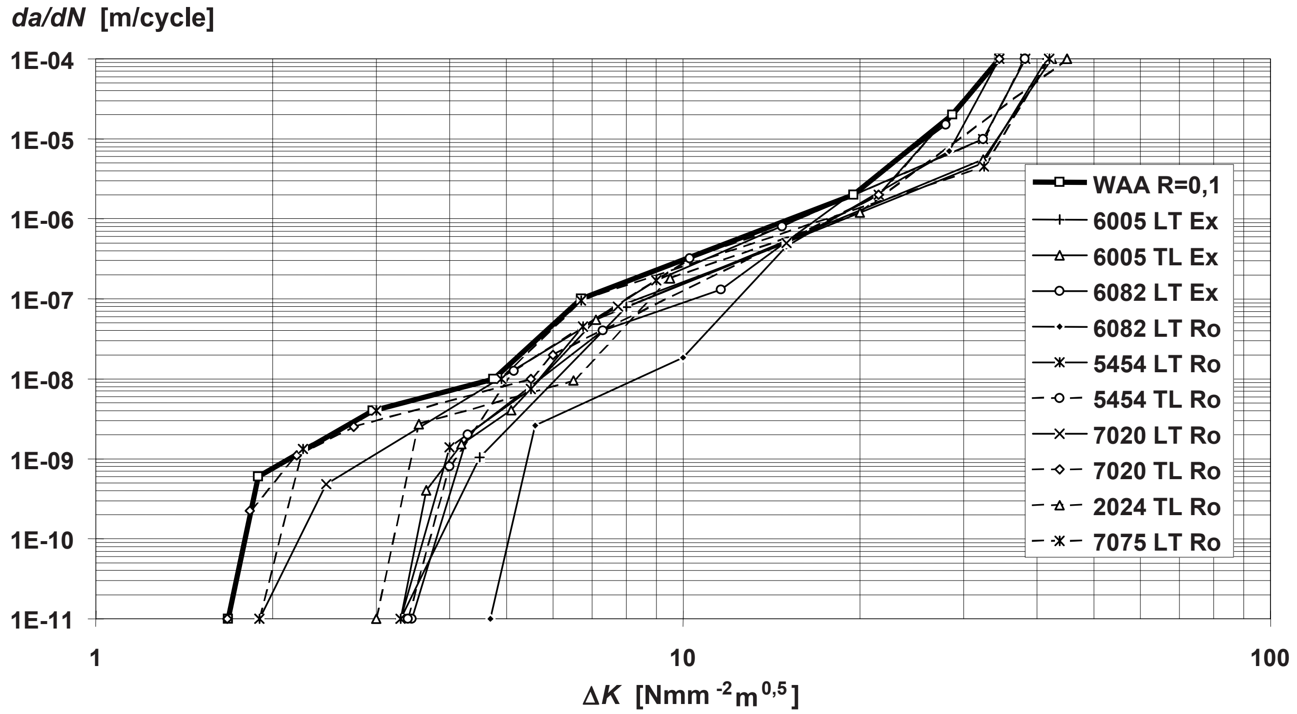
Table B.1(a) —Fatigue crack growth rate data for EN AW-6005A T6 LT, $R = K_{min}/K_{max}$ = constant

