



ESDU 04019

Issued August 2004

With Amendment A

November 2006

Endurance of high-strength steels

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THE PREPARATION OF THIS DATA ITEM

The work on this particular Data Item was monitored and guided by the Fatigue Committee, which first met in 1955 and now has the following membership:

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ENDURANCE OF HIGH-STRENGTH STEELS

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ENDURANCE OF HIGH-STRENGTH STEELS

1. INTRODUCTION

This Data Item presents endurance data for high-strength steels. The results of more than 10 000 constant-amplitude fatigue tests, on plain and notched specimens subjected to rotating-bending, plain-bending and axial loading, are presented in the form of curves of S_a against N ; additional figures, where the effects of different variables are illustrated, are presented as curves of S_a/f_t against N .

The curves through the data have been derived using ESDUpac A9724, the program that accompanies Data Item No. 97024*. The equations of the curves are given on the figures.

In this Data Item, a high-strength steel is defined as a steel having a room-temperature 0.2 per cent proof stress greater than 800 MN/m^2 ($116 \times 10^3 \text{ lbf/in}^2$). The data presented relate to the medium- and high-cycle regimes, that is endurance of greater than 10 000 cycles.

The data are grouped according to type of steel, based on the unified numbering system (UNS) codes, and also according to alloy content, the tempering temperature applied to the specimen before testing, the test-piece shape, the surface condition of the specimen and the size of the notch, when present. Test temperature and mean stress are also considered.

An index to the data presented is given near the beginning of Section 5. The data points that are plotted on the figures are also available in the Microsoft™ Excel file, E0419v10.xls, which accompanies this Data Item. (Note that the values given in the file are not, in some cases, the actual test results, but are values digitised from figures in the derivations.)

Additional data on the endurance of high-strength steels in bending are presented in Data Item No. 71027†.

2. NOTATION

Both SI and British units are quoted. Further, more detailed, definitions of terms employed in this Item can be found in Data Item No. 70016‡; for convenience, the definitions of fatigue strength and fatigue limit given in that Item are reproduced in part at the end of this section.

f_t	ultimate tensile strength	N/m^2	lbf/in^2
K_t	theoretical elastic stress concentration factor based on net cross-sectional area		
N	endurance	cycles	cycles
R	stress ratio		
S_a	alternating stress	N/m^2	lbf/in^2
S_m	mean stress	N/m^2	lbf/in^2
S_{max}	algebraic maximum stress in cycle	N/m^2	lbf/in^2

* Data Item No. 97024, "Derivation of endurance curves from fatigue test data, including run-outs".

† Data Item No. 71027, "Endurance of high strength steels (in bending)".

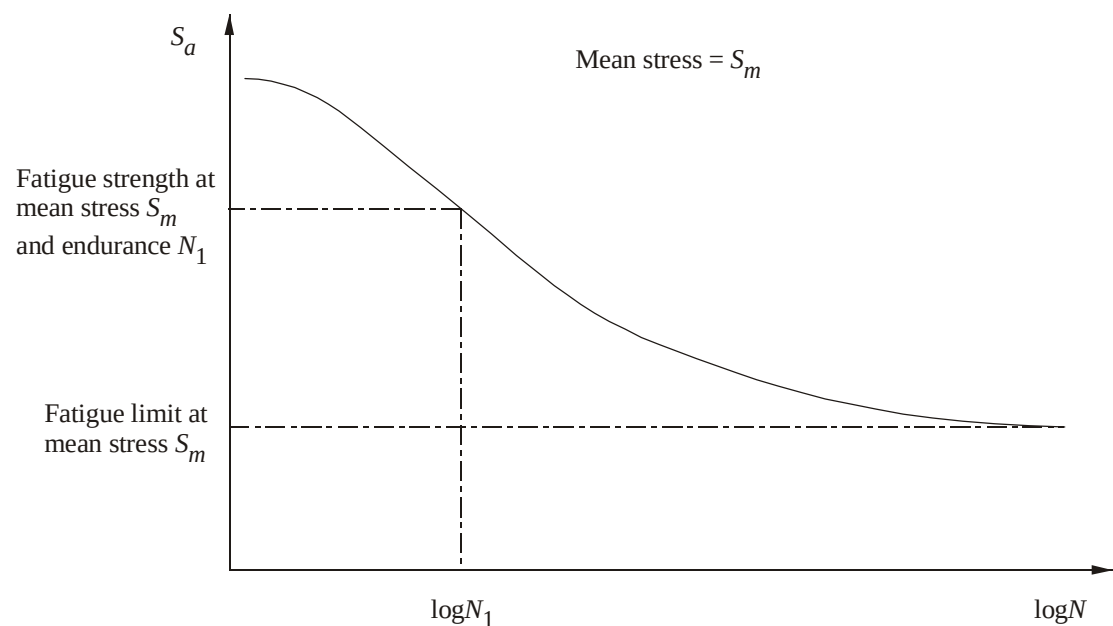
‡ Data Item No. 70016, "Terms and notation for fatigue endurance data".

S_{nom}	nominal stress based on net cross-sectional area	N/m^2	lbf/in^2
t_2	0.2 per cent proof stress	N/m^2	lbf/in^2
σ_{max}	maximum local stress	N/m^2	lbf/in^2
σ_y	yield stress	N/m^2	lbf/in^2

- Fatigue strength – The alternating stress at a specified mean stress that gives rise to an endurance N , see Sketch 2.1. In order to distinguish between fatigue strengths at different mean stresses and endurances, the values of mean stress and endurance should be quoted, though they are often omitted for brevity.
- Fatigue limit – The highest level of alternating stress for a given mean stress at which the endurance may be regarded as infinite, see Sketch 2.1. Where a fatigue limit has not been shown to exist, is often taken to be the value of alternating stress at an acceptably high value of N .

2.1 Abbreviations

AC	Air-cooled	NA	Not available
Ad	Austenised	OQ	Oil-quenched
Cbz	Carburized	Q	Quenched
FC	Furnace-cooled	rms	root-mean-square
HR	Hot-rolled	RT	Room temperature
h	hours	SR	Stress-relieved
LPB	Low-plasticity-burnished	T	Tempered
min	minutes	WC	Water-cooled
N	Normalised		



Sketch 2.1 Illustration of fatigue strength and fatigue limit

3. DISCUSSION OF DATA PRESENTED

3.1 General

There is a fairly strong relationship between fatigue strength and tensile strength, fatigue strength increasing with increasing strength. This relationship is illustrated, in terms of fatigue limit, in Data Item No. 88008^{*}; the relationship between fatigue limit and tensile strength does, however, become less pronounced at the extremes of the practical range of strengths for a given material.

3.2 Tempering Temperature

Tempering is heat treatment used to control the mechanical properties of a steel and also to relieve any residual stresses created in cold working; the tempering temperature and duration are dependent on the steel type and final properties required.

