

# SHOT PEENING STRESS PROFILES

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These fifteen profiles of shot peening stress are published to permit users of the process to form judgments of the expected results with different combinations of parameters.

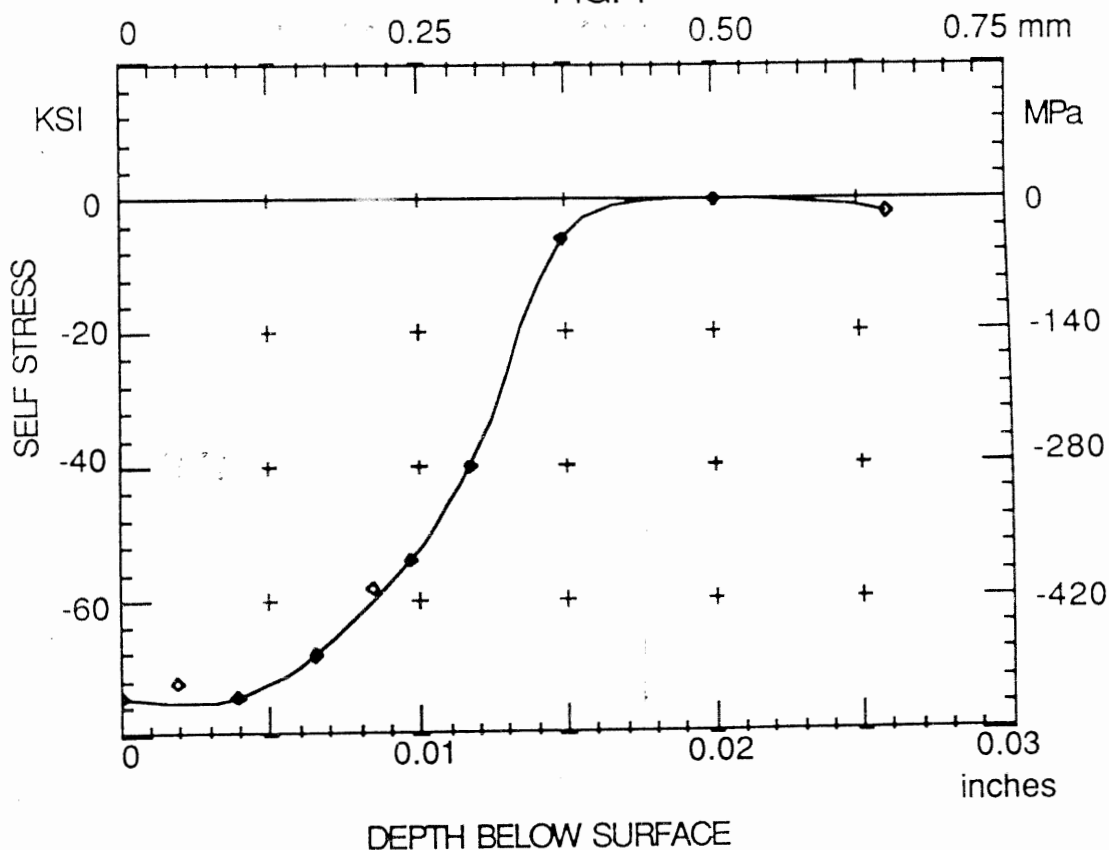
Note that the profiles are drawn to different scales: The stress scale extends to 300 ksi (2100 MPa) or to 80 ksi (560 MPa) compression, depending on the strength of the peened material; the depth scale extends to 0.03 or 0.01 or 0.002 inches (0.75, 0.25, or 0.05 mm) depending on the peening intensity.

The curves are drawn from the given references. Where test points were shown in the references they are shown in the profiles. Details of materials, specimens, and processes are given as completely as they could be read from the references. Peening intensities from a French source are given as arc heights in millimeters (e.g. 0.16 N) and also in the standard notation (e.g. 6 N) where the numbers indicate the arc height in thousandths of an inch (0.006").

We hope these profiles will be useful and that collections of profiles of stresses produced by other processes will become available in the future. Suggestions for improvement of this publication will be welcome.

H. O. F. September 1986

FIG. 1



Material: ASTM A508 class 2 quenched & tempered vacuum treated steel forgings

Yield strength: 64-70 ksi (442-483 MPa)

Hardness: Rockwell B 84.5-87.5

(Minimum specified elongation 18%, reduction of area 38%)

Specimen: 4x4x1/2 in (100x100x12.5 mm) peened on one side

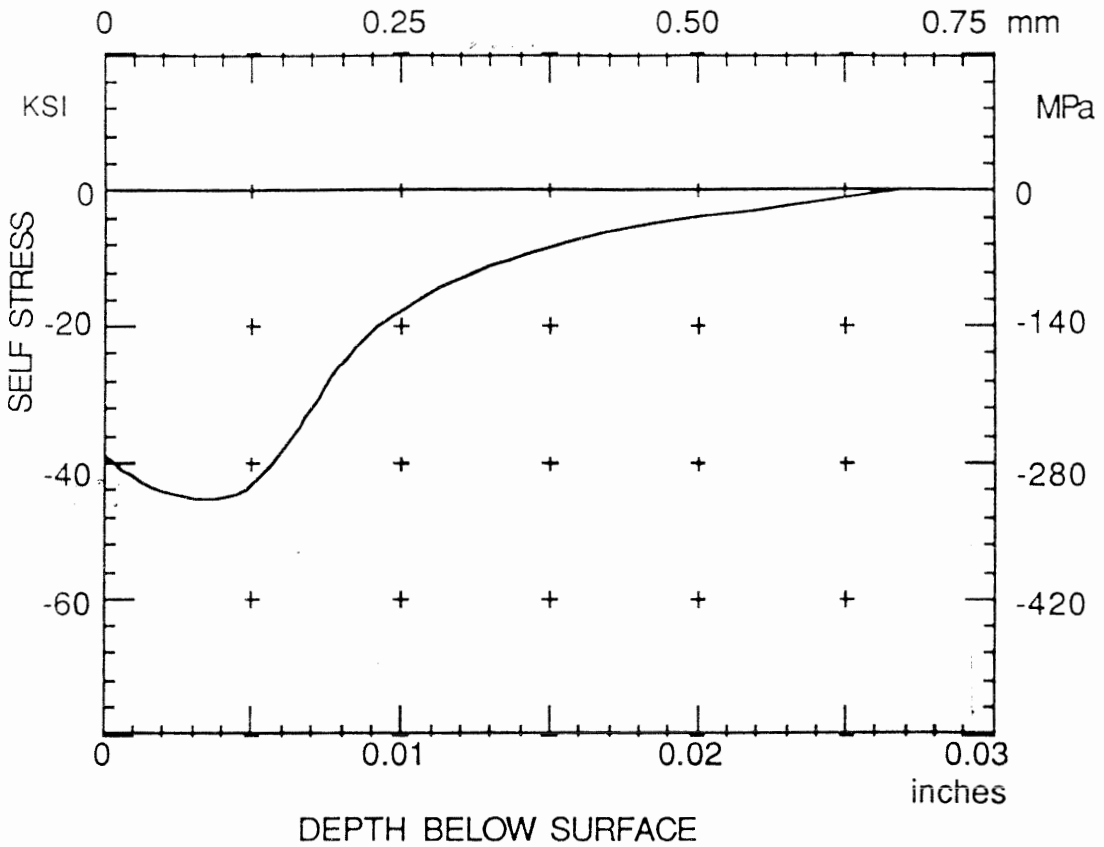
Intensity: 14-16 A

Coverage: 200%

Shot: S330 (0.8 mm nominal)

