

Mechanical Behavior of Materials | (2nd Edition)

Step-by-step solution

Step 1 of 5

For quenched steel, calculate the term $f\left(\frac{a}{W}\right)$ for single edge notch bend specimen.

$$f\left(\frac{a}{W}\right)=\frac{3\frac{s}{W}\sqrt{\frac{a}{W}}}{2\left(1+2\frac{a}{W}\right)\left(1-\frac{a}{W}\right)^{3/2}}\left[1.99-\frac{a}{W}\left(1-\frac{a}{W}\right)\left\{2.15-3.93\left(\frac{a}{W}\right)+2.7\left(\frac{a}{W}\right)^2\right\}\right]\text{Here,}$$

outer span is s .

Substitute 128 mm for s , 32 mm for W , and 13.7 mm for a .

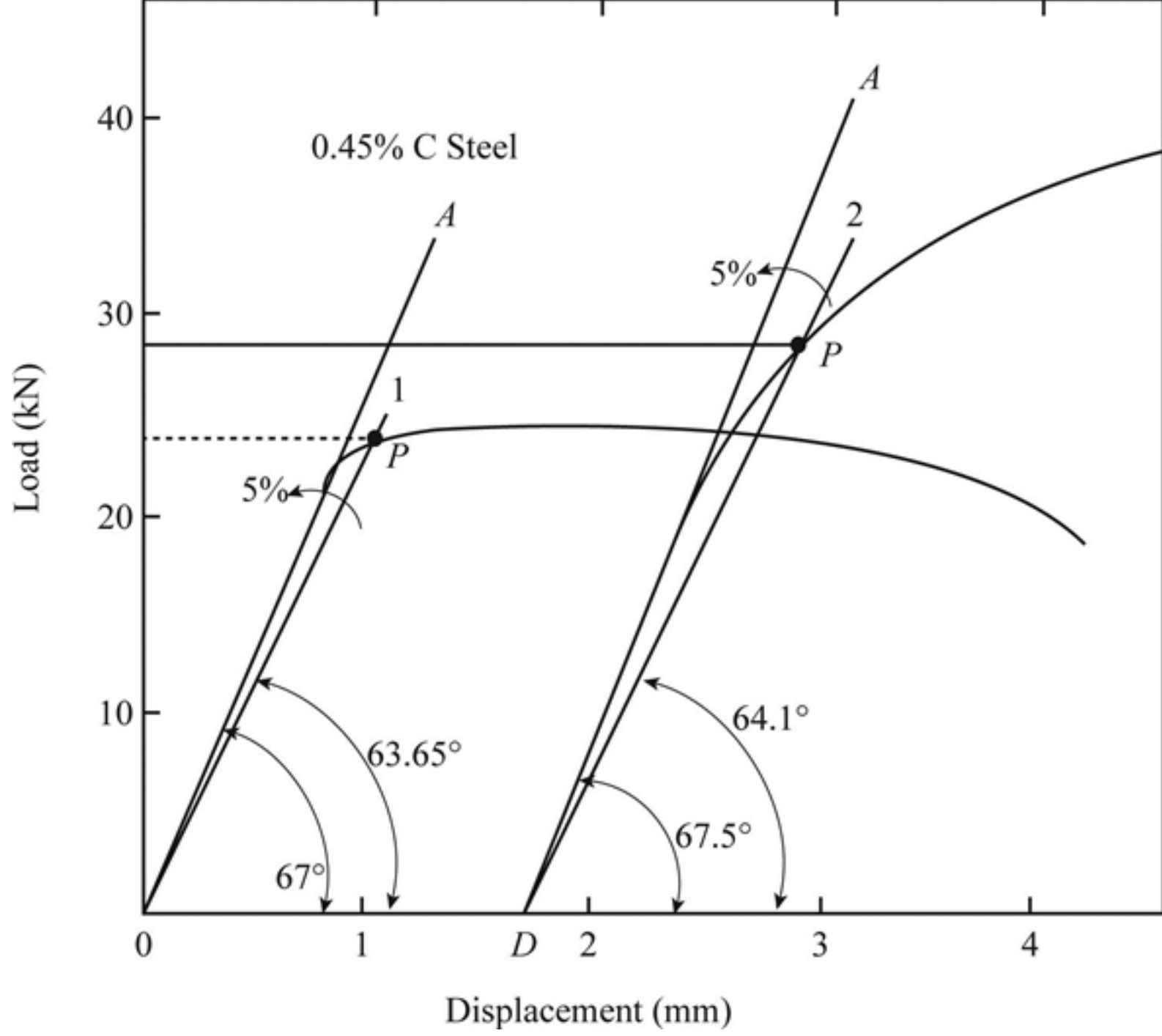
$$f\left(\frac{a}{W}\right)=\left[\frac{3\frac{128\text{ mm}}{32\text{ mm}}\sqrt{\frac{13.7\text{ mm}}{32\text{ mm}}}}{2\left(1+2\frac{13.7\text{ mm}}{32\text{ mm}}\right)\left(1-\frac{13.7\text{ mm}}{32\text{ mm}}\right)^{3/2}}\left[1.99-\frac{13.7\text{ mm}}{32\text{ mm}}\left(1-\frac{13.7\text{ mm}}{32\text{ mm}}\right)\left\{2.15-3.93\left(\frac{13.7\text{ mm}}{32\text{ mm}}\right)+2.7\left(\frac{13.7\text{ mm}}{32\text{ mm}}\right)^2\right\}\right]\right]$$
$$=(4.89)(1.754)$$
$$=8.579$$

Comment

Step 2 of 5

From the graph of load versus displacement curve, draw the linear slope line along the curve of quenched and normalized steel. Draw the secant line at the slope of 5% less than linear slope of line OA. Mark the intersection point on curve as P in the quenched and normalized steel curve.

Sketch the graph of load versus displacement of two samples of steel as in Figure (1).



Comments (1)

Step 3 of 5

Calculate the fracture toughness of the metal sample.

$$K_{Ic}=f\left(\frac{a}{W}\right)\frac{P}{B\sqrt{W}}$$

Here, crack length is a , thickness is B , width is W , and applied load is P .

From the Figure (1), select the load value corresponding to the point 1 and 2 at 0.45% C steel as 24 kN and 29 kN .

Substitute 8.579 for $f\left(\frac{a}{W}\right)$, 32 mm for W , 16 mm for B and 24 kN for P .

$$K_{Ic}=(8.579)\frac{24\text{ kN}}{(16\text{ mm})\sqrt{32\text{ mm}}}$$
$$=(8.579)\frac{24\text{ kN}}{(16\text{ mm})\left(\frac{1\text{ m}}{1000\text{ mm}}\right)\sqrt{32\text{ mm}\left(\frac{1\text{ m}}{1000\text{ mm}}\right)}}\left(\frac{10^3\text{ N}}{1\text{ kN}}\right)$$
$$=71.94\times10^6\text{ N}\cdot\text{m}/\text{m}^2\sqrt{\text{m}}\left(\frac{1\text{ Pa}}{1\text{ N}/\text{m}^2}\right)$$
$$=71.94\times10^6\text{ Pa}\cdot\sqrt{\text{m}}$$

Comment

Step 4 of 5

Express the thickness of the steel sample.

$$B\geq2.5\left(\frac{K_{Ic}}{\sigma_y}\right)^2$$

Here, fracture toughness is K_{Ic} , and yield stress is σ_y .

Substitute $71.94\times10^6\text{ Pa}\cdot\sqrt{\text{m}}$ for K_{Ic} , and $1050\text{ MN}/\text{m}^2$ for σ_y .

$$B\geq2.5\left(\frac{71.94\times10^6\text{ Pa}\cdot\sqrt{\text{m}}}{1050\text{ MN}/\text{m}^2}\right)^2$$
$$\geq2.5\left(\frac{71.94\times10^6\text{ Pa}\cdot\sqrt{\text{m}}\left(\frac{1\text{ N}/\text{m}^2}{1\text{ Pa}}\right)}{1050\times10^6\text{ N}/\text{m}^2}\right)^2\left(\frac{1000\text{ mm}}{1\text{ m}}\right)$$
$$\geq11.7\text{ mm}$$

From the above obtained results for quenched steel, the condition $B\geq2.5\left(\frac{K_{Ic}}{\sigma_y}\right)^2$ is satisfied.

Hence, the fracture toughness for quenched steel is valid for the test.

Use spreadsheet and repeat the above procedure to calculate the fracture toughness and thickness of steel sample for the quenched steel and normalized steel as in Table (1).

Steel	B , mm	s , mm	W , mm	a , mm	$f\left(\frac{a}{W}\right)$	P , N	K_{Ic} MPa $\cdot\sqrt{\text{m}}$	σ_y , MPa	B , mm
Quenched	16	128	32	13.7	8.579	24000	71.945	1050	11.7
	16	128	32	11.6	7.16	24000	60.04	1050	8.17
	16	128	32	9.6	6.084	24000	51.02	1050	5.9
Normal	16	128	32	9.3	5.94	29000	60.19	620	23.5
	16	128	32	8.9	5.754	29000	58.3	620	22.1
	16	128	32	9.4	5.988	29000	60.67	620	23.9

Comment

Step 5 of 5

From the Table (1) results, the fracture toughness for quenched steel is valid for the test by

satisfying the condition $B\geq2.5\left(\frac{K_{Ic}}{\sigma_y}\right)^2$. However, it does not satisfy the condition in fracture

toughness for normalized steel and hence, it is not valid for the test.

From the results of Table (1), the fracture toughness of quenched steel is higher.

Since, the plane strain condition does not meet due to fracture toughness, which depends on the crack size. Hence, the quenched steel are still in plane stress region.

Generally, the fracture toughness of normalized steel is higher than the quenched steel. Hence, the obtained result does not match the expectation.

Comment

Was this solution helpful?



Recommended solutions for you in Chapter 9

Chapter 9, Solution 17E

Calculate the term for compact specimen of test 1. Here, width is W . Substitute 76.34 mm for W , and 24.60 mm for a .

See solution

$$f\left(\frac{a}{W}\right)$$

Chapter 9, Solution 9E

Calculate the term for compact specimen. Here, width is W . Substitute 50 mm for W , and 20 mm for a .

See solution

$$f\left(\frac{a}{W}\right)$$

ABOUT CHEGG

Become a Tutor
Chegg For Good
College Marketing
Corporate Development
Investor Relations
Jobs
Join Our Affiliate Program
Media Center
Site Map

LEGAL

Advertising Choices
Cookie Notice
General Policies
Intellectual Property Rights
International Privacy Policy
Terms of Use
Chegg Tutors Terms of Service
US Privacy Policy
Your CA Privacy Rights

CHEGG PRODUCTS AND SERVICES

Cheap Textbooks
Chegg Coupon
Chegg Play
Chegg Study Help
College Textbooks
eTextbooks
Chegg Math Solver
Mobile Apps

Online Tutoring
Sell Textbooks
Solutions Manual
Study 101
Test Prep
Textbook Rental
Used Textbooks
Digital Access Codes

CHEGG NETWORK

CareerMatch
Easybib
Internships.com
Studyblue

CUSTOMER SERVICE

Customer Service
Give Us Feedback
Help with Chegg Tutors
Help to use EasyBib Plus
Manage Chegg Study Subscription
Return Your Books
Textbook Return Policy