Data are presented for materials tempered at temperatures of between 420 and 850°C (790 and 1560°F). In this range of temperatures, the precipitates present in the steel are subject to effects such as Ostwald ripening (coarsening) (note that this is a time-dependent process) and grain-boundary segregation, and a decrease in the density of dislocations occurs. Each of these effects leads to a decrease in the strength of the steel and a decrease in fatigue strength, see Reference 25. See Figures 1a, 4a, 4b, 6a to 6c, 8a, 8b, 9a, 10a, 10b, 11a, 12a and 13a which show a decrease in fatigue strength with increasing tempering temperature. Figure 14a is a comparative plot that illustrates this effect.

The effects of tempering temperature on the fatigue strength of high-strength steels are non-linear; for tempering temperatures between approximately 300 and 400°C (570 and 750°F), an increase in tempering temperature increases the fatigue strength, see Reference 19. This is due to the formation of carbides throughout the structure, which pin mobile dislocations and increase the ultimate tensile strength of the steel and, in doing so, increase the fatigue strength.

3.3 Mean Stress

Data are presented for values of R of 0 and -1 . As is generally the case for other materials, for most high-strength steels, an increase in mean stress results in a decrease in fatigue strength. This effect can be seen in Figures 1b, 2c, 5c, 6d, 7c, 8b, 9b, 11b, 12b and 13b and a comparative plot is presented in Figure 14b in which the results of tests with stress ratios of $R = -1$ ($S_m = 0$) and $R = 0$ ($S_m = S_{mqx}/2$) are presented. The effects of mean stress are covered in Data Items Nos FAT A.00.01[†], FAT A.00.02[‡] and 76014^{**}.

3.4 Test Temperature and Frequency

Data obtained from tests conducted between room temperature and 600°C (1110°F) are presented.

As temperature increases, the fatigue strength of high-strength steels decreases, as can be seen in Figures 3a to 3e, 11c to 11g and 14c.

There are two basic ways in which exposure to elevated temperatures lowers the fatigue strength of steels: firstly, the tensile strength decreases as a direct result of exposure to elevated temperature and consequently the fatigue strength decreases; secondly, as an elevated-temperature test progresses, the tensile strength

* Data Item No. 88008, "Fatigue limit of unnotched steels (related to tensile strength)".

† Data Item No. FAT A.00.01, "The effect of mean stress on fatigue strength (plain test piece)".

‡ Data Item No. FAT A.00.02, "The effect of mean stress on fatigue strength (test piece with stress concentration)".

** Data Item No. 76014, "Estimation of endurance and construction of constant amplitude SN curves from related data corrected for notch and mean stress effects".

decreases because the steel is effectively being tempered and, again, consequently the fatigue strength decreases. These effects of exposure to elevated temperatures can be explained by a reduction in the effectiveness of strengthening mechanisms, such as dispersion- or carbide-strengthening, grain-size refinement, and the increased mobility of dislocations. Some annealing might also occur which will relieve residual stresses, including beneficial compressive stresses.

Creep can also influence component failure under tensile mean stress if the temperature is greater than about 500°C (930°F). Factors such as cyclic frequency and waveform (*i.e.* the shape of the load cycle) have greater significance at higher temperatures: a lower cyclic frequency allows longer for time- and temperature-dependent processes to occur.

The data presented are obtained from tests conducted at frequencies of between 10 and 160 Hz. The effect of test frequency on fatigue strength is dependent on the test environment. In non-corrosive environments at room temperature, the effects of test frequency tend to be insignificant. Conversely, in corrosive environments and at higher temperatures, the effects of test frequency can be marked. Low test frequencies allow more time for corrosion/oxidation to take place, particularly at elevated temperature, and resulting endurance are shorter (Reference 22).

3.5 Loading Type

The data presented in this Item are from tests conducted using either axial or rotating-bending loading (with the exception of the data given on Figure 9c, which are from plain-bending tests).

The type of loading is known to have an effect on measured fatigue strength. For plain specimens, in a rotating-bending test the maximum stress occurs at the surface of the specimen whereas in an axial test the stress is uniformly distributed over the cross-section (assuming no misalignment). For this reason, beneficial surface treatments have a more favourable effect on fatigue strength for specimens tested using rotating bending than on that for those tested axially (Reference 20).

Similarly, for notched specimens, or other cases where a stress gradient is present, beneficial treatments of the regions of higher stress have a more favourable effect on fatigue strength.

It should be noted that the effects of loading type are well-documented but the underlying mechanisms, which include several complex and interactive effects, are not fully understood and many contrasting opinions on the subject exist in the literature.

Values of the ratio of fatigue limit under reversed axial loading to that under rotating-bending loading for homogeneous materials in plain unnotched test pieces are typically between 0.6 and 1.0 (References 20 and 23). Some of this discrepancy may be attributed to the difficulty in obtaining perfect alignment for the axial test; the results of tests in which care has been taken to minimise axial alignment are in good agreement with those obtained from rotating-bending tests (Reference 20).

When comparing the results of axial tests with those of rotating-bending tests, the volume of critically-stressed material might also have an influence because of size effects. For example, for identical plain specimens, the volume of critically-stressed material is greater in an axial test than in a rotating-bending test.

3.6 Surface Roughness and Notches

The surface finishes of the specimens from which the data presented were obtained include polished, as-machined and as-carburized. Any imperfections, such as scratches, pits or machining marks on the surface of the steel, increase local stress and form possible fatigue-crack-initiation sites. The surface

condition is more critical for high-strength steels, which have a uniform microstructure and low levels of impurity. In general, fatigue life increases as the degree of surface roughness decreases. For further information on the effect of surface roughness, see Data Item No. 74027*.

Fatigue strength is reduced significantly by the introduction of a stress-raiser such as a notch or a hole. The theoretical elastic stress concentration factor is defined as:

$$K_t = \frac{\sigma_{max}}{S_{nom}}, \quad (3.1)$$

where, in this Item, S_{nom} is based on the net cross-sectional area. K_t is dependent on geometry and mode of loading. As K_t increases, the stress at the notch increases and so the fatigue strength decreases. Data are presented for values of K_t of between 1 and 3.

The calculation of the actual stresses at the root of a notch and the effects of notch size are treated in Data Item No. 76014.

The sensitivity of materials to notches and surface roughness becomes more pronounced as the tensile strength of the materials increases (Reference 24).

3.7 Surface Treatment

Data obtained from specimens with the following surface treatments are presented: shot-peened, polished, carburized, nitrided and low-plasticity-burnished. (The process of low-plasticity-burnishing involves a hard sphere on a fluid bearing which is pressed against and rolled along the component creating a layer of compressive residual stress at the surface). Surface treatments can be used to increase fatigue strength. However, the degree of benefit, if any, obtained from surface treatments depends heavily on the distribution of stress within the component and on the details of the treatment process. For this reason, the data presented in this Item should only be used to obtain an indication of the improvements in fatigue strength that might be realised through the use of a particular treatment.

Shot-peening and low-plasticity-burnishing have the effect of cold-working the surface, creating a layer of compressive residual stress at the surface of the steel and so increasing the fatigue strength, especially under rotating bending. However, the creation of high residual compressive stresses at the surface of the steel might cause sub-surface fatigue failures. Carburizing and nitriding have the effect of increasing the strength of the material at the surface as well as instigating a localized volumetric change, which creates a compressive residual stress. Effective polishing of the surface reduces the number of potential crack-initiation sites.

Data for various surface treatments are presented in Figures 2a to 2c, 5a to 5c, 7a to 7c, 9d and 14d.

It should be noted that some surface treatments have adverse effects on fatigue strength; see, for example, Data Item No. 86033†.

Furthermore, inappropriate use or misapplication of ‘nominally’ beneficial treatments might have malefic effects on fatigue strength.

* Data Item No. 74027, “The effect of surface roughness on the fatigue limit of steels (at zero mean stress)”.

† Data Item No. 86033, “The effect of electrodeposited chromium on the fatigue strength of low alloy steel”.

4. DERIVATION AND REFERENCES

4.1 Derivation

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2. NRIM DATA SHEET 9 Data sheets on fatigue properties of SCM435 (0.35C-1Cr-0.2Mo) steel for machine structural use. National Research Institute for Metals, Tokyo, Japan, 1979.
3. NRIM DATA SHEET 23 Data sheets on elevated-temperature, high-cycle fatigue properties of SCM435 (0.35C-1Cr-0.2Mo) steel for machine structural use. National Research Institute for Metals, Tokyo, Japan, 1980.
4. NRIM DATA SHEET 17 Data sheets on fatigue properties of SMn443 (0.43C-1.5Mn) steel for machine structural use. National Research Institute for Metals, Tokyo, Japan, 1980.
5. NRIM DATA SHEET 24 Data sheets on fatigue properties of SNC631 (0.31C-2.7Ni-0.8Cr) steel for machine structural use. National Research Institute for Metals, Tokyo, Japan, 1981.
6. NRIM DATA SHEET 26 Data sheets on fatigue properties of SNCM447 (0.47C-1.8Ni-0.8Cr-0.2Mo) steel for machine structural use. National Research Institute for Metals, Tokyo, Japan, 1981.
7. NRIM DATA SHEET 25 Data sheets on fatigue properties of SNCM439 (0.39C-1.8Ni-0.8Cr-0.2Mo) steel for machine structural use. National Research Institute for Metals, Tokyo, Japan, 1981.
8. NRIM DATA SHEET 35 Data sheets on elevated-temperature, high-cycle fatigue properties of SUH616-B (12Cr-1Mo-1W-0.3V) heat-resisting steel bar. National Research Institute for Metals, Tokyo, Japan, 1983.
9. NRIM DATA SHEET 37 Data sheets on fatigue properties of SCr420 (0.20C-1Cr) carburizing steel for machine structural use. National Research Institute for Metals, Tokyo, Japan, 1984.
10. NRIM DATA SHEET 50 Data sheets on fatigue properties of SNCM220 (0.20C-0.5Ni-0.5Cr-0.2Mo) carburizing steel for machine structural use. National Research Institute for Metals, Tokyo, Japan, 1986.
11. NRIM DATA SHEET 51 Data sheets on fatigue properties of SNCM420 (0.20C-1.8Ni-0.5Cr-0.2Mo) carburizing steel for machine structural use. National Research Institute for Metals, Tokyo, Japan, 1986.
12. NRIM DATA SHEET 59 Data sheets on high-cycle fatigue properties of SUP7 (2.0Si-0.8Mn) steel for springs. National Research Institute for Metals, Tokyo, Japan, 1988.
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| 16. | EVERETT Jr, R.A.
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| 17. | CAMMETT, J.T.
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4.2 References

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5. TABLES AND FIGURES

Notes on Presentation of Data

Unless stated otherwise:

- the compositional ranges given are specification, rather than measured, values;
- the mechanical properties are measured, rather than specification, values;
- $K_t = 1$.

The numbers on the figures next to some data points indicate the number of coincident data points.

In some cases, where two or more data points fall on, or very close to, one another, data points have been displaced slightly on the figures to aid presentation; the values given in the Excel file that accompanies this Item are the true, un-displaced, values.

The curves through the data have been derived using ESDUpac A9724. For a number of the sets of data, the large numbers of run-outs at relatively high stresses initially gave rise to unrealistic curves. The approach was therefore adopted whereby run-outs that occurred at stresses above those at which failure occurred in other tests were treated as failures. This approach has been used throughout, for all sets of data.

Index to Figures

Figure No.	Material		Type of Steel	Test Variable
	UNS Designation	Derivation		
1a	—	6	Cr-Mo Stainless Steel	Tempering Temperature
1b	—	6	Cr-Mo Stainless Steel	Mean Stress
2a	G43200	11	Ni-Cr-Mo Alloy Steel	Surface Treatment
2b	G43200	11	Ni-Cr-Mo Alloy Steel	Surface Treatment
2c	G43200	11	Ni-Cr-Mo Alloy Steel	Surface Treatment, Mean Stress
3a	S42200	8	Cr Stainless Steel	Stress Concentration Factor, Test Temperature
3b	S42200	8	Cr Stainless Steel	Stress Concentration Factor, Test Temperature
3c	S42200	8	Cr Stainless Steel	Stress Concentration Factor, Test Temperature
3d	S42200	8	Cr Stainless Steel	Stress Concentration Factor, Test Temperature
3e	S42200	8	Cr Stainless Steel	Stress Concentration Factor, Test Temperature
4a	G51600	13, 14	Cr Alloy Steel	Tempering Temperature
4b	G51600	13, 14	Cr Alloy Steel	Tempering Temperature, Mean Stress
5a	G51200	9	Cr Alloy Steel	Surface Treatment
5b	G51200	9	Cr Alloy Steel	Surface Treatment

Index to Figures (Continued)

Figure No.	Material		Type of Steel	Test Variable
	UNS Designation	Derivation		
5c	G51200	9	Cr Alloy Steel	Surface Treatment, Mean Stress
6a	G41400	1	Cr-Mo Alloy Steel	Tempering Temperature
6b	G41400	1	Cr-Mo Alloy Steel	Tempering Temperature
6c	G41400	1	Cr-Mo Alloy Steel	Tempering Temperature
6d	G41400	1	Cr-Mo Alloy Steel	Mean Stress
7a	G86200	10	Ni-Cr-Mo Alloy Steel	Surface Treatment
7b	G86200	10	Ni-Cr-Mo Alloy Steel	Surface Treatment
7c	G86200	10	Ni-Cr-Mo Alloy Steel	Surface Treatment, Mean Stress
8a	T20813	15	Hot Work Tool Steel	Tempering Temperature
8b	T20813	15	Hot Work Tool Steel	Tempering Temperature, Mean Stress
9a	G43400	7	Ni-Cr-Mo Alloy Steel	Tempering Temperature
9b	G43400	7	Ni-Cr-Mo Alloy Steel	Mean Stress
9c	G43400	17	Ni-Cr-Mo Alloy	Surface Treatment
9d	G43400	16	Ni-Cr-Mo Alloy Steel	Surface Treatment
10a	G92600	12, 14	Si-Mn Alloy Steel	Tempering Temperature
10b	G92600	12	Si-Mn Alloy Steel	Tempering Temperature
11a	G41370	2	Cr-Mo Alloy Steel	Tempering Temperature
11b	G41370	2	Cr-Mo Alloy Steel	Mean Stress
11c	G41370	3	Cr-Mo Alloy Steel	Stress Concentration Factor, Test Temperature
11d	G41370	2	Cr-Mo Alloy Steel	Stress Concentration Factor, Test Temperature
11e	G41370	3	Cr-Mo Alloy Steel	Stress Concentration Factor, Test Temperature
11f	G41370	3	Cr-Mo Alloy Steel	Stress Concentration Factor, Test Temperature
11g	G41370	3	Cr-Mo Alloy Steel	Stress Concentration Factor, Test Temperature
12a	G15410	4	Mn Alloy Steel	Tempering Temperature
12b	G15410	4	Mn Alloy Steel	Mean Stress
13a	-	5	Ni-Cr Alloy Steel	Tempering Temperature
13b	-	5	Ni-Cr Alloy Steel	Mean Stress