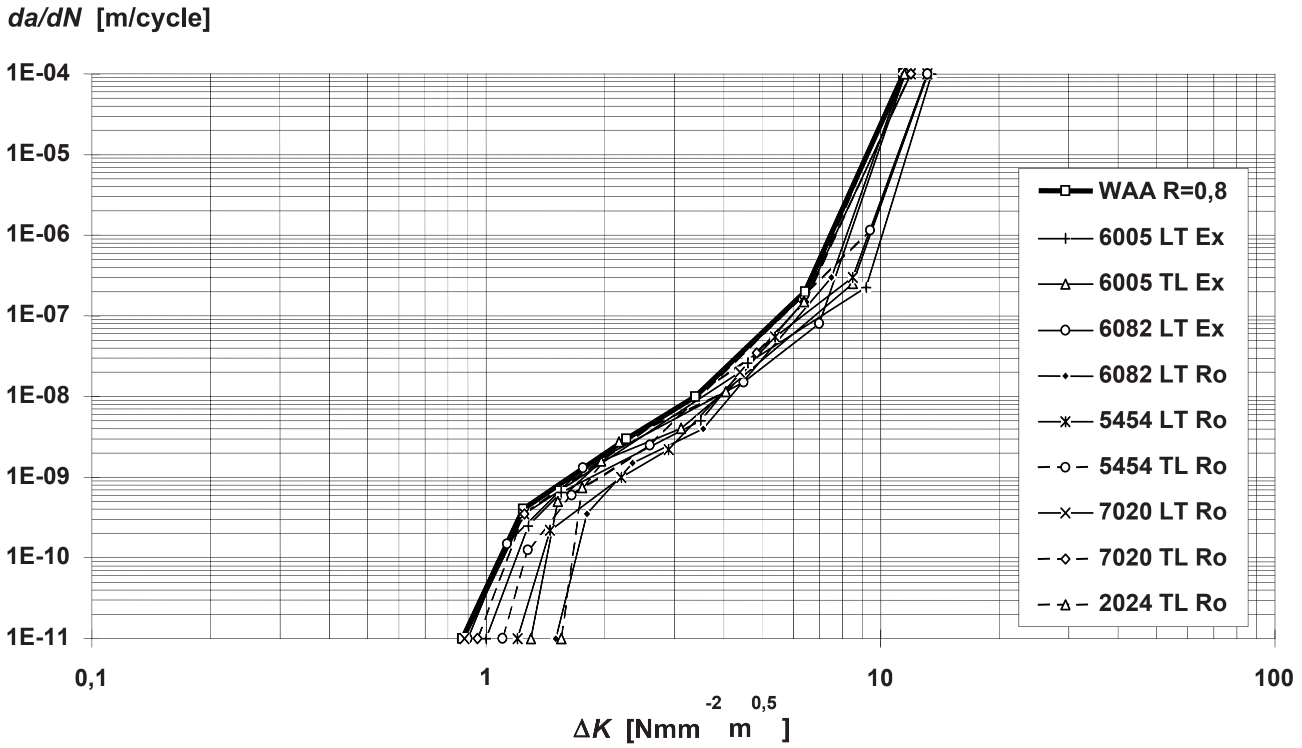
R-ratio	Stress Intensity ΔK [$Nmm^{-2}m^{0,5}$]	*m*	*A*	*R*-ratio	Stress Intensity ΔK [$Nmm^{-2}m^{0,5}$]	*m*	*A*
0,100	3,30	15,00	1,65789E-19	0,500	2,00	16,29	1,24322E-16
	4,50	7,52	1,29310E-14		2,72	3,85	3,17444E-11
	8,00	2,96	1,67380E-10		4,20	4,87	7,41477E-12
	32,4	12,0	4,10031E-24		6,50	2,81	3,50674E-10
	41,61	12,0	4,10031E-24		21,00	12,23	1,21158E-22
	60,00	12,0	4,10031E-24		29,17	12,23	1,21158E-22
					42,50	12,23	1,21158E-22
0,200	2,90	18,53	2,67965E-20	0,650	1,50	16,93	1,04285E-14
	3,80	5,87	5,94979E-13		1,95	4,43	4,41861E-11
	7,50	2,93	2,22754E-10		2,20	2,39	2,20681E-10
	29,60	12,43	2,25338E-24		3,55	4,77	1,06838E-11
	37,98	12,43	2,25338E-24		6,00	3,05	2,32639E-10
	55,00	12,43	2,25338E-24		15,00	12,00	6,08450E-21
					22,18	12,00	6,08450E-21
0,300	2,60	18,67	1,77471E-19	0,800	1,00	13,03	9,99999E-12
	3,40	5,24	2,47080E-12		1,28	4,99	7,28970E-11
	7,35	2,82	3,06087E-10		1,55	2,50	2,16851E-11
	26,00	12,40	8,41151E-24		3,50	6,03	2,61124E-12
	34,49	12,40	8,41151E-24		4,60	3,12	2,22506E-10
	50,00	12,40	8,41151E-24		9,20	15,93	9,83032E-23
					13,48	15,93	9,83032E-23

Table B.1(b) – Fatigue crack growth rate data for EN AW-6005A-T6 LT, K_{max} = 10 Nmm^{-2}m^{0,5} = constant

R-ratio	Stress Intensity ΔK [Nmm^{-2}m^{0,5}]	*m*	*A*	*R*-ratio	Stress Intensity ΔK [Nmm^{-2}m^{0,5}]	*M*	*A*
0,100	0,85	11,09	6,06810E-11	0,500	0,85	11,09	6,06910E-11
	1,16	3,74	1,80712E-10		1,16	3,74	1,80712E-10
	1,60	2,69	2,96984E-10		1,60	2,70	2,95817E-10
	8,00	2,96	1,67380E-10		5,55	5,09	4,92250E-12
	32,40	12, 0	4,10322E-24		6,50	2,81	3,50674E-10
	41,61	12, 0	4,10322E-24		21,00	12,20	1,20951E-22
					29,17	12,20	1,20951E-22
0,300	0,85	11,09	6,06910E-11	0,650	0,85	11,09	6,06910E-11
	1,16	3,74	1,80712E-10		1,16	3,74	1,80712E-10
	1,60	2,71	2,93585E-10		1,60	2,69	2,96037E-10
	6,70	5,52	1,41317E-12		4,95	4,76	1,08127E-11
	7,35	2,82	3,06087E-10		6,00	3,05	2,32639E-10
	26,00	12,40	8,42100E-24		15,00	12,04	6,08100E-21
	34,49	12,40	8,42100E-24		22,18	12,04	6,08100E-21
				0,800	0,85	11,09	6,06910E-11
					1,16	3,74	1,80712E-10
					1,60	2,72	2,92718E-10
					4,15	6,01	2,68983E-10
					4,60	3,12	2,22506E-10
					9,20	15,93	9,81913E-23
					13,48	15,93	9,81913E-23



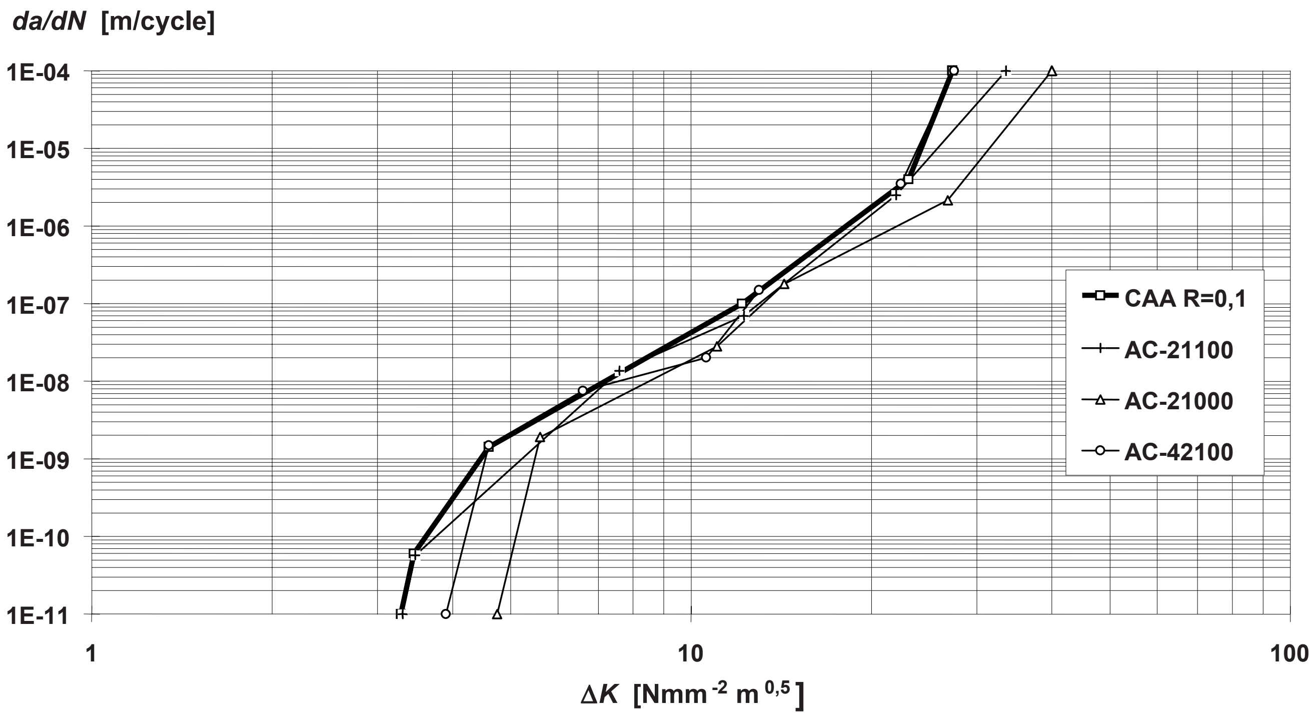
a) R = 0,1



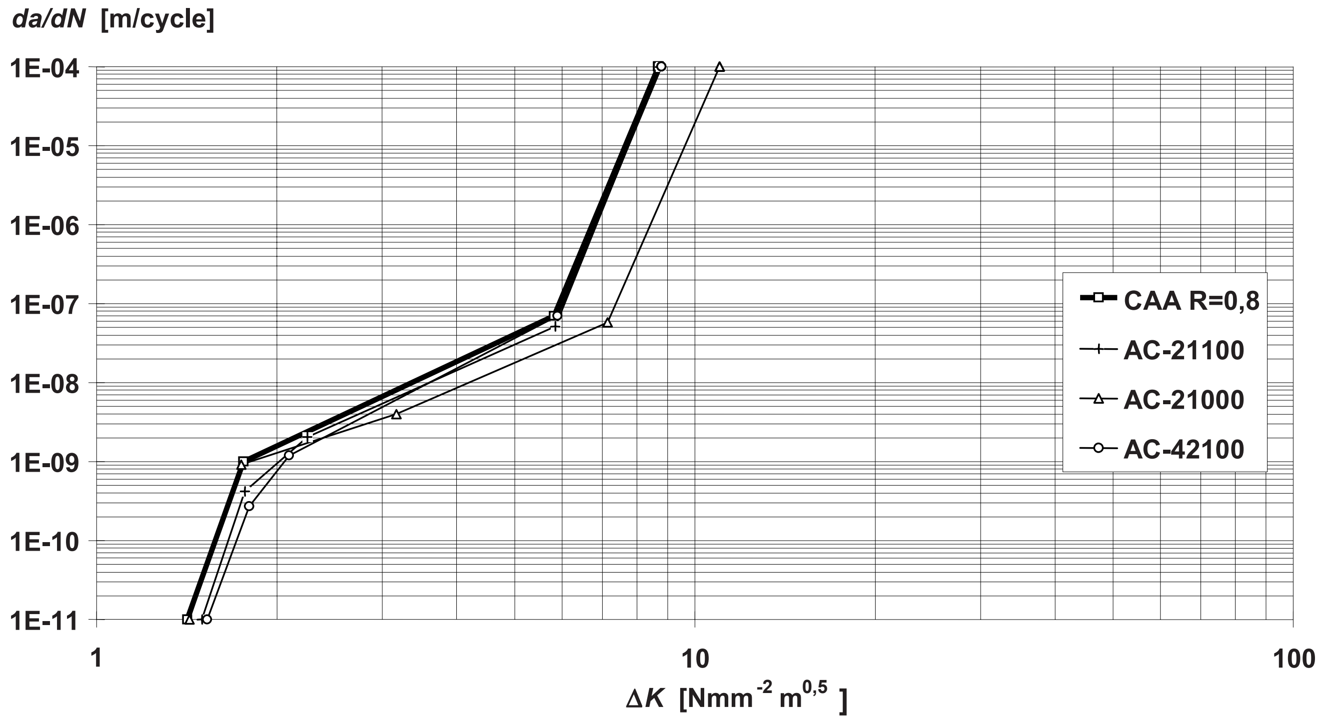
b) R = 0,8

Figure B.4 – Typical fatigue crack growth rate curves for various wrought alloys

NOTE The alloys 2024 TL Ro and 7075 LT Ro are not recommended for buildings and civil engineering works. They are given here for comparative reasons.



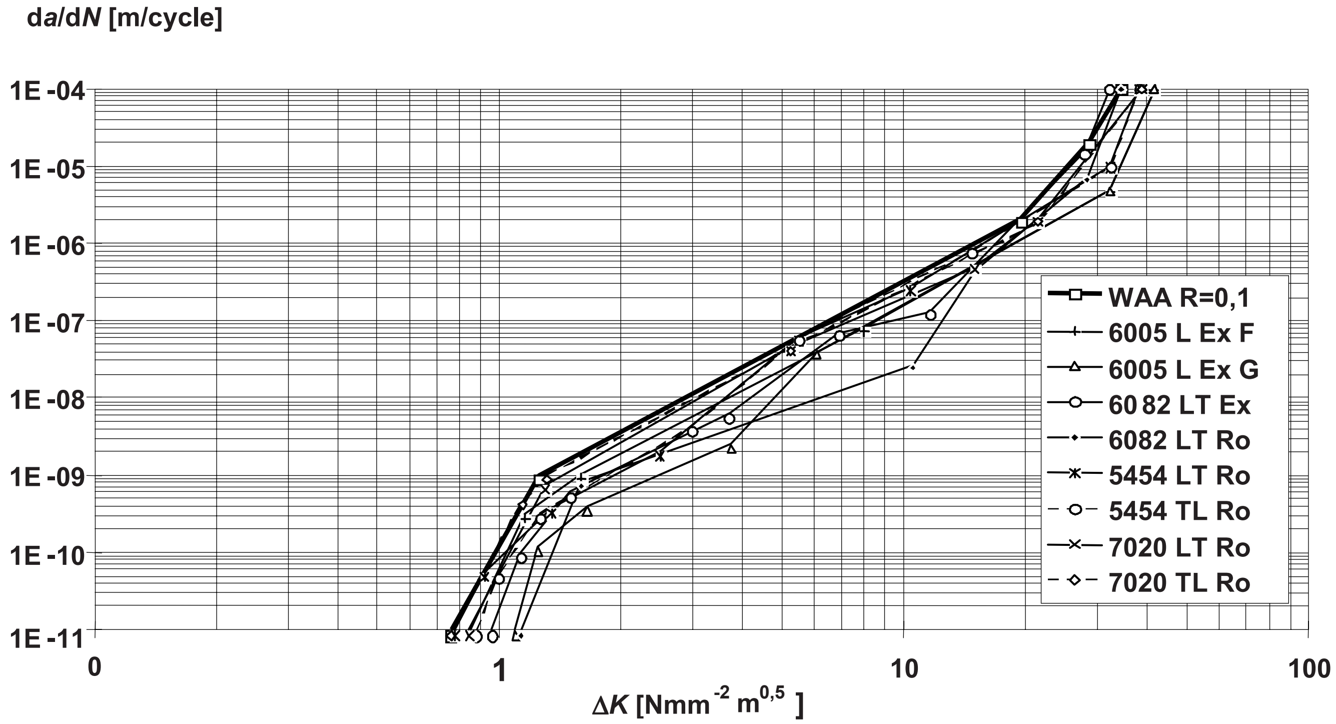
a) R = 0,1



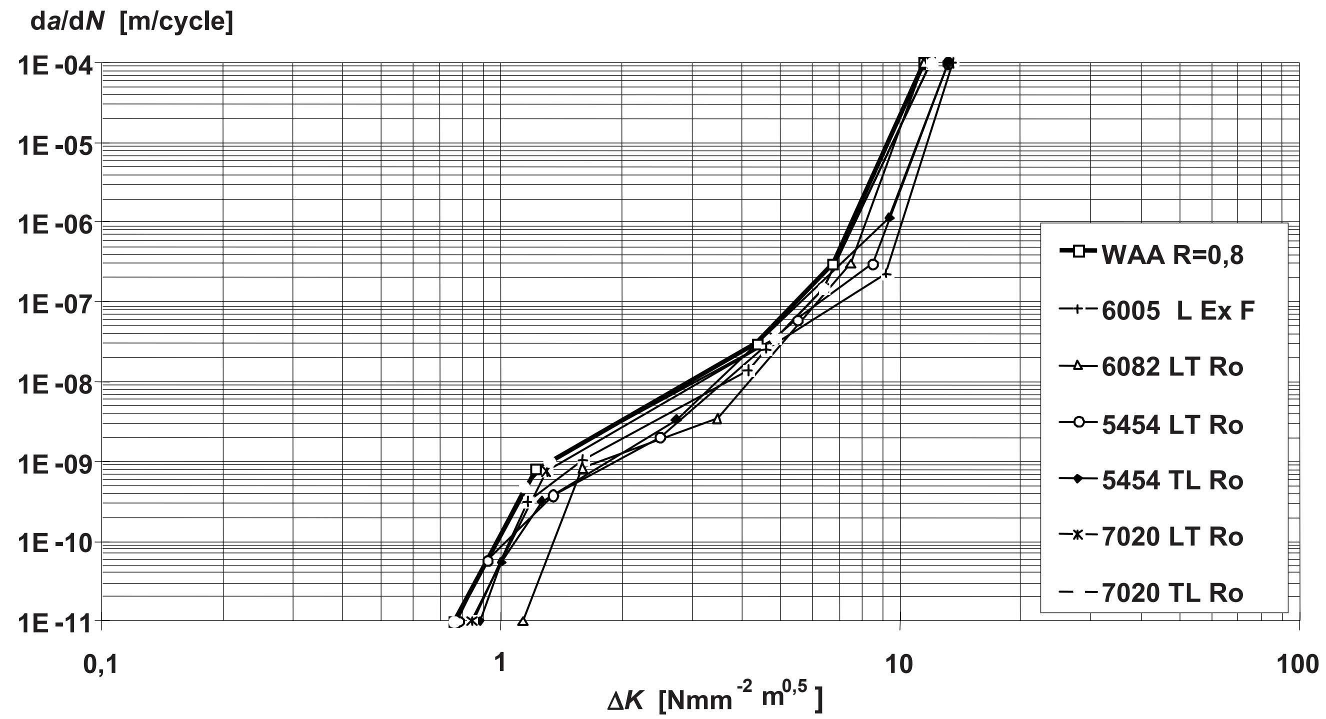
b) R = 0,8

Figure B.5 – Typical fatigue crack growth curves for various cast alloys

NOTE The alloys AC-21100 and AC-211000 are not recommended for buildings and civil engineering works. They are given here for comparative reasons.



a) R = 0,1; K_{max} = 10 Nmm^{-2}m^{0,5}



b) R = 0,8; K_{max} = 10 Nmm^{-2}m^{0,5}

Figure B.6 – Typical fatigue crack growth curves for various wrought alloys

Table B.2 – Fatigue crack growth rate data for wrought alloys, $R = K_{min}/K_{max}$=constant

R-ratio	Stress Intensity ΔK [$Nmm^{-2}m^{0,5}$]	*m*	*A*
a) 0,100	1,68	34,8	1,47182E-19
	1,89	4,23	4,06474E-11
	2,96	1,94	4,88644E-10
	4,75	6,69	2,95135E-13
	6,70	2,80	4,82538E-10
	19,51	5,96	4,12350E-14
	28,70	8,74	3,57541E-18
	34,50	8,74	3,57541E-18
b) 0,800	0,87	10,43	4,27579E-11
	1,24	3,33	1,95935E-10
	2,27	2,98	2,60324E-10
	3,40	4,69	3,24644E-11
	6,44	10,8	3,73040E-16
	11,45	10,8	3,73040E-16

NOTE These values are upper bound envelopes derived from curves in Figure B.4(a) and (b).

Table B.3 —Fatigue crack growth rate cast alloys $R = K_{min}/K_{max}$ = constant

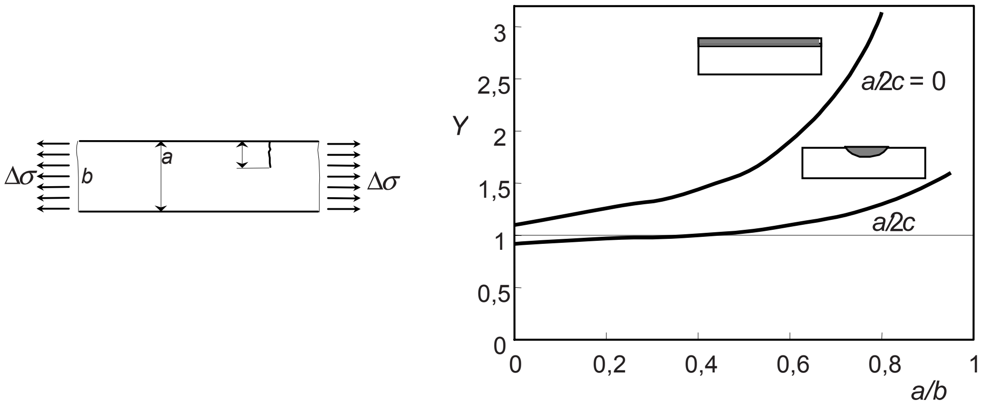
R-ratio	Stress Intensity ΔK [$Nmm^{-2}m^{0,5}$]	*m*	*A*
a) 0,100	3,28	35,46	5,10219E-30
	3,45	11,01	7,18429E-17
	4,60	4,37	1,82159E-12
	12,18	5,78	5,37156E-14
	23,07	19,12	3,47503E-32
	27,30	19,12	3,47503E-32
b) 0,800	1,42	21,24	6,08486E-15
	1,76	3,55	1,34235E-10
	5,82	18,1	1,05480E-21
	8,70	18,1	1,05480E-21

NOTE Values are upper bound envelopes derived from curves in Figure B.5(a) and (b).