Reference: Prevey, P.S., Lambda Research Inc., Cincinnati, Ohio, Report dated 13 Sept. 1979, p.14

FIG. 2



Material: AFNOR E 490 steel weldment

Tensile strength: 652 MPa (94 ksi)

Elastic limit: 550 MPa (80 ksi)

Reduction of area: 25.5%

Specimen: 8 mm (.31 in) thick, 60-85 mm (2.4-3.1 in) wide machine welded. Stresses measured at the toe of the weld

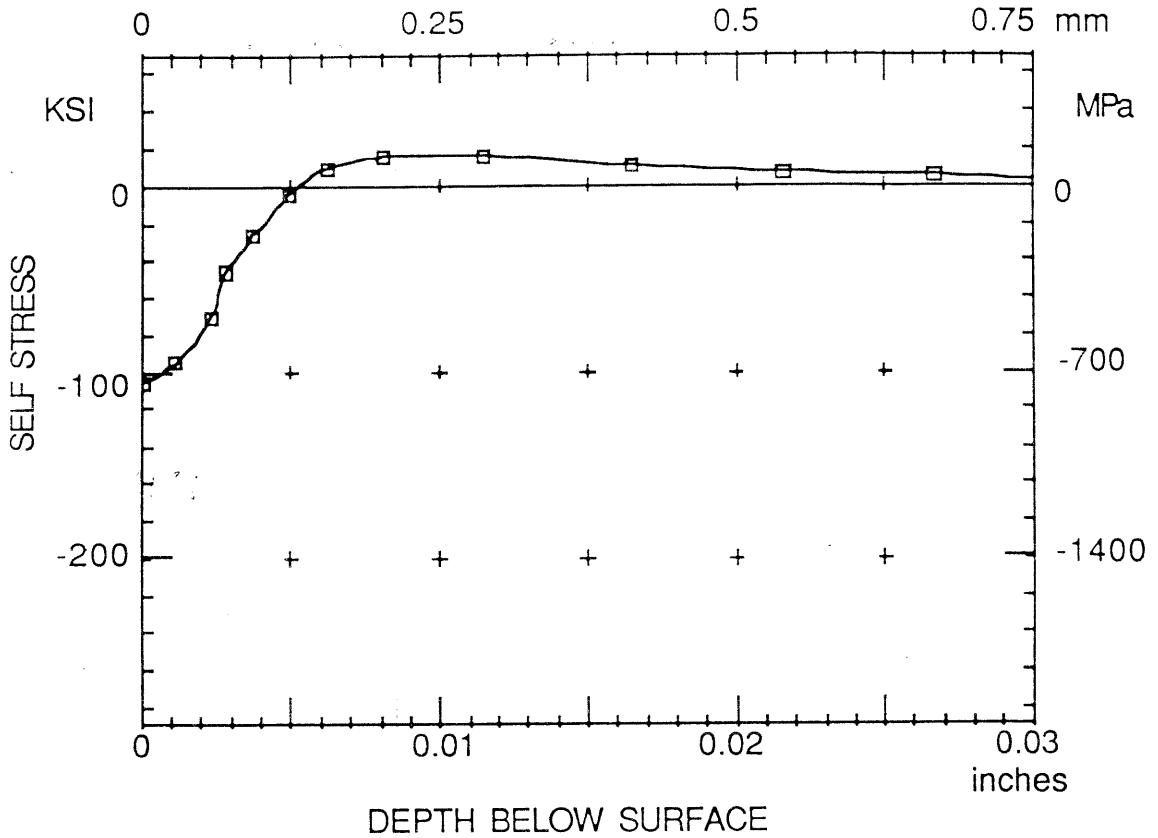
Intensity: 14-16 A

Coverage: 200%

Shot: S170 (0.43 mm nominal)

Reference: Picouet, L., Bignonnet, A., Lieurade, H.P., "Influence du grenailage sur le comportement en fatigue d'assemblages soudés en acier HLE" in Proceedings 2nd Intl. Conf. on Shot Peening ICSP-2 H.O.Fuchs ed. 1984 pp346-354.

FIG. 3



Material: 4340 steel

Hardness: Rockwell C 30

Tensile strength: 131 ksi (905 MPa)

Yield strength: 107 ksi (740 MPa)

Specimen: 2x2x1/4 in (50x50x6.3 mm)

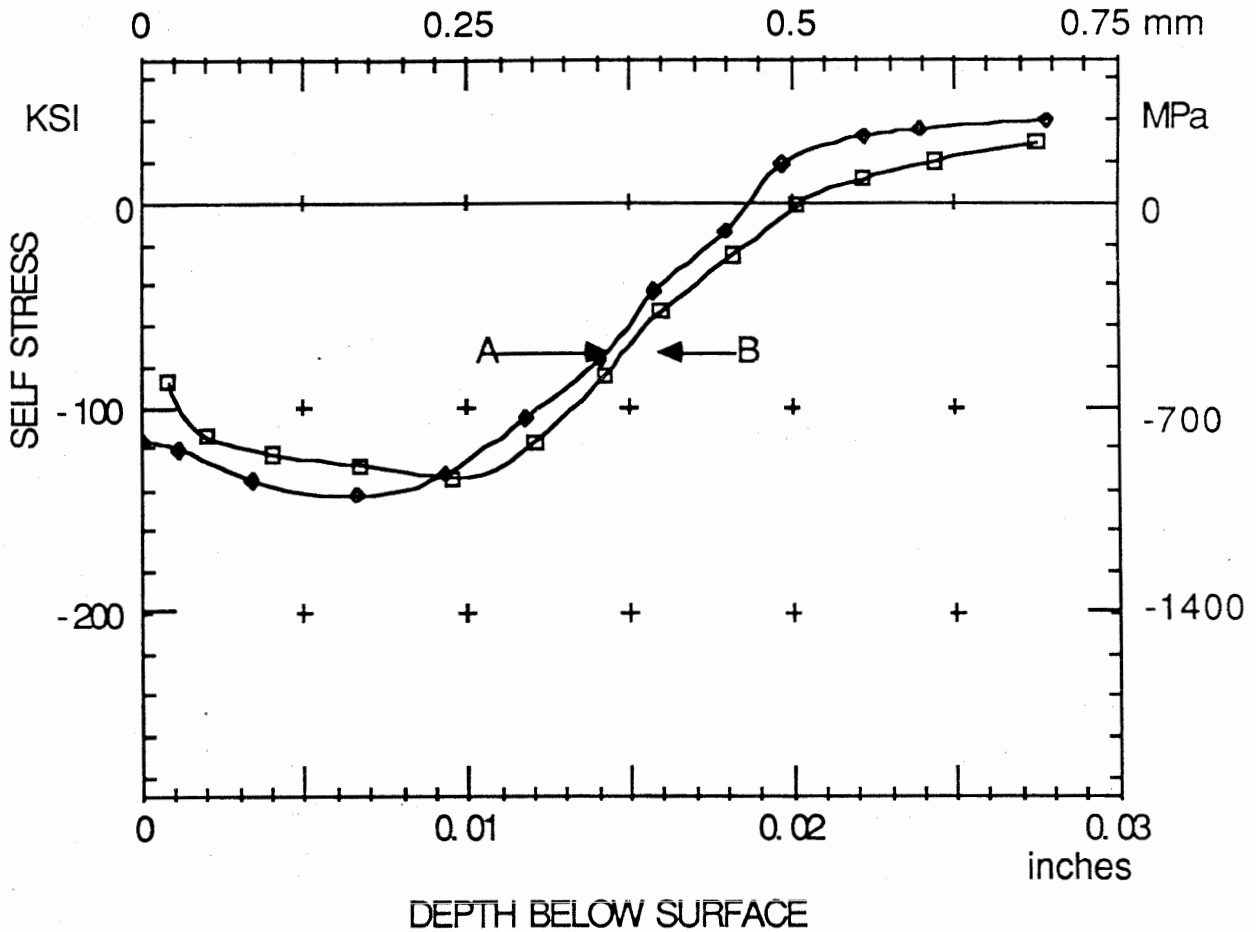
Intensity: 4 A

Shot: S110 (0.28 mm nominal)

Coverage: Complete (95%)

Reference: Brodrick, R.F., Protective Shot Peening of Propellers, Part 1, June 1955, p.51. WADC Technical Report 55-56 Part 1.

FIG. 4



Material: 4340 steel, two slightly different hardnesses.

	A	B
<u>Hardness:</u> Rockwell C	51	50
<u>Tensile strength:</u>	251 ksi (1730 MPa)	244 ksi (1685 MPa)
<u>Yield strength:</u>	221 ksi (1525 MPa)	217 ksi (1500 MPa)

Specimen: 2x2x1/4 in (50x50x6.3 mm)

Intensity: 10 C

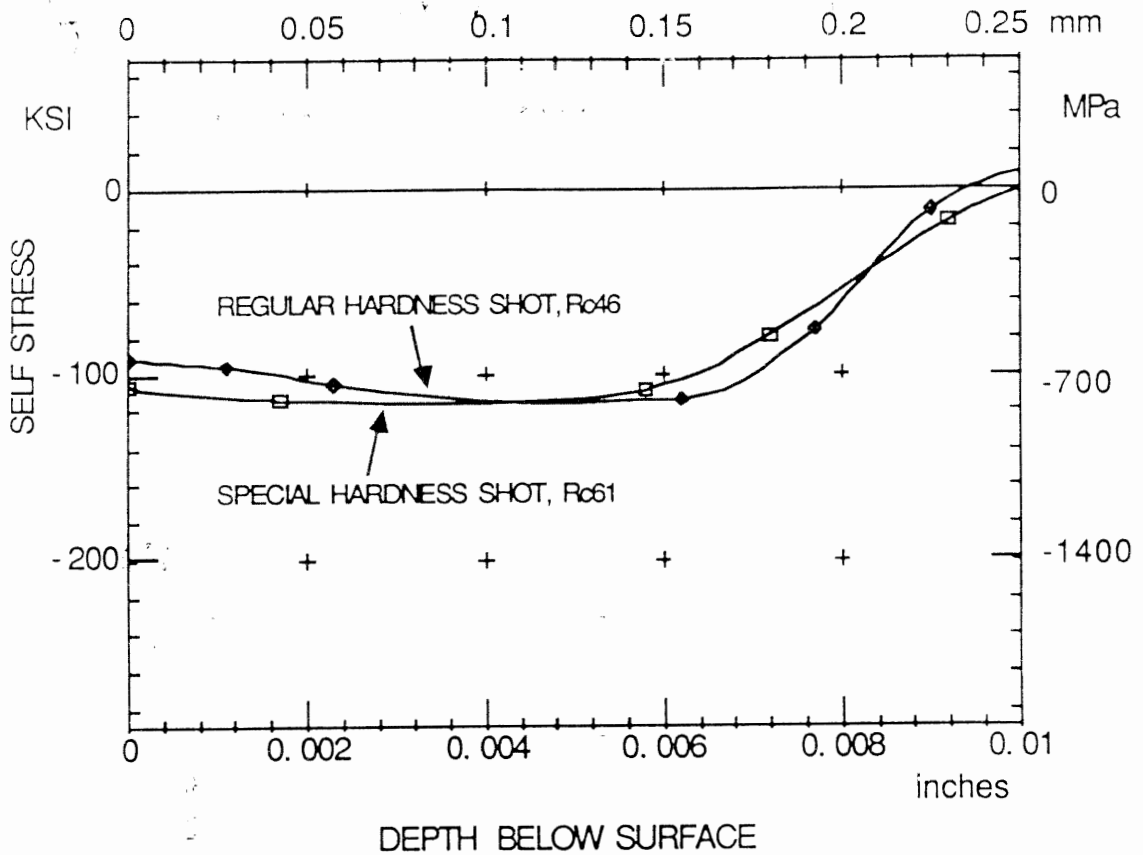
Shot: 1/8 in. (3.2 mm) diameter

Coverage: 400% 95%

Air pressure: 30 psi (200 kPa) 50 psi (350 kPa)

Reference: Brodrick, R.E., Protective Shot Peening of Propellers, Part 1, June 1955, pp 306,309. WADC Technical Report 55-56 Part 1.

FIG. 5



Material: 1045 steel

Hardness: Rockwell C 48

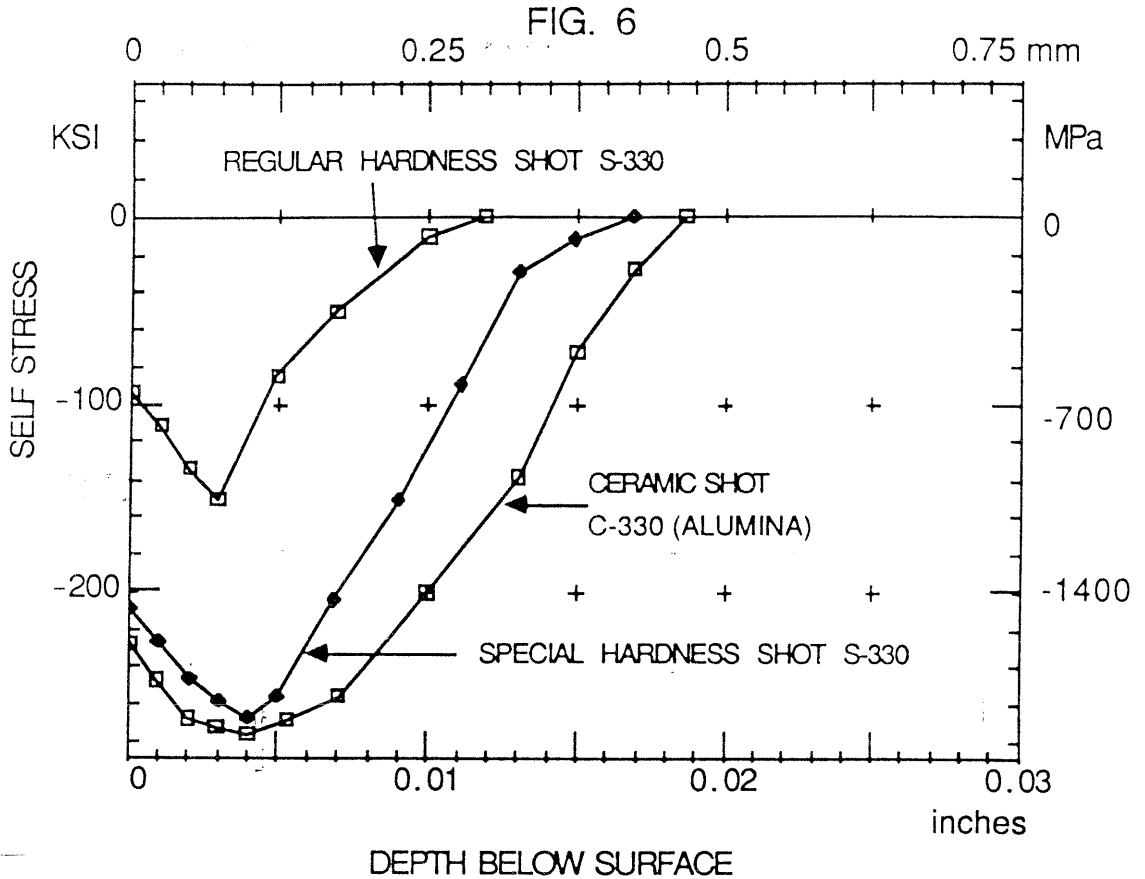
Tensile strength: 230 ksi (1600 MPa) estimated

Intensity: 14 A

Shot size: S 330 (0.84 mm nominal)

Reference: Lauchner, E., Peening of High Strength Steel Using Hard Shot. Presentation at WESTEC, March 1974

FIG. 6



Material: 300 M steel

Hardness: Rockwell C 54 (estimated)

Tensile strength: 280 ksi (1930 MPa) (specified)

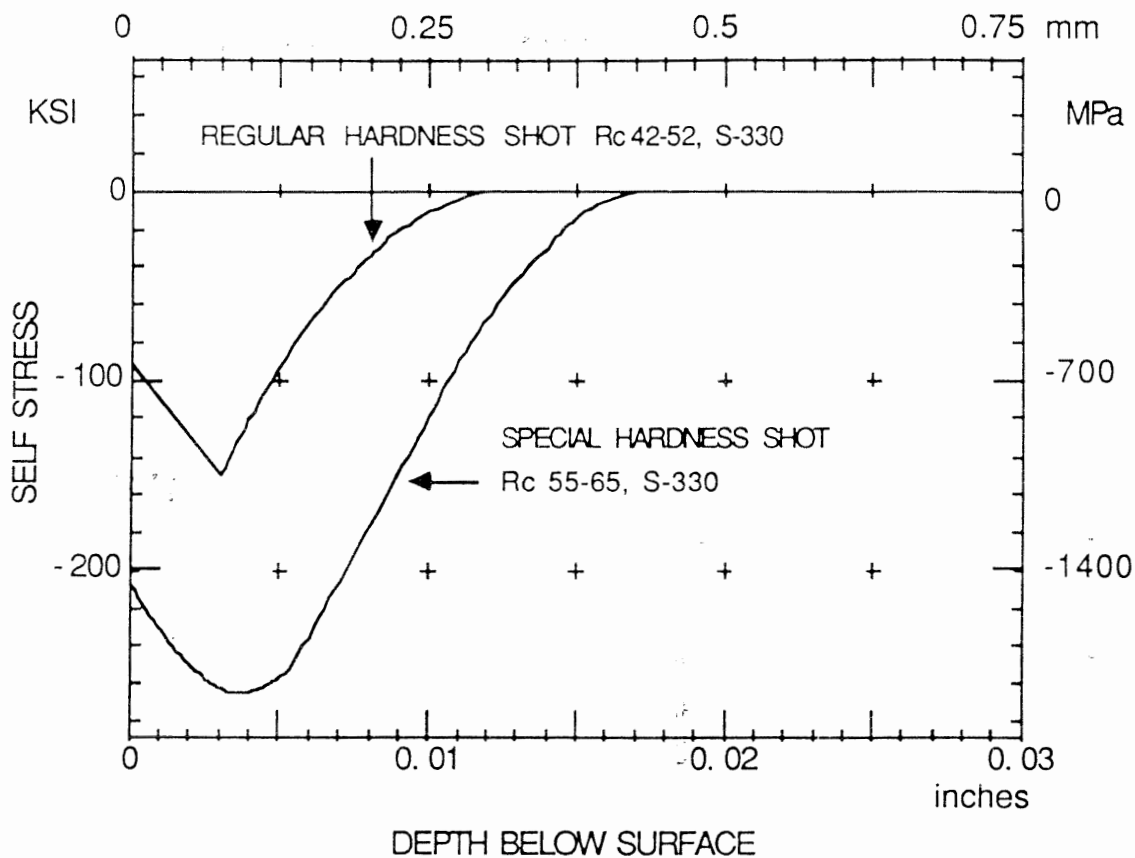
Yield strength: 230 ksi (1590 MPa) (specified)

Intensity: 15 A

Shot size: S 330 (0.84 mm nominal)

Reference: Lauchner, E., Peening of High Strength Steel Using Hard Shot. Presentation at WESTEC, March 1974.

FIG. 7



Material: 4340 M steel

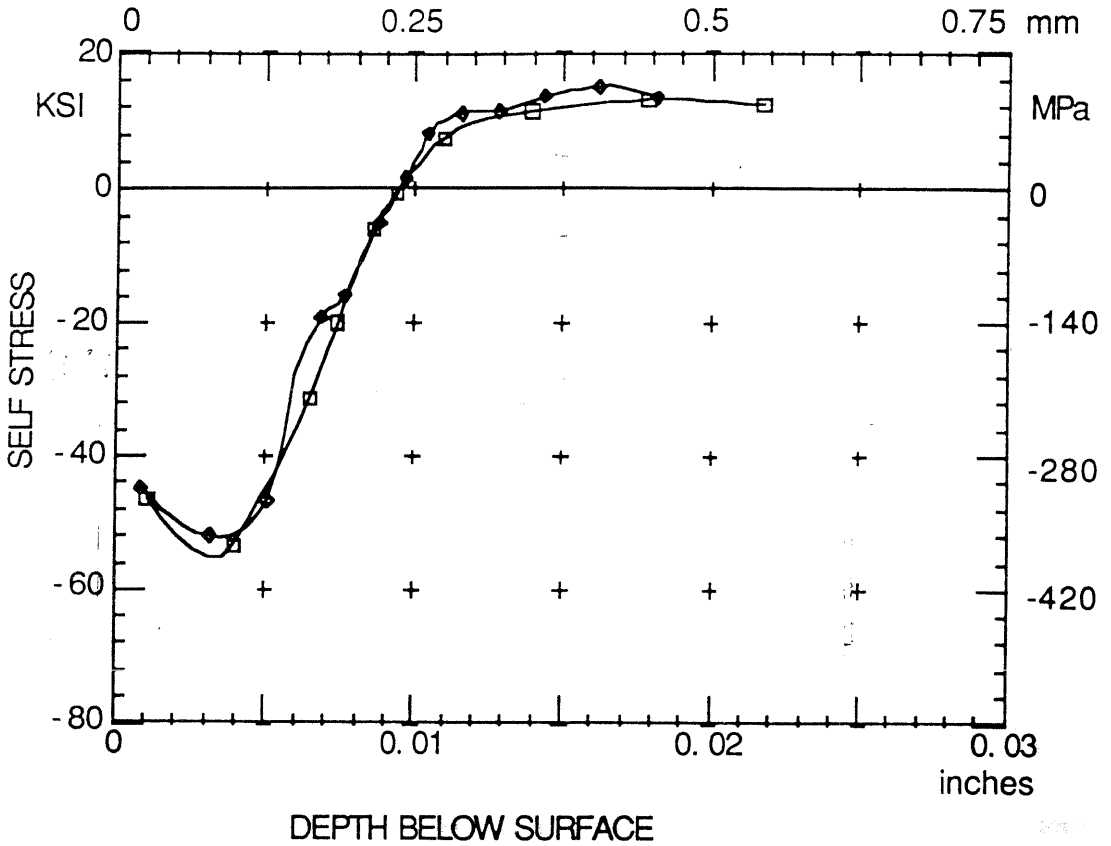
Tensile Strength: 275 - 300 ksi (1900 - 2070 MPa)

Intensity: 14 A

Shot size: S 330 (0.84 mm nominal)

Reference: Boeing Materials Technology Summary Report  
BMT-SR-846, November 1978

FIG. 8



Material: 7075-T6 aluminum alloy

Tensile strength: 80 ksi (550 MPa) (handbook data)

Yield strength: 70 ksi (485 MPa) (handbook data)

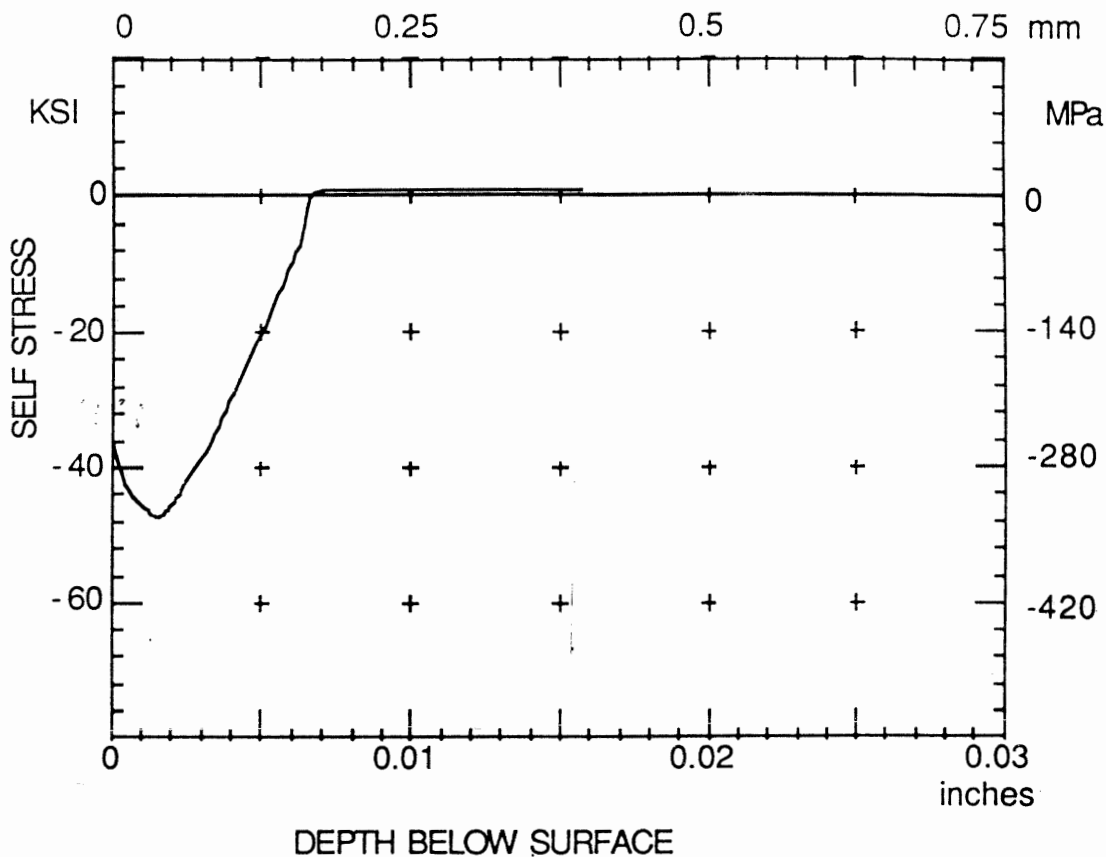
Specimen: Sheet 0.104 in (2.64 mm) thick

Intensity: 11 A

Shot: P 19 (0.019 in 0.5 mm nominal dia)

Reference: Waisman, J.L., Report from Technical Service Co. to Metal Improvement Co. 1952

FIG. 9



Material: 7075-T7351 aluminum alloy

Tensile strength: 460 MPa (67 ksi)

Yield strength: 370 MPa (54 ksi)

Specimen: Profile computed for 20 mm (0.79 in) thickness  
measured on thinner strips

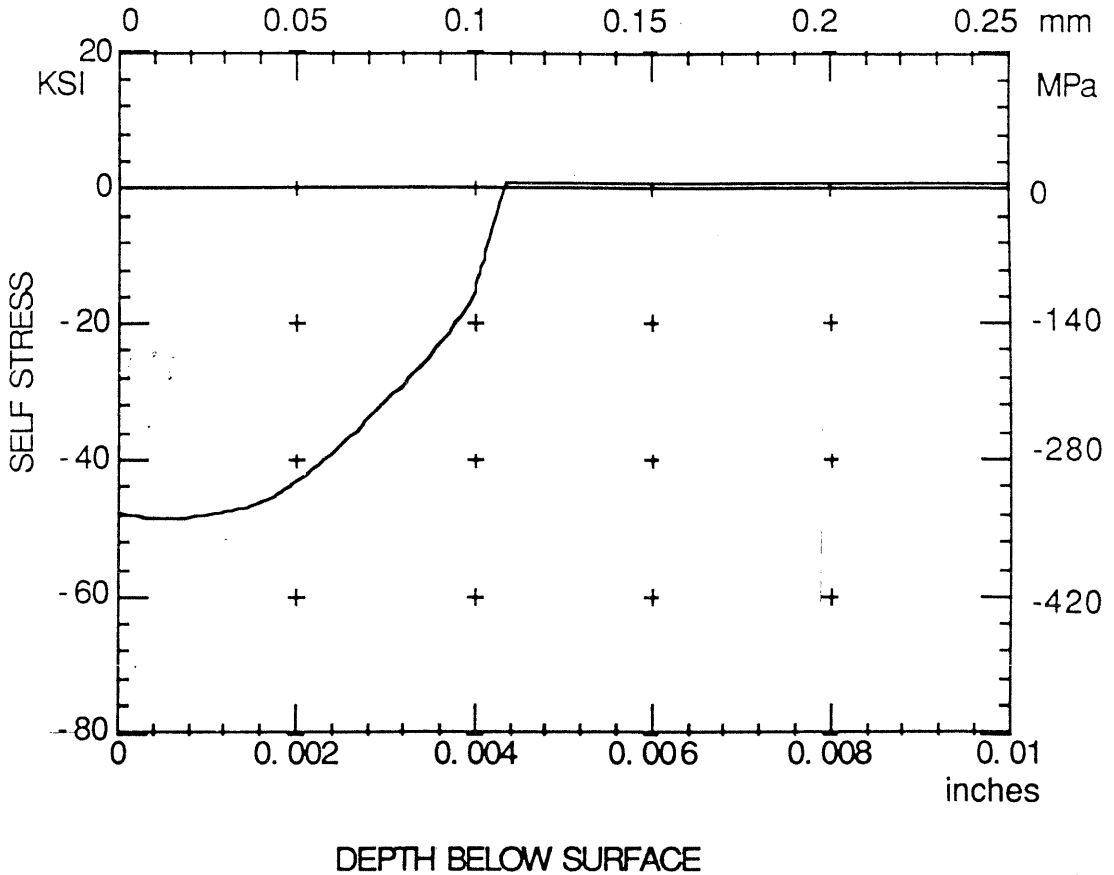
Intensity: 0.26 -0.32 N (10-12 N)

Shot: 0.3 mm (0.012 in) glass

Coverage: 200%

Reference: Niku-Lari, A., "Contraintes residuelles et fatigue  
des alliages d'aluminium grenailles" in Proceedings, 2nd. Intl.  
Conf. on Shot Peening, ICSP-2, H.O.Fuchs ed (1984) pp 102-114

FIG. 10



Material: 2024 T351 aluminum alloy

Tensile strength: 420 MPa (60 ksi)

Yield strength: 300 MPa (43 ksi)

Specimen: Profile computed for 20 mm (0.79 in thickness)  
measured on thinner strips

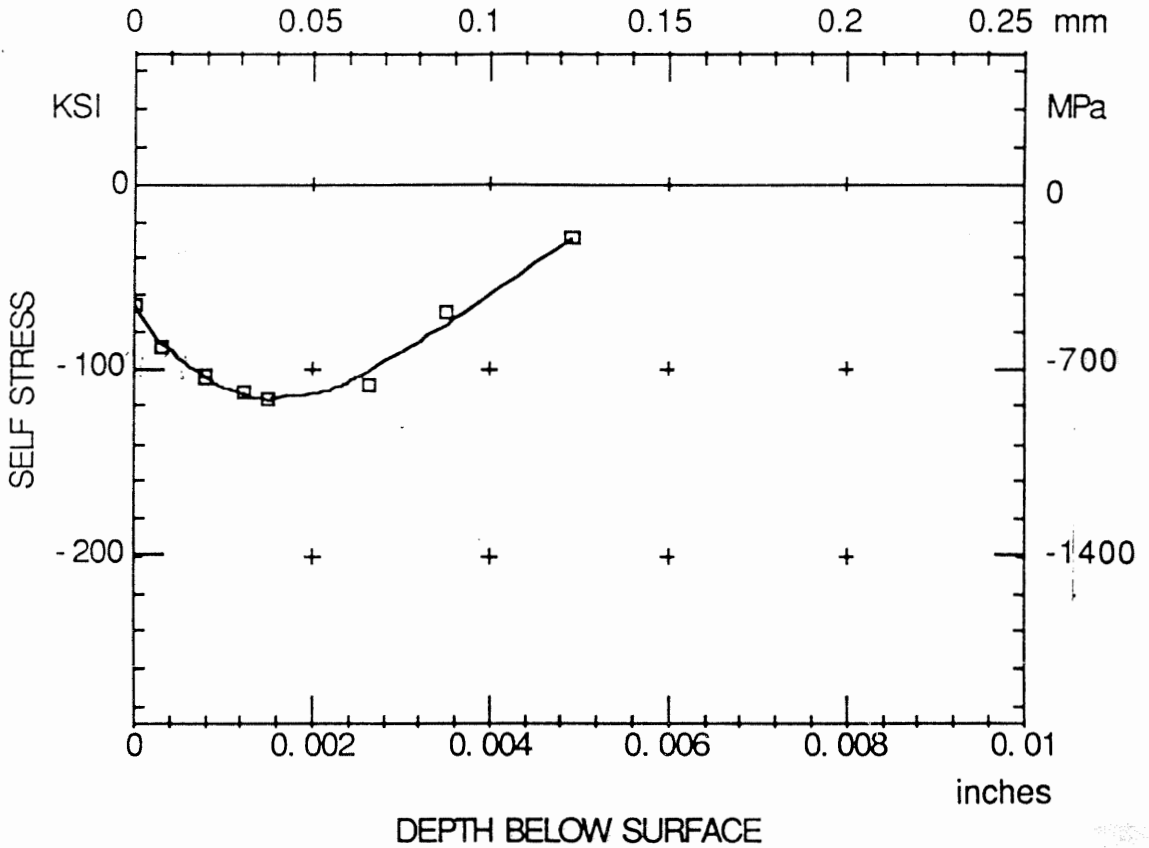
Intensity: 0.16-0.20 N (6-8 N)

Shot: 0.3 mm (0.012 in) glass

Coverage: 200%

Reference: Niku-Lari, A., " Contraintes residuelles et fatigue des alliages d'aluminium grenailles" in Proc. 2nd Intl. Conf. on Shot Peening, H.O.Fuchs, ed. (1984) pp102-114