14a	Illustration of effect of tempering temperature on fatigue strength of Cr-Mo alloy steel
14b	Illustration of effect of stress ratio on fatigue strength of Cr-Mo alloy steel
14c	Illustration of effect of test temperature on fatigue strength of Cr alloy steel
14d	Illustration of effect of carburizing on fatigue strength of Cr alloy steel

TABLE 5.1 Supplementary Data for Figures 1a and 1b

Specification	SNCM447									
Material Type	Cr-Mo Stainless Steel									
Composition	C	Cr	Mn	Mo	Ni	P	S	Si	Cu	
Minimum	0.44	0.60	0.60	0.15	1.60			0.15		
Maximum	0.50	1.00	0.90	0.30	2.00	0.030	0.030	0.35	0.30	

Derivation	6
σ_y MN/m ² (10 ³ lbf/in ²)	(a) 1032 (150) (b) 920 (133) (c) 830 (120)
t_2 MN/m ² (10 ³ lbf/in ²)	(a) 1037 (150) (b) 912 (132) (c) 793 (115)
f_t MN/m ² (10 ³ lbf/in ²)	(a) 1131 (164) (b) 1013 (147) (c) 889 (129)
Loading Type	Rotating bending, Axial
Specimen Geometry	Rotating bending: parallel; Axial: hourglass
Heat Treatment	N at 870°C (1598°F) for 30 min, AC, T at 845°C (1553°F) for 30 min, OQ, then (a) T at 580°C (1076°F) for 1 h, WC (b) T at 630°C (1116°F) for 1 h, WC (c) T at 680°C (1256°F) for 1 h, WC
Temperature °C (°F)	RT
R	−1, 0
Frequency Hz	Rotating bending: 50; Axial: 10-20, 120-160
Grain Direction	NA
Surface Finish/Treatment	Longitudinally polished with 600 grade SiC paper
Test Variable	Tempering temperature, Mean stress

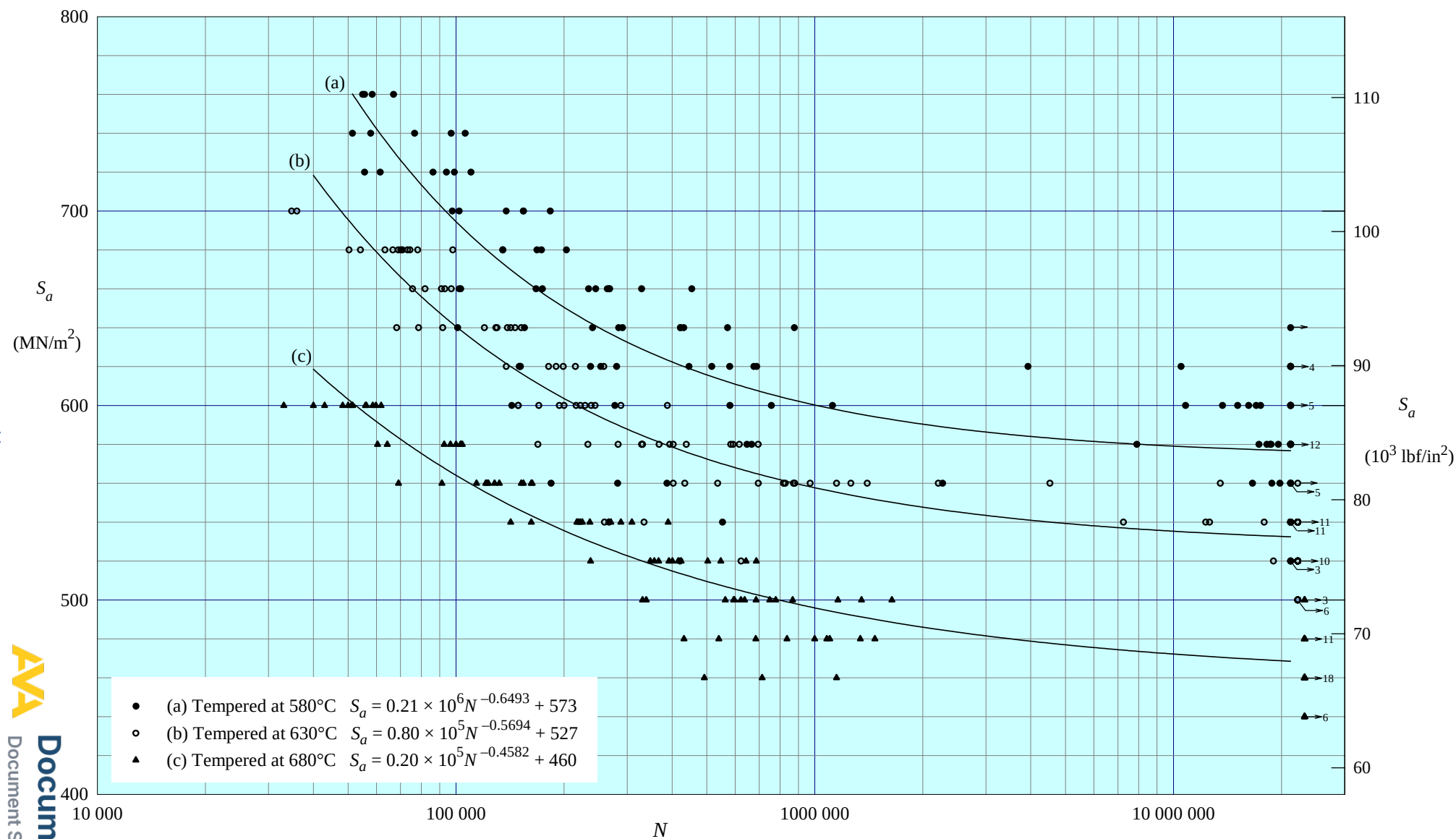


FIGURE 1a EFFECT OF TEMPERING TEMPERATURE ON FATIGUE STRENGTH OF G43370 FERRITIC HIGH Cr-Mo STAINLESS STEEL.
ROTATING BENDING, $R = -1$

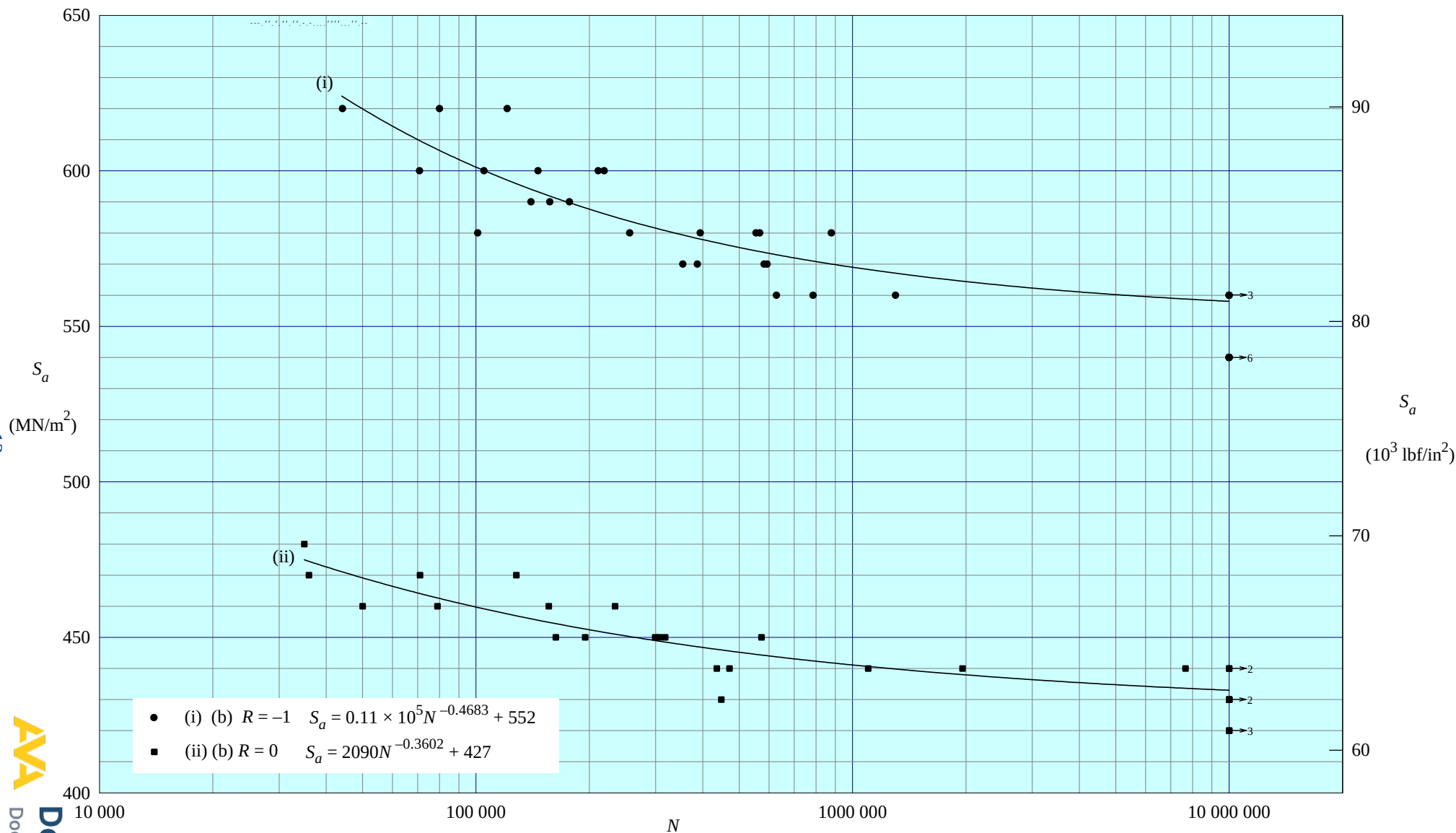


FIGURE 1b EFFECT OF MEAN STRESS ON FATIGUE STRENGTH OF G43370 FERRITIC HIGH Cr-Mo STAINLESS STEEL TEMPERED AT 630°C (1166°F). AXIAL LOADING

TABLE 5.2 Supplementary Data for Figures 2a to 2c

UNS Specification	G43200							
Material Type	Ni-Cr-Mo Alloy Steel							
Composition	C	Cr	Mn	Mo	Ni	P	S	Si
Minimum	0.17	0.40	0.45	0.20	1.65			0.15
Maximum	0.22	0.60	0.65	0.30	2.00	0.035	0.040	0.35

Derivation	11					
σ_y MN/m ² (10 ³ lbf/in ²)	NA					
t_2 MN/m ² (10 ³ lbf/in ²)	(a) 1209 (175)	(b) 1173 (170)	(c) 1110 (161)	(d) 1259 (183)	(e) 1130 (164)	(f) 855 (124) (20 mm (0.79 in) diameter bar)
f_t MN/m ² (10 ³ lbf/in ²)	(a) 1334 (193)	(b) 1317 (191)	(c) 1348 (196)	(d) 1288 (187)	(e) 1480 (215)	(f) 1221 (177) (20 mm (0.79 in) diameter bar)
Loading Type	Rotating bending, Axial					
Specimen Geometry	Hourglass					
Heat Treatment °C (°F)	N at 930 (1706) for 30 min in salt bath, AC, then (a) Cbz in enriching gas at 930 (1706) for 2 h 20 min, T at 850 (1562) for 15 min, OQ to 60 (140), SR at 160 (320) for 2 h, AC (b) Cbz in enriching gas at 930 (1706) for 7 h 50 min, T at 850 (1562) for 15 min, OQ to 60 (140), SR at 160 (320) for 2 h, AC (c) Cbz in enriching gas at 930 (1706) for 9 h, T at 850 (1562) for 15 min, OQ to 140 (284), SR at 160 (320) for 2 h, AC (d) Cbz in enriching gas at 930 (1706) for 7 h 50 min, T at 850 (1562) for 15 min, OQ to 60 (140), SR at 200 (392) for 2 h, AC (e) T in salt bath at 930 (1706) for 2 h 20 min, T at 850 (1562) for 15 min, OQ to 60 (140), SR at 160 (320) for 2 h, AC (f) T in salt bath at 930 (1706) for 2 h 20 min, T at 850 (1562) for 15 min, OQ to 60 (140), SR at 160 (320) for 2 h, AC (20 mm (0.79 in) diameter bar)					
Temperature °C (°F)	RT					
R	-1, 0					
Frequency Hz	Rotating bending 50; Axial 120-160					
Grain Direction	NA					
Surface Finish/Treatment	Rotating bending Cbz: polished with 1-4 µm (39-157 µin) chromium oxide suspension; or as-Cbz Rotating bending non-Cbz: longitudinally polished with 600 grade SiC paper Axial Cbz: polished with 1-4 µm (39-157 µin) chromium oxide suspension Axial non-Cbz: longitudinally polished with 600 grade SiC paper					
Test Variable	Surface treatment, Mean stress					