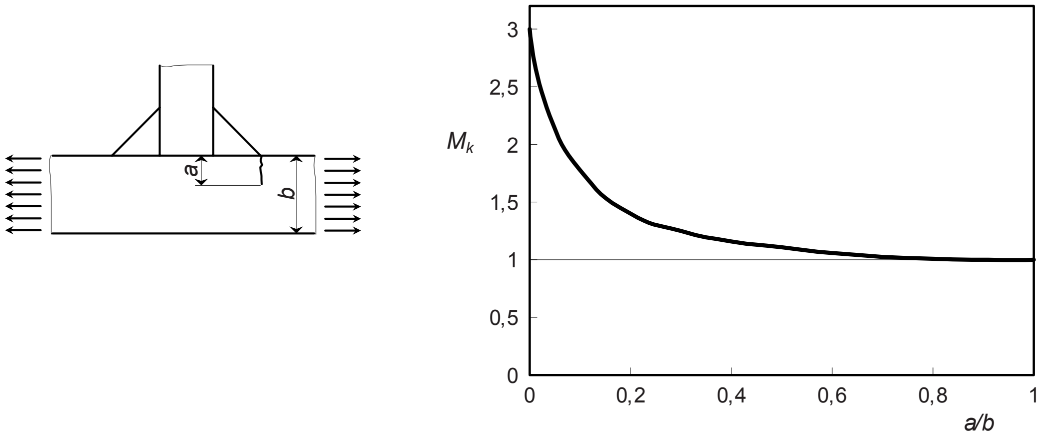
Table B.4 – Fatigue crack growth rate data for wrought alloys, *K*max=10 Nmm-2m0,5 = constant

R-ratio	Stress Intensity ΔK [$Nmm^{-2}m^{0,5}$]	*m*	*A*
0,100	0,76	9,13	1,21148E-10
	1,26	2,77	5,26618E-10
	19,50	5,95	4,18975E-14
	28,71	8,79	3,07173E-18
	34,48	8,79	3,07173E-18
0,800	0,76	9,27	1,27475E-10
	1,22	2,84	4,56026E-10
	4,37	5,28	1,24266E-11
	6,76	11,02	2,12818E-16
	11,45	11,02	2,12818E-16

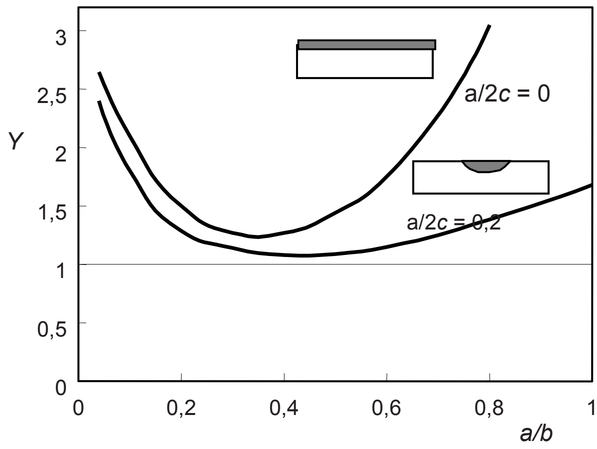
NOTE Values are upper bound envelopes derived from curves in Figure B.6(a) and (b).



a) *Y* value for plain plate; *a*/*b* = crack depth ratio



b) M_k value for weld toe stress concentration



c) *Y* values for welded joint

Figure B.7 – Use of typical standard geometry solutions for *Y* and M_k

Annex C [informative]: Testing for fatigue design

C.1 General

(1) Where there are insufficient data for complete verification of a structure by calculations in accordance with 2.2.1 or 2.2.2, supplementary evidence should be provided by a specific testing programme. In this case test data may be required for one or more of the following reasons:

a) The applied load history or spectrum, for either single or multiple loads, is not available and is beyond practical methods of structural calculations (see 2.3.1 and 2.3.2). This may apply particularly to moving, hydraulically or aerodynamically loaded structures where dynamic or resonance effects can occur;

b) the geometry of the structure is so complex that estimates of member forces or local stress fields can not be obtained by practical methods of calculations (see 5.2 and 5.4);

c) the materials, dimensional details, or methods of manufacture of members or joints are different from those given in detail category tables;

d) crack growth data are needed for damage tolerant design verification.

(2) Testing may be carried out on complete prototypes, on structures equal to the one to be built or on component parts thereof. The type of information being derived from the test should take into account the degree to which the loading, materials, constructional details and methods of manufacture of the test structure or components thereof reflect the structure to be built.

(3) Test data should only be used in lieu of standard data if it is obtained and applied using controlled procedures.

C.2 Derivation of action loading data

C.2.1 Fixed structures subject to mechanical action

(1) This includes structures such as bridges, crane girders and machinery supports. Existing similar structures subject to the same loading sources may be used to obtain the amplitude, phasing and frequency of the applied loads.

(2) Strain, deflection or acceleration transducers fixed to selected components which have been calibrated under known applied loads can record the force pattern over a typical working period of the structure, using analog or digital data acquisition equipment. The components should be selected in such a way that the main load components can be independently deduced using the influence coefficients obtained from the calibration loads.

(3) Alternatively load cells can be mounted at the interfaces between the applied load and the structure and a continuous record obtained using the same equipment.

(4) The mass, stiffness and logarithmic decrement of the test structure should be within 30% of that in the final design and the natural frequency of the modes giving rise to the greatest strain fluctuations should be within 10%. If this is not the case the loading response should be subsequently verified on a structure made to the final design.

(5) The frequency component of the load spectrum obtained from the working period should be multiplied by the ratio of the design life to the working period to obtain the final design spectrum. Allowance for growth in intensity or frequency, or statistical extrapolation from measured period to design life should also be made as required.

C.2.2 Fixed structures subject to actions due to exposure conditions

(1) This includes structures such as masts, chimneys, and offshore topside structures. The methods of derivation of the loading spectrum are basically the same as in C.2.1 except that the working period will generally need to be longer due to the need to obtain a representative spectrum of exposure condition loads such as wind and wave actions. The fatigue damage tends to be confined to a specific band in the overall loading spectrum due to effects of fluid flow induced resonance. This tends to be very specific to direction, frequency and damping. For this reason greater precision is needed in simulating both the structural properties (mass, stiffness and damping) and aerodynamic properties (cross-sectional geometry).

(2) It is recommended that the loading is subsequently verified on a structure to the final design if the original loading data are obtained from structures with a natural frequency or damping differing by more than 10%, or if the cross-sectional shape is not identical.

(3) A final design spectrum can be obtained in terms of direction, intensity and frequency of loading, suitably modified by comparing the loading data during the data collection period with the meteorological records obtained over a typical design life of the structure.

C.2.3 Moving structures

(1) This includes structures such as travelling cranes and other structures on wheels, vehicles and floating structures. In these types of structure the geometry of the riding surface should be adequately defined in terms of shape and amplitude of undulations and frequency, as this will have a significant effect on the dynamic loading on the structure.

(2) Other load effects such as cargo on and off loading can be measured using the principles outlined in C.2.1.

(3) Riding surfaces such as purpose-built test tracks may be used to obtain load histories for prototype designs. Load data from previous structures should be used with caution, as small differences, particularly in bogie design for example, can substantially alter the dynamic response. It is recommended that loading is verified on the final design if full scale fatigue testing is not to be adopted (see C.3).

C.3 Derivation of stress data

C.3.1 Component test data

(1) Where simple members occur such that the main force components in the member can be calculated or measured easily it will be suitable to test components containing the joint or constructional detail to be analysed.

(2) A suitable specimen of identical dimensions to that used in the final design should be gauged according to the simplified geometric stress assessment (see Annex D) using a convenient method such as electric resistance strain gauges, moiré fringe patterns or thermal elastic techniques. The ends of the component should be sufficiently far from the local area of interest that the local effects at the point of application of the applied loads do not affect the distribution of stress at the point. The force components and the stress gradients in the region of interest should be identical to those in the whole structure.

(3) Influence coefficients can be obtained from statically applied loads which will enable the stress pattern to be determined for any desired combination of load component. If required the coefficients can be obtained from scaled down specimens, provided the whole component is scaled equally.