FIG. 11



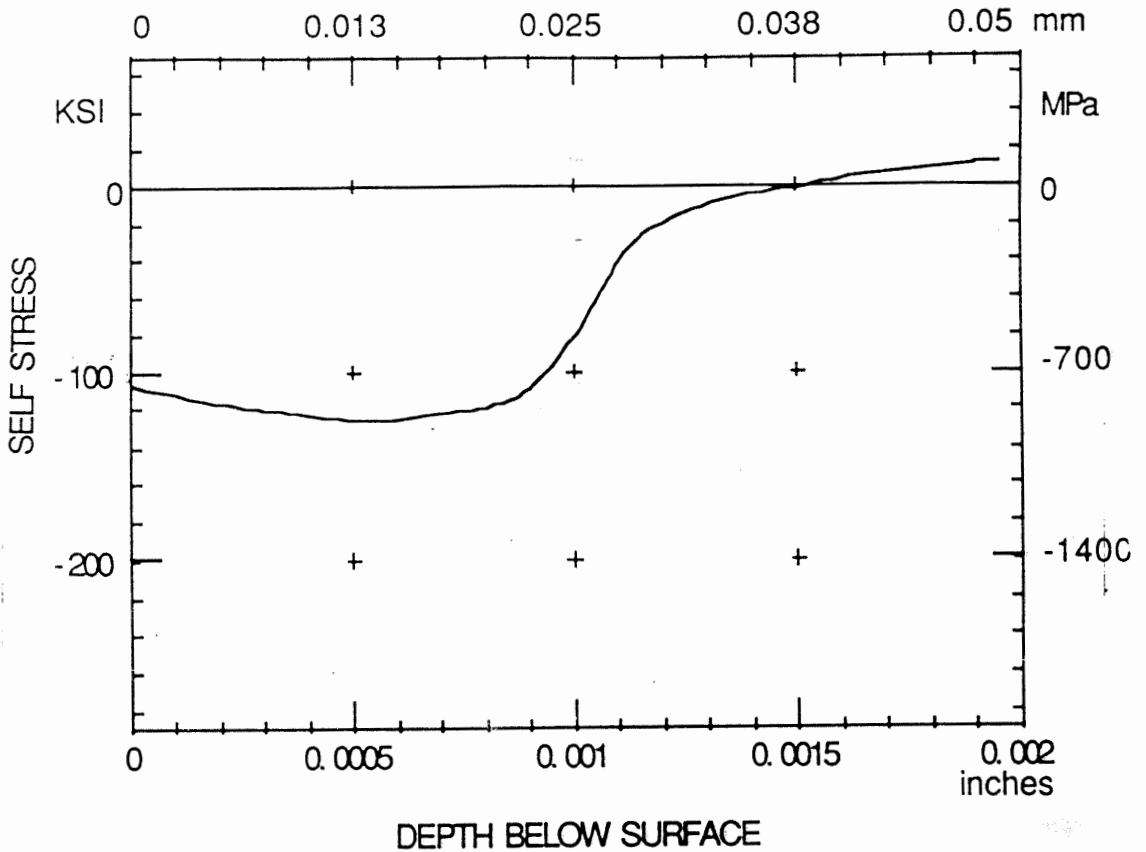
Material: Titanium alloy Ti-6Al-4V  
Quenched from 1227 K and aged at 977K

Specimen: approximately 50x20x2 mm(2xo.8xo.08 in)

Intensity: 6 A

Reference: Leverant, G.R., Langer, B.S., Yuen, A., and Hopkins, S.W.,  
"Surface Residual Stresses, Surface Topography, and the Fatigue  
Behavior of Ti-6Al-4V" Metallurgical Transactions, Vol 10 A  
February 1979, pp251-257

FIG. 12



Material: Titanium alloy Ti-6Al-4V

Tensile strength: 163 ksi (1125 MPa)

Yield strength: 151 ksi (1040 MPa)

Specimen: 0.046x1.5x1.5 in (1.2x38x38 mm)  
peened on one side

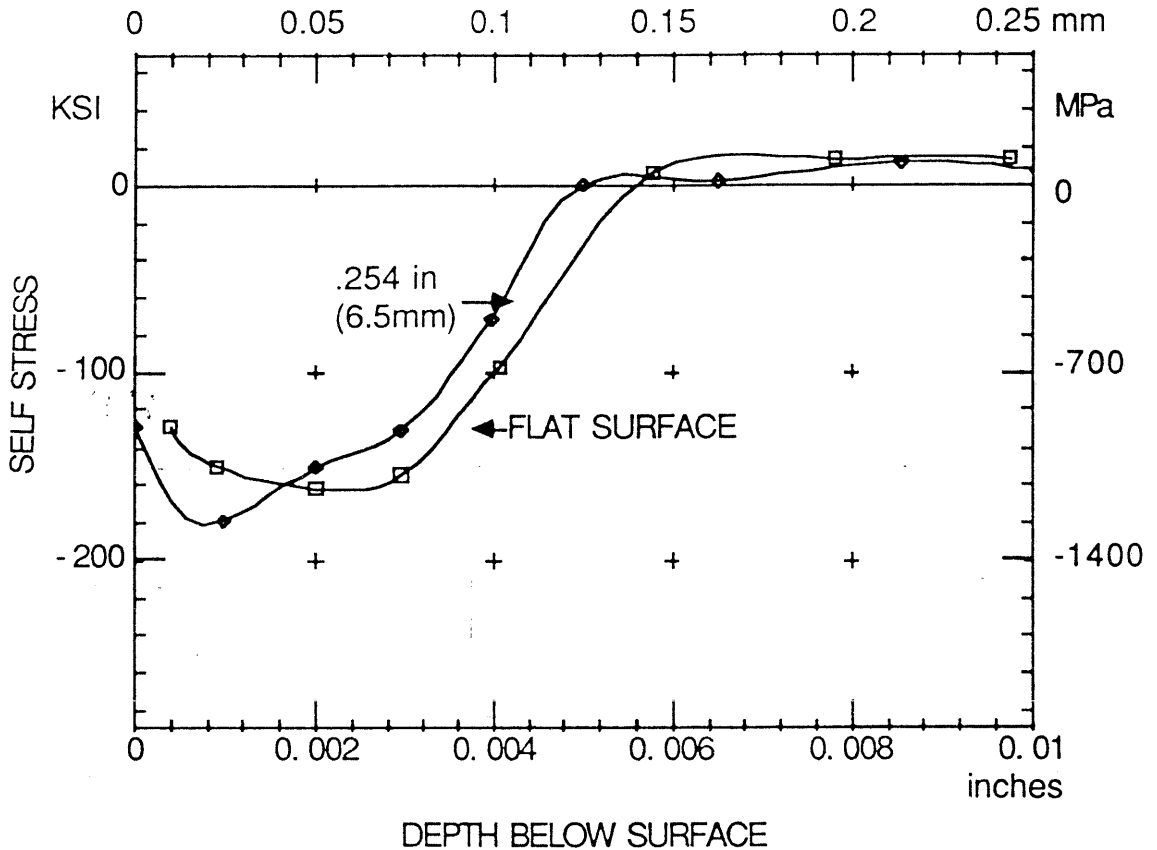
Intensity: 60 psi 3/16 nozzle (4-6 N expected)

Coverage: 5 seconds peening time

Shot: GP 25 glass (0.06 mm nominal diameter)

Reference: Braski, D.N. and Royster, D.M. "X-Ray Measurement of Residual Stress in Titanium Alloy Sheet. in J.B. Newkirk and G.R. Mallett, editors, Advances in X-Ray Analysis, Vol. 10 (1966) pp 295-310

FIG. 13



Material: Inconel 718 turbine disk

Hardness: Rockwell C 47

Yield strength: 196 ksi (1350 MPa)

Specimens: a) hole  $\phi$ .254 in (6.5 mm) diameter  
b) flat surface

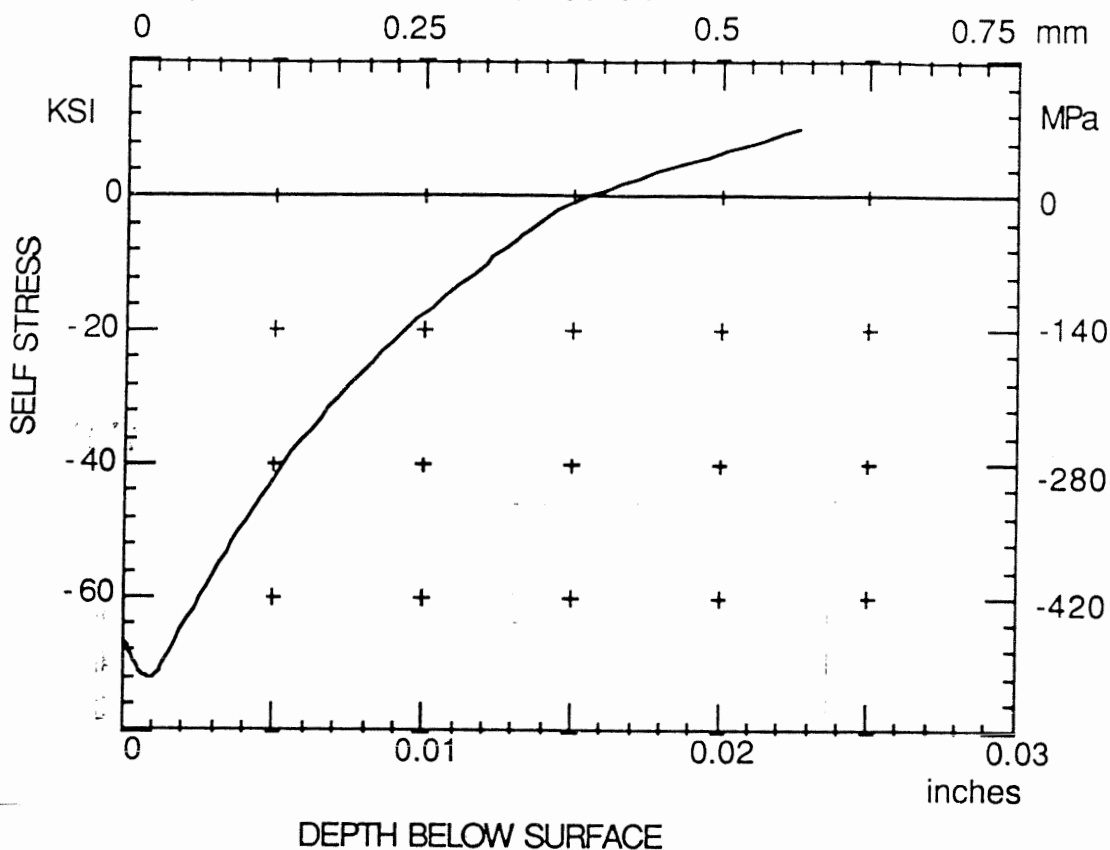
Intensity: 7 A

Coverage: 1.25 x saturation time

Shot: S 110 cast steel, ( $\phi$ .28 mm nom.) hardness Rockwell C 57

Reference: Happ, M.B., "Shot Peening Bolt Holes in Aircraft Engine Hardware" in Proc. 2nd Intl. Conf. on Shot Peening, H.O.Fuchs, ed. 1984, pp43-49

FIG. 14



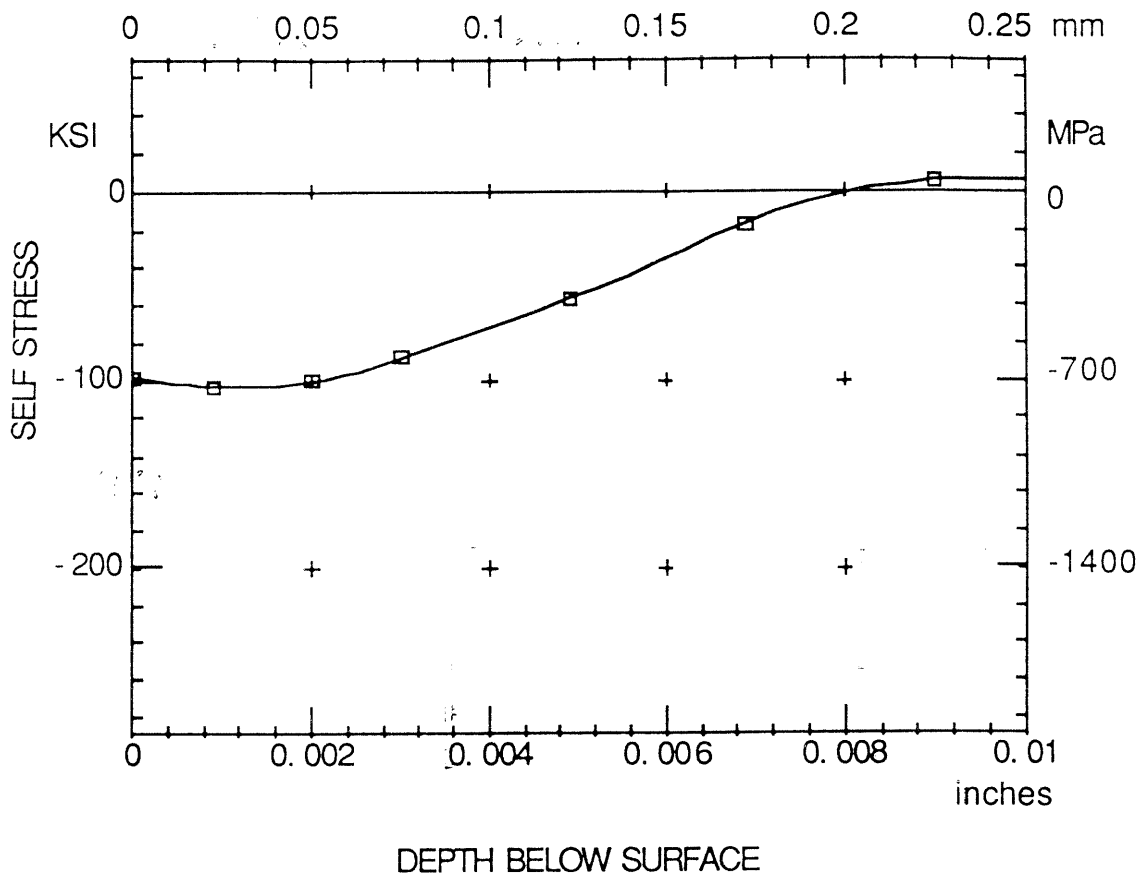
Material: Stainless steel type 304

Intensity: 10 A

Shot: 0.023 (.58 mm nominal)

Reference: Winter, P.M. and McDonald, W.J. "Biaxial Residual Surface Stresses from Grinding and Finishing Type 304 Stainless Steel Determined by a New Dissection Technique" ASME Paper No. 68-WAMET-9, December 1968, quoted by W. H. Friske in "Shot Peening to Prevent the Corrosion of Austenitic Stainless Steels. Rockwell International report No. AI-75-52, September 1975.

FIG. 15



Material: Stainless steel type 17-4 PH

Specimen: 0.249 in (6.32 mm) diameter.

Intensity: 12-14 A

Coverage: 400 %

Shot: S 230 (0.58 mm nominal)

Reference: Prevey, P.S. X-Ray Diffraction Determination of the Subsurface Longitudinal Residual Stress Profile on two Hourglass Corrosion Cracking Specimens Manufactured from 17-4 PH Stainless Steel. Lambda Research Inc. report, Cincinnati, Ohio, June 28, 1979