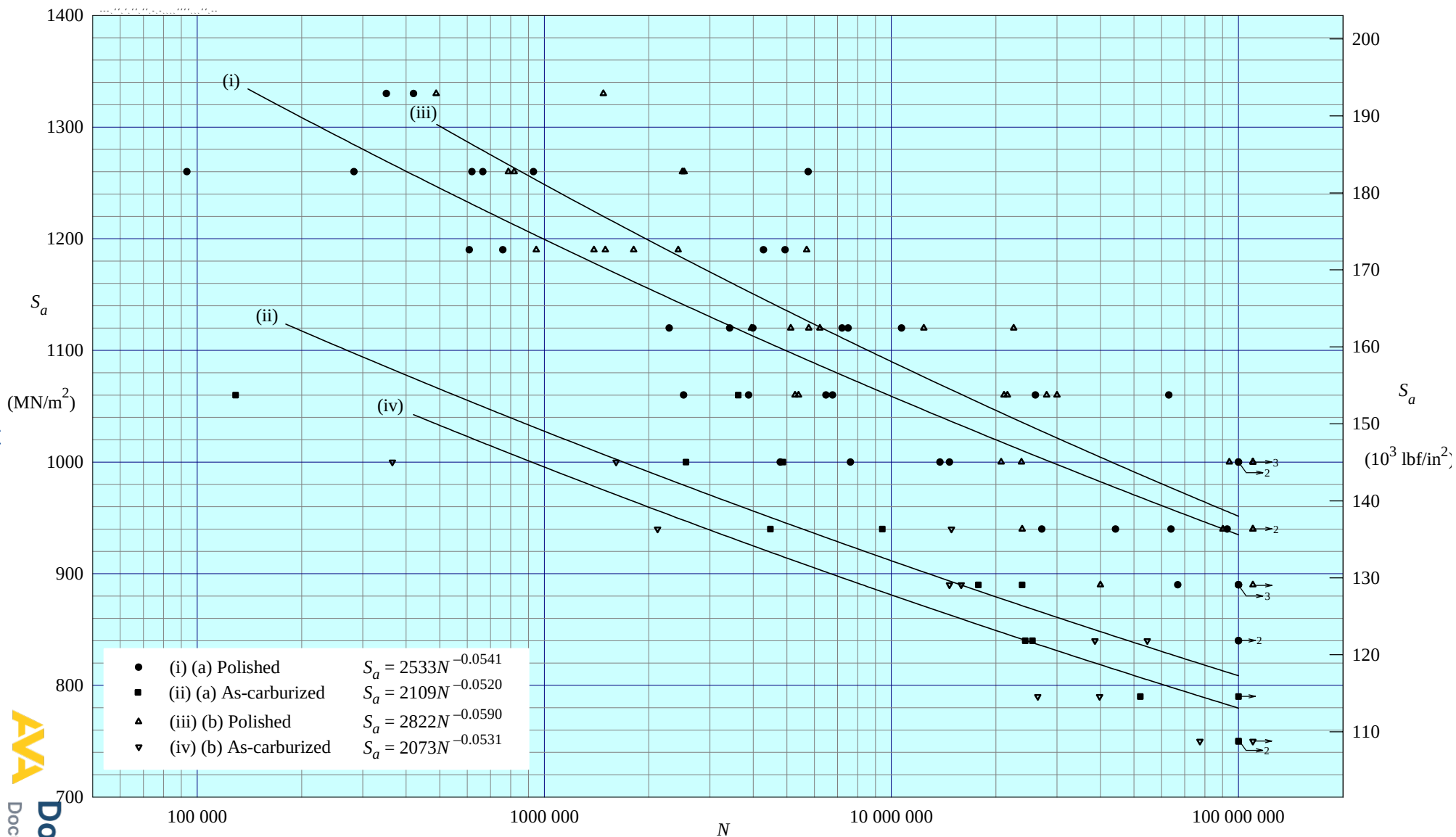


FIGURE 2a EFFECT OF SURFACE TREATMENT ON FATIGUE STRENGTH OF G43200 Ni-Cr-Mo ALLOY STEEL.
ROTATING BENDING, $R = -1$

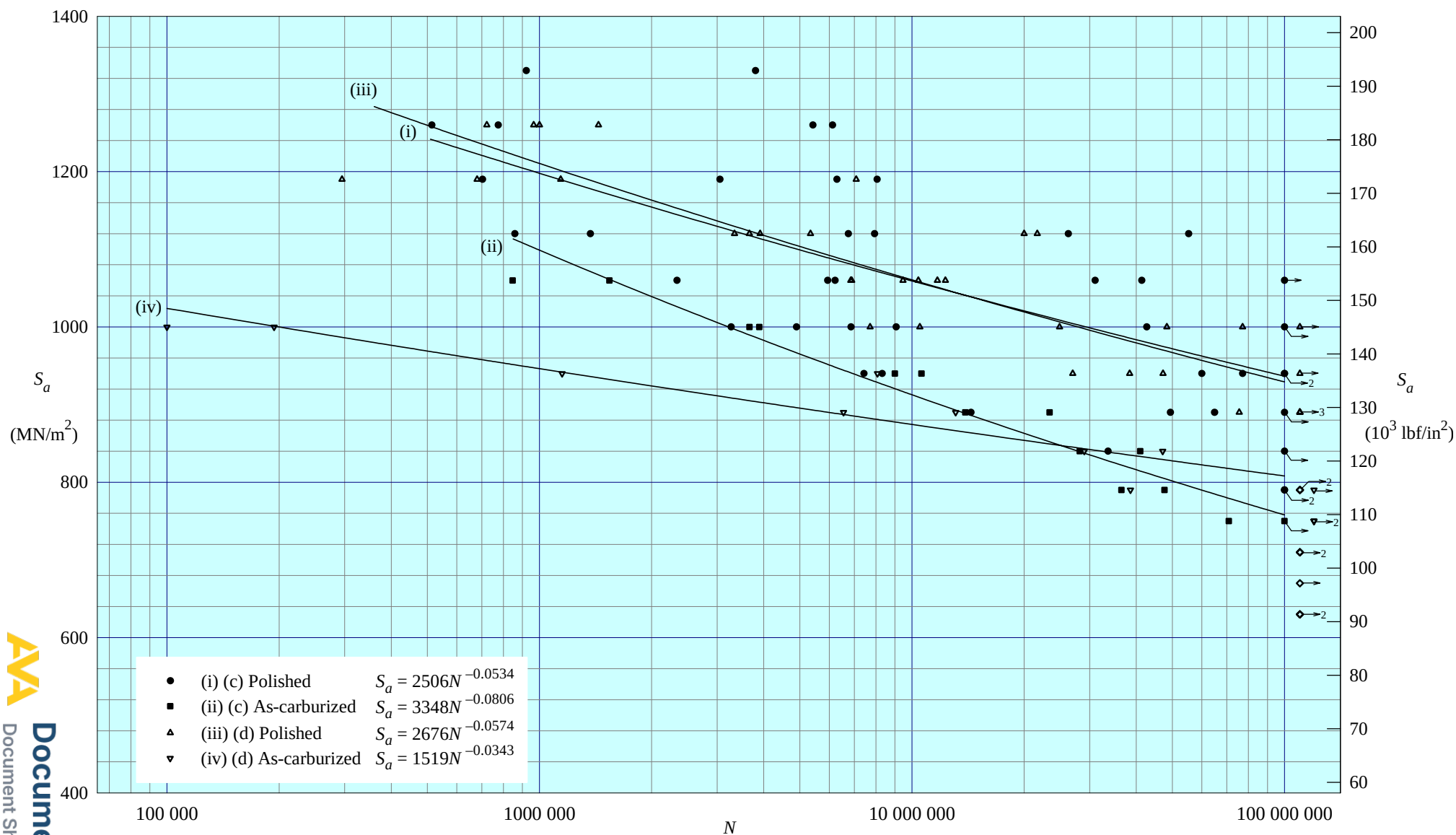


FIGURE 2b EFFECT OF SURFACE TREATMENT ON FATIGUE STRENGTH OF G43200 Ni-Cr-Mo ALLOY STEEL. ROTATING BENDING, $R = -1$

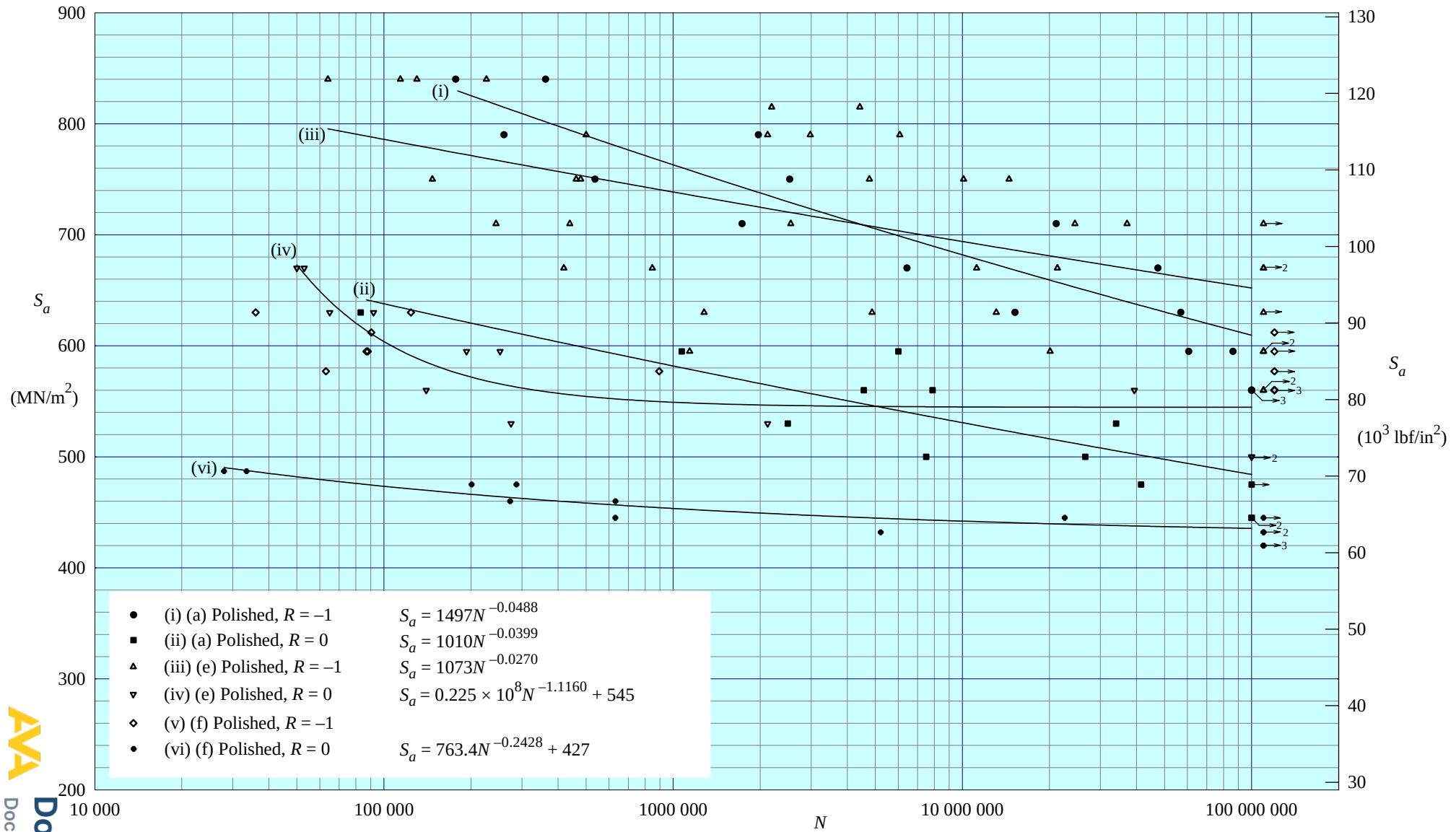


FIGURE 2c EFFECT OF MEAN STRESS ON FATIGUE STRENGTH OF G43200 Ni-Cr-Mo ALLOY STEEL.
AXIAL LOADING

TABLE 5.3 Supplementary Data for Figures 3a to 3e

UNS Specification	S42200										
Material Type	Cr Stainless Steel										
Composition	C	Cr	Mn	Mo	Ni	P	S	Si	V	W	
Minimum	0.20	11.50		0.75	0.50				0.15	0.75	
Maximum	0.25	13.50	1.00	1.25	1.00	0.040	0.030	0.75	0.30	1.25	

Derivation	8
σ_y MN/m ² (10 ³ lbf/in ²)	NA
t_2 MN/m ² (10 ³ lbf/in ²)	894 (130)
f_t MN/m ² (10 ³ lbf/in ²)	1088 (158)
Loading Type	Rotating bending
Specimen Geometry	Parallel, Notched
Heat Treatment	HR at 1030°C (1886°F), OQ, 630°C (1166°F), AC
Temperature °C (°F)	RT, 300 (572), 400 (752), 500 (932), 600 (1112)
R	−1
Frequency Hz	125
Grain Direction	NA
Surface Finish/Treatment	Longitudinally polished with 600 grade SiC paper
Test Variable	Test temperature, Stress concentration factor

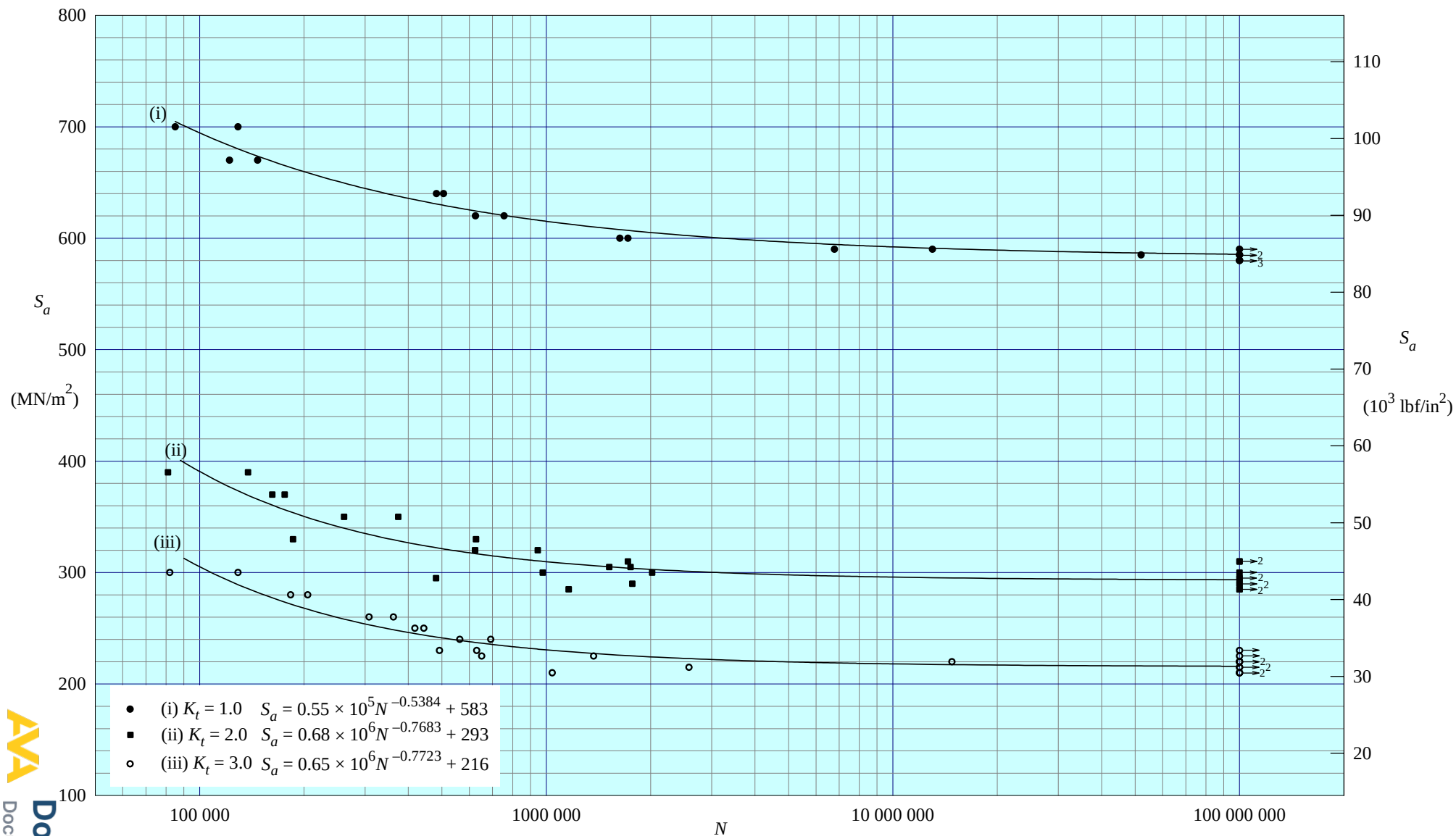


FIGURE 3a EFFECT OF K_t ON FATIGUE STRENGTH OF S42200 Cr STAINLESS STEEL AT ROOM TEMPERATURE.
ROTATING BENDING, $R = -1$

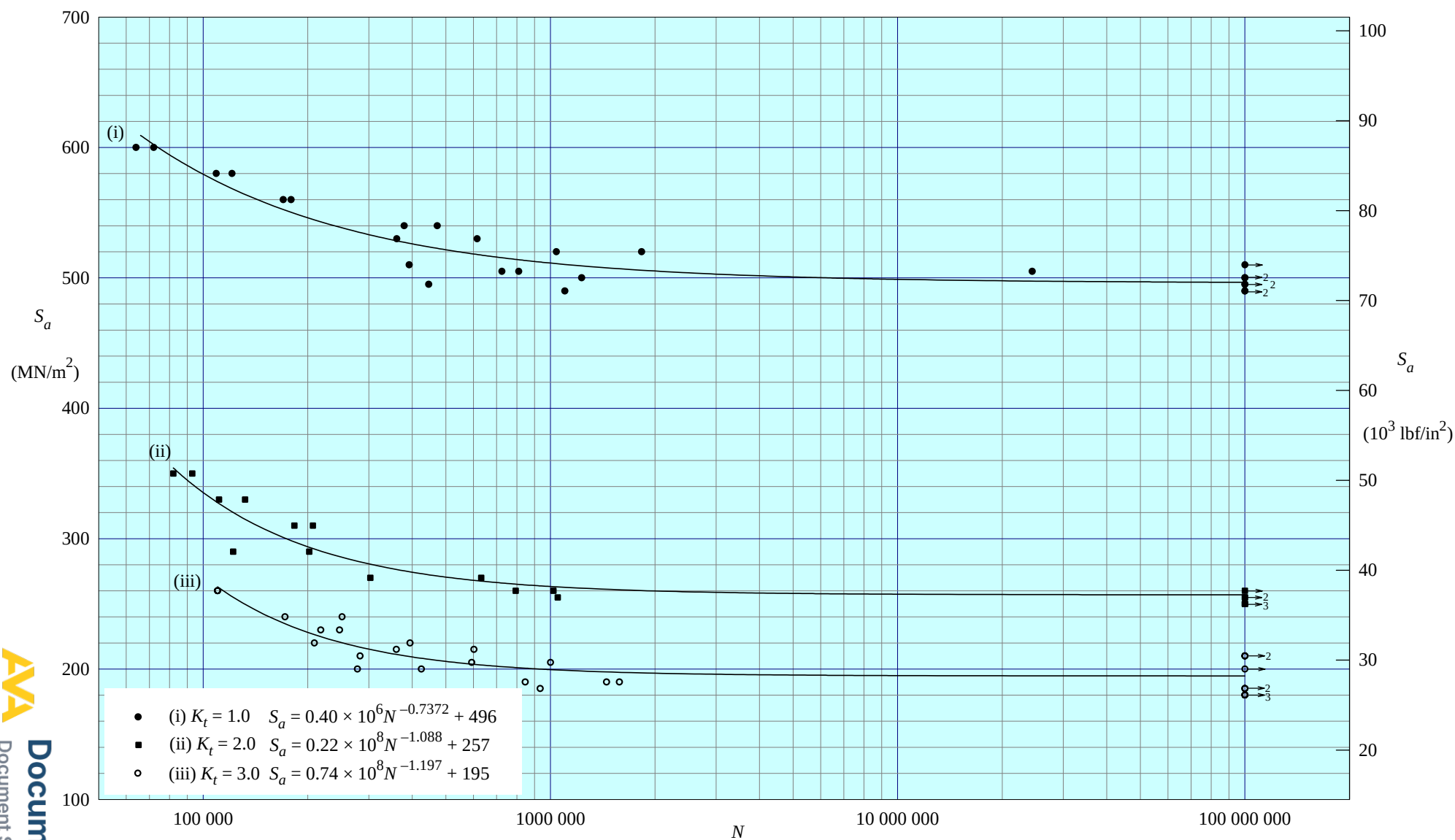


FIGURE 3b EFFECT OF K_t ON FATIGUE STRENGTH OF S42200 Cr STAINLESS STEEL AT 300°C (572°F).

ROTATING BENDING, $R = -1$