CONCENTRATION OF STRESSES CONT'D.

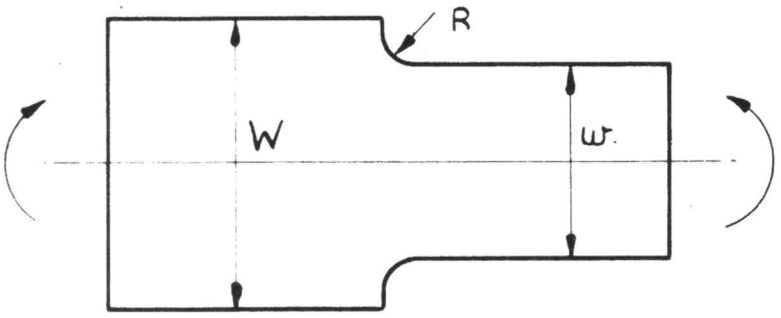
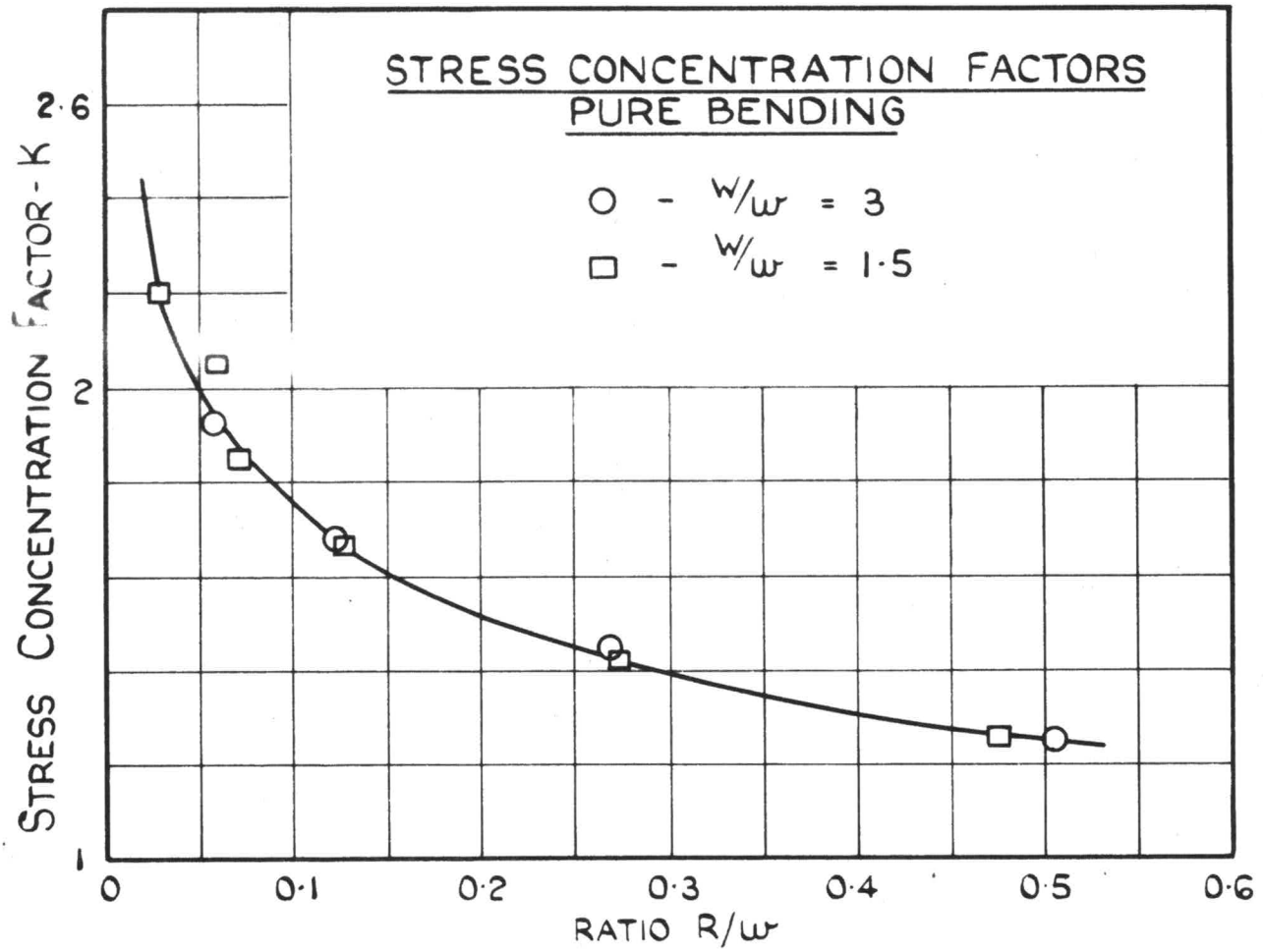
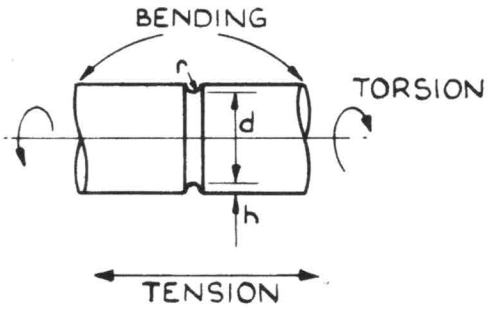


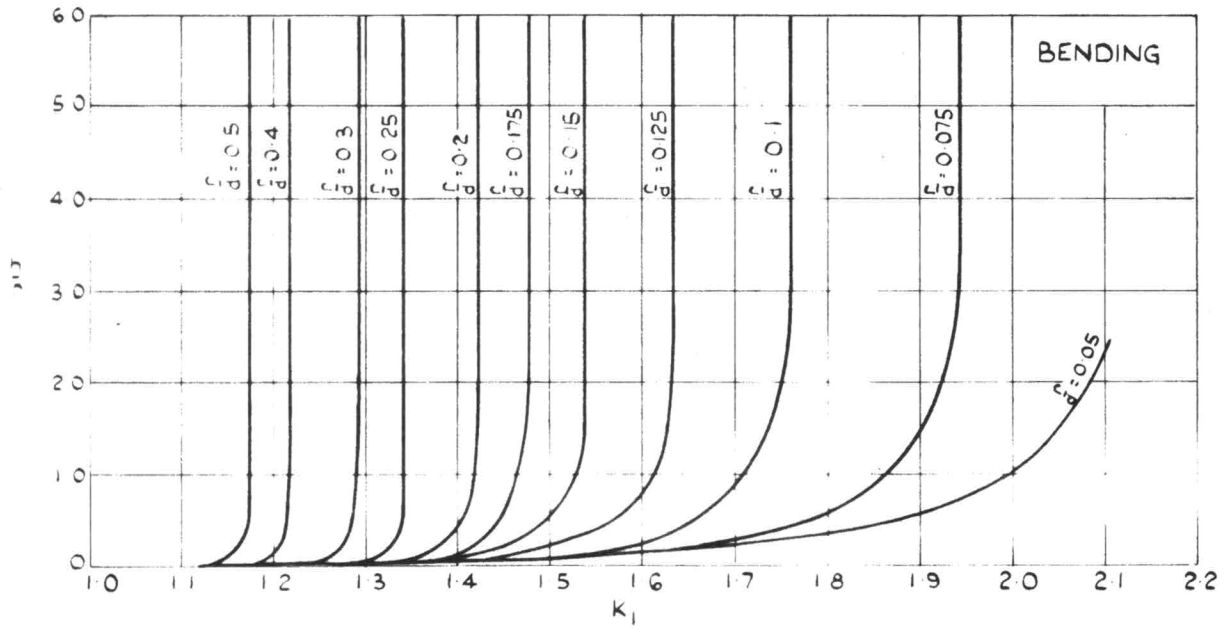
FIG. 31.

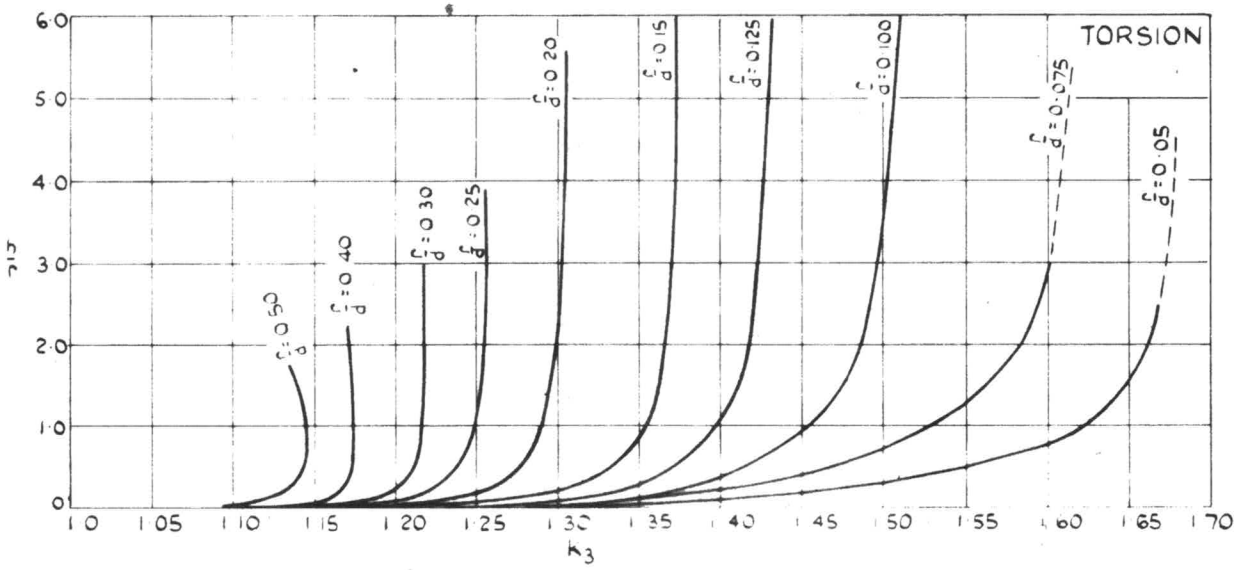


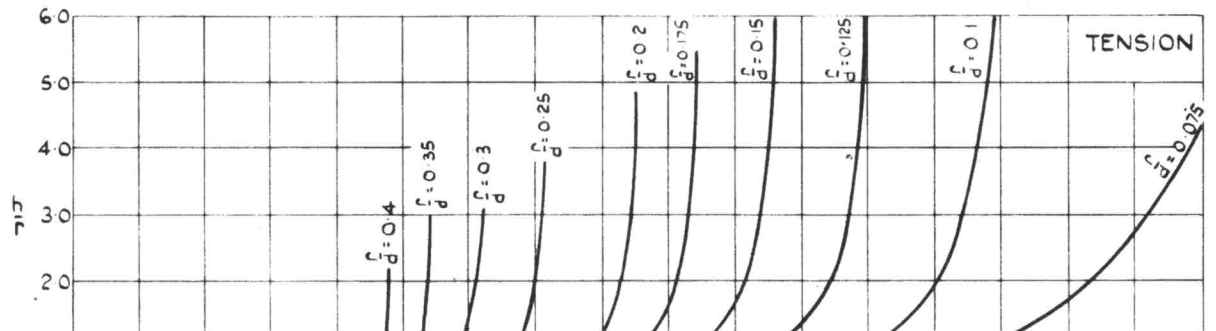
STRESS CONCENTRATION FACTORS FOR A U-NOTCH IN A CIRCULAR SHAFT.

ABRUPT VARIATIONS OF STRESS DISTRIBUTION DUE TO A CHANGE IN A CROSS-SECTIONAL AREA CAUSE STRESS CONCENTRATIONS. THE FOLLOWING FACTORS ARE GIVEN FOR CONDITIONS OF BENDING, TORSION AND TENSION LOADS, AND ARE A MEASURE OF THE INCREASED LOCAL STRESS









24. MEASUREMENT OF ANGLES AND TRIANGLES.

ANGLES

1 RADIAN = 57·29578 DEGREES = 57° - 17′ - 45″

π RADIANS = 3·14159 RADIANS = 180°

·0174533 RADIANS = 1 DEGREE

·0002909 RADIANS = 1 MINUTE

·0000048 RADIANS = 1 SECOND

A RADIAN IS AN ANGLE SUBTENDED BY AN ARC EQUAL IN LENGTH TO THE RADIUS OF A CIRCLE SEE FIGURE 33.

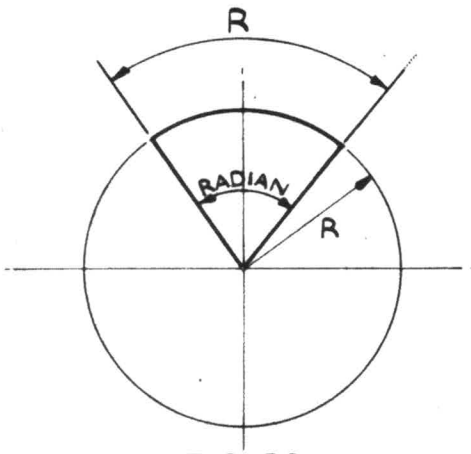


FIG. 33.

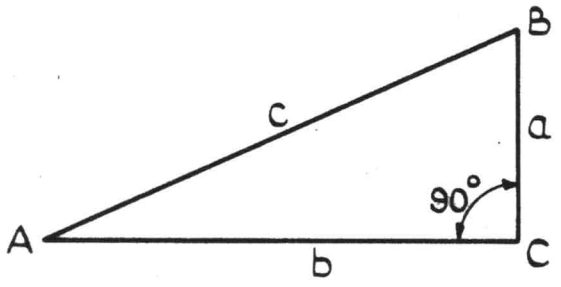
TABLE OF EQUIVALENT INCLINATION.

RISE	ANGLE OF INCLINATION	TANGENT	SINE	RADIANS
1 IN 30	1° – 55′	·0333	·0333	·0333
1 IN 25	2° – 17′	·0400	·0400	·0400
1 IN 20	2° – 52′	·0500	·0500	·0500
1 IN 18	3° – 11′	·0555	·0554	·0555
1 IN 16	3° – 35′	·0625	·0624	·0625
1 IN 14	4° – 5′	·0714	·0712	·0713
1 IN 12	4° – 46′	·0833	·0831	·0832
1 IN 10	5° – 43′	·1000	·0996	·0997
1 IN 9	6° – 21′	·1111	·1103	·1105
1 IN 8	7° – 8′	·1250	·1242	·1245
1 IN 7	8° – 8′	·1429	·1415	·1419
1 IN 6	9° – 28′	·1667	·1645	·1652
1 IN 5	11° – 19′	·2000	·1926	·1975
1 IN 4	14° – 2′	·2500	·2425	·2449
1 IN 3	18° – 26′	·3333	·3162	·3217

MEASUREMENT OF ANGLES CONT'D.
AND TRIANGLES

TRIANGLES.

TRIGNOMETRICAL RATIOS.

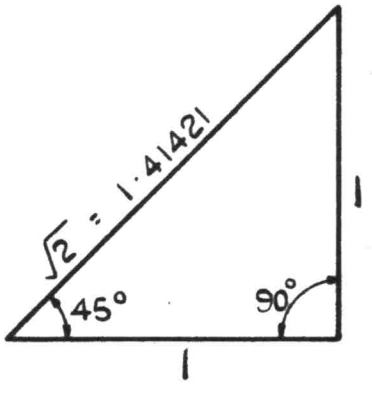


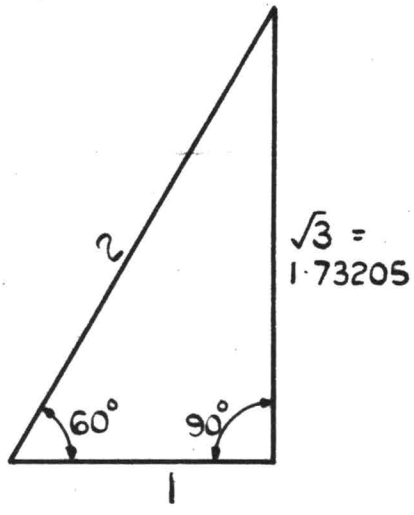
$$\text{SIN. A} = \frac{\text{OPPOSITE SIDE}}{\text{HYPOTENUSE}} = \frac{a}{c} \qquad \text{SEC. A} = \frac{1}{\text{COS A}} = \frac{c}{b}$$

$$\text{COS. A} = \frac{\text{ADJACENT SIDE}}{\text{HYPOTENUSE}} = \frac{b}{c} \qquad \text{COSEC. A} = \frac{1}{\text{SINE A}} = \frac{c}{a}$$

$$\text{TAN. A} = \frac{\text{OPPOSITE SIDE}}{\text{ADJACENT SIDE}} = \frac{a}{b} \qquad \text{COT. A} = \frac{1}{\text{TAN A}} = \frac{b}{a}$$

RATIOS OF SIDES.



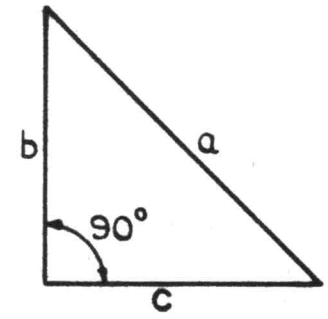


EXAMPLE

45° TRIANGLE - IF THE LENGTH OF ONE OF THE SIDES IS EQUAL TO 5" THEN THE HYPOTENUSE IS EQUAL TO 5" x 1·41421 = 7·07105"

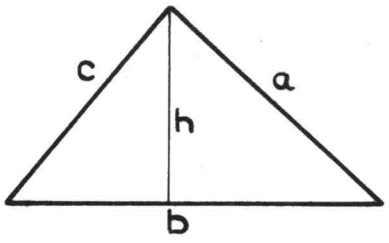
60° TRIANGLE - THE SAME METHOD APPLIES TO THIS TRIANGLE I.E. IF THE BASE OF THE TRIANGLE IS EQUAL TO 5" THEN THE VERTICAL SIDE IS EQUAL

AREA



RIGHT ANGLE TRIANGLE

$$\text{AREA} = \frac{bc}{2}$$

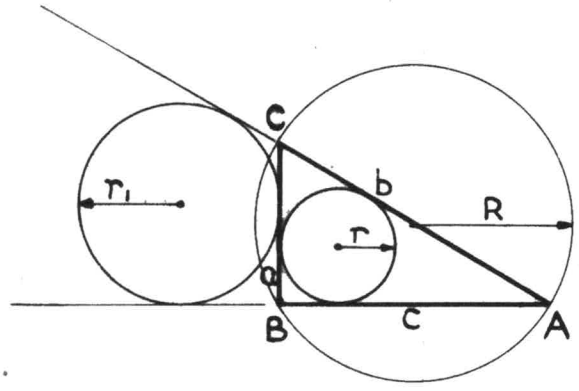


ACUTE ANGLE TRIANGLE

$$\text{AREA} = \frac{bh}{2} = \frac{b}{2}\sqrt{a^2-\left(\frac{a^2+b^2-c^2}{2b}\right)^2}$$

$$\text{OR} = \sqrt{S(S-a)(S-b)(S-c)}$$

$$\text{WHERE } S = \tfrac{1}{2}(a+b+c)$$



RADIUS OF CIRCUMSCRIBING CIRCLE.

$$R = \frac{a.b.c}{4 \times \text{AREA}}$$

$$2R = \frac{a}{\text{SIN.A}} = \frac{b}{\text{SIN.B}} = \frac{c}{\text{SIN.C}}$$

RADIUS OF INSCRIBED CIRCLE.

$$r = \frac{\Delta}{S} = \sqrt{\frac{(S-a)(S-b)(S-c)}{S}}$$

$$= (S-a)\,\text{TAN.}\frac{A}{2} = (S-b)\,\text{TAN.}\frac{B}{2} = (S-c)\,\text{TAN.}\frac{C}{2}$$

RADIUS OF ESCRIBED CIRCLE.

$$r_1 = \frac{\Delta}{S-a}$$

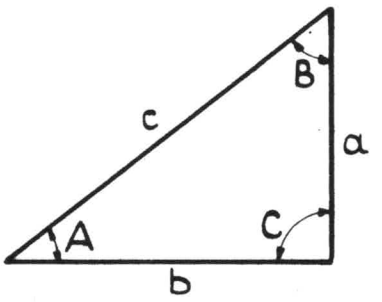
$$= \sqrt{\frac{S(S-b)(S-c)}{(S-a)}} = S\,\text{TAN.}\frac{A}{2}$$

WHERE Δ = AREA OF TRIANGLE

MEASUREMENT OF ANGLES CONT'D AND TRIANGLES

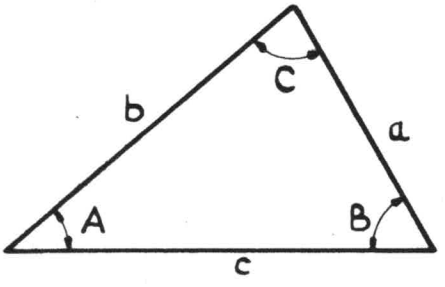
SOLUTION OF TRIANGLES.

RIGHT ANGLED TRIANGLES.



PARTS GIVEN	PARTS TO BE FOUND.				
	a	b	c	A	B
a & c	–	$\sqrt{c^2 - a^2}$	–	SIN. A = $\frac{a}{c}$	COS. B = $\frac{a}{c}$
a & b	–	–	$\sqrt{a^2 + b^2}$	TAN. A = $\frac{a}{b}$	COT. B = $\frac{a}{b}$
c & b	$\sqrt{c^2 - b^2}$	–	–	COS. A = $\frac{b}{c}$	SIN. B = $\frac{b}{c}$
A & a	–	a x COT. A	$\frac{a}{\text{SIN. A}}$	–	90° - A
A & b	b x TAN. A	–	$\frac{b}{\text{COS. A}}$	–	90° - A
A & c	c x SIN. A	c x COS. A	–	–	90° - A

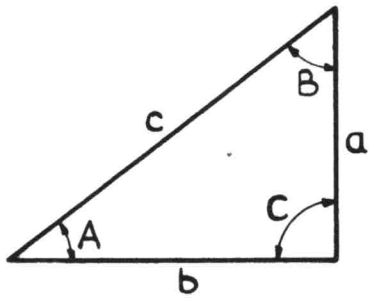
ACUTE ANGLE TRIANGLES.



PARTS GIVEN	PARTS TO BE FOUND.		
	SIDE a	SIDE b	SIDE c
a b c	–	–	–
b c A	$\sqrt{b^2 + c^2 - 2bc \text{ COS. A}}$	–	–
a c B	–	$\sqrt{a^2 + c^2 - 2ac \text{ COS. B}}$	–
a b C	–	–	$\sqrt{a^2 + b^2 - 2ab \text{ COS C}}$
a b A	–	–	$\frac{a \text{ SIN. C}}{\text{SIN. A}}$
a b B	–	–	$\frac{b \text{ SIN. C}}{\text{SIN. B}}$
a c A	–	$\frac{a \text{ SIN. B}}{\text{SIN. A}}$	–
a c C	–	$\frac{c \text{ SIN. B}}{\text{SIN. C}}$	–
b c B	$\frac{b \text{ SIN. A}}{\text{SIN B}}$	–	–
b c C	$\frac{c \text{ SIN. A}}{\text{SIN. C}}$	–	–
a A B	–	$\frac{a \text{ SIN. B}}{\text{SIN. A}}$	$\frac{a \text{ SIN. C}}{\text{SIN. A}}$
a A C	–	$\frac{a \text{ SIN. B}}{\text{SIN. A}}$	$\frac{a \text{ SIN. C}}{\text{SIN. A}}$
a B C	–	$\frac{a \text{ SIN. B}}{\text{SIN. A}}$	$\frac{a \text{ SIN. C}}{\text{SIN. A}}$
b A B	$\frac{b \text{ SIN. A}}{\text{SIN B}}$	–	$\frac{b \text{ SIN. C}}{\text{SIN. B}}$
b A C	$\frac{b \text{ SIN. A}}{\text{SIN B}}$	–	$\frac{b \text{ SIN. C}}{\text{SIN. B}}$

MEASUREMENT OF ANGLES CONT'D.
AND TRIANGLES

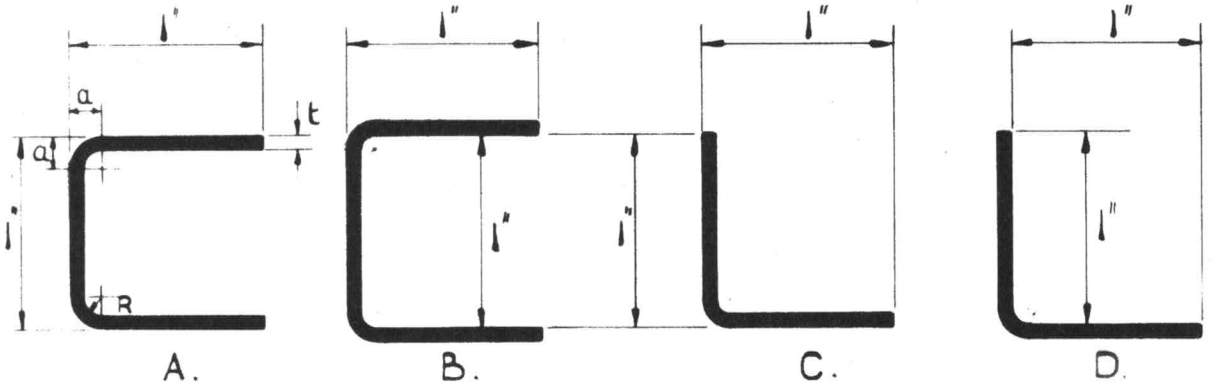
ACUTE ANGLE TRIANGLES



PARTS GIVEN	PARTS TO BE FOUND		
	ANGLE A	ANGLE B	ANGLE C
a b c	$\frac{b^2 + c^2 - a^2}{2bc}$ = Cos. A	$\frac{a^2 + c^2 - b^2}{2ac}$ = Cos. B	$\frac{a^2 + b^2 - c^2}{2ab}$ = Cos. C
b c A	—	$\frac{b \text{ SIN. } A}{c - b \text{ COS } A}$ = TAN. B	$\frac{c \text{ SIN. } A}{b - c \text{ COS } A}$ = TAN. C
a c B	$\frac{a \text{ SIN. } B}{c - a \text{ COS } B}$ = TAN. A	—	$\frac{c \text{ SIN. } B}{a - c \text{ COS } B}$ = TAN. C
a b C	$\frac{a \text{ SIN. } C}{b - a \text{ COS } C}$ = TAN. A	$\frac{b \text{ SIN } C}{a - b \text{ COS } C}$ = TAN. B	—
a b A	—	$\frac{b \text{ SIN. } A}{a}$ = SIN. B	180° - (A + B)
a b B	$\frac{a \text{ SIN } B}{b}$ = SIN. A	—	180° - (A + B)
a c A	—	180° - (A + C)	$\frac{c \text{ SIN. } A}{a}$ = SIN. C
a c C	$\frac{a \text{ SIN } C}{c}$ = SIN. A	180° - (A + C)	—
b c B	180° - (B + C)	—	$\frac{c \text{ SIN. } B}{b}$ = SIN. C
b c C	180° - (B + C)	$\frac{b \text{ SIN. } C}{c}$ = SIN. B	—
a A B	—	—	180° - (A + B)
a A C	—	180° - (A + C)	—
a B C	180° - (B + C)	—	—
b A B	—	—	180° - (A + B)
b A C	—	180° - (A + C)	—
b B C	180° - (B + C)	—	—
c A B	—	—	180° - (A + B)
c A C	—	180° - (A + C)	—
c B C	180° - (B + C)	—	—

SHEET METAL SECTIONS.

THE CHART BELOW IS A MEANS OF QUICKLY ESTIMATING THE BLANK DIMENSIONS OF CHANNELS, ANGLES AND VARIOUS OTHER SECTIONS. IN THE DETERMINATION OF THE BENDING ALLOWANCE FOR A 90° BEND, THE CONSTANT 0·4 t HAS BEEN USED. EXPERIENCE HAS SHOWN THIS TO BE A SATISFACTORY VALUE. THE METAL FORMING THE EXTERNAL BEND IS IN TENSION AND MORE RAPIDLY YIELDS THAN THAT AT THE INTERNAL RADIUS. THIS CAUSES A REDUCTION OF THICKNESS AND A DISPLACEMENT OF THE NEUTRAL AXIS.



A. B. C. D.

					FIG. A.	FIG. B.	FIG. C.	FIG. D.
SWG	t	R	B A	a	DEVELOP-MENT.	DEVELOP-MENT	DEVELOP-MENT	DEVELOP-MENT.
20	·036	1/16	·121	·098	2·85	2·922	1·925	1·997
18	·048	1/16	·128	·110	2·816	2·912	1·908	2·004
16	·064	1/16	·1385	·126	2·773	2·901	1·886	2·014
16	·064	1/8	·237	·189	2·718	2·846	1·859	1·987
14	·080	1/16	·1485	·142	2·729	2·889	1·864	2·024
14	·080	1/8	·247	·205	2·674	2·834	1·837	1·997
12	·104	1/8	·262	·229	2·608	2·816	1·804	2·012
12	·104	3/16	·360	·2915	2·554	2·762	1·777	1·985
10	·128	1/8	·277	·253	2·542	2·798	1·771	2·027
10	·128	1/4	·473	·378	2·434	2·69	1·717	1·973
	1/8	1/4	·471	3/8	2·442	2·692	1·721	1·971
	1/8	1/8	·275	·250	2·55	2·80	1·775	2·025
	3/16	1/8	·314	5/16	2·378	2·753	1·689	2·064
	3/16	3/16	·411	3/8	2·322	2·697	1·661	2·036
	3/16	1/4	·51	7/16	2·27	2·647	1·635	2·010
	1/4	1/4	·55	1/2	2·1	2·6	1·55	2·05
	1/4	3/8	·745	5/8	1·99	2·49	1·495	1·995

B.A = BEND ALLOWANCE FOR 90° BEND = 1·5708(R+0·4t)

DEVELOPMENT OF FIG. A = (3" - 4a) + 2 B.A.

DEVELOPMENT OF FIG. B = (3" - 4a) + 2 B.A + 2 t

ALLOWANCES FOR FORMED SHEET METAL SECTIONS CONT'D.

EXAMPLE 1.

DETERMINE THE BLANK DIMENSIONS REQUIRED FOR A 4 IN. x 2 IN FORMED CHANNEL WITH INSIDE RADIUS 1/8 IN. MATERIAL :- 14 S.W.G (·08) DIMENSIONED AS FIG. A. DEVELOPMENT OF FIG. A IS FOR 1 IN. FLANGES AND 1 IN. WEB.

∴ DEVELOPMENT OF 4 IN. x 2 IN. CHANNEL
= 2·674 IN. PLUS THE DIFFERENCE OF WEB AND FLANGE DIMENSIONS.
∴ DIMENSIONS = 2·674 + (1+1+3) = 7·674 INS.

EXAMPLE 2.

DETERMINE THE BLANK DIMENSIONS REQUIRED FOR A 3/4 IN. x 1/2 IN. FLANGED FORMED CHANNEL WITH INSIDE RADIUS 1/16 IN.
MATERIAL :- 20 S.W.G (·036") DIMENSIONED AS FIG. B.
DEVELOPMENT OF FIG. B IS FOR 1 IN. FLANGES AND 1 IN. WEB (MEASURED INSIDE FLANGES)

∴ DEVELOPMENT OF 3/4 IN. x 1/2 IN. CHANNEL
= 2·922 IN. MINUS THE DIFFERENCE OF WEB AND FLANGE DIMENSIONS.
∴ DIMENSIONS = 2·922 - (1/2 + 1/2 + 1/4) = 1·672 INS.

FOR THE DEVELOPMENT OF ANGLE SECTIONS, FIGS. C AND D ARE USED IN A MANNER SIMILAR TO THAT DESCRIBED IN THE FOREGOING EXAMPLES. DEVELOPMENT OF Z OR 'TOP HAT' SECTIONS CAN BE FOUND BY REGARDING THE SECTION AS A COMBINATION OF SEVERAL ANGLES OR A CHANNEL AND ANGLES, USING FIGS. A, B, C AND D.

26. SHEET STEEL, NOTES ON.

1. DIRECTION OF ROLLING IN RELATION TO BENDS OR FOLDS IN SHEET STEEL.

IN ORDER TO MINIMISE FATIGUE AT THE POINT OF BENDING IN SHEET STEEL, IT IS IMPORTANT THAT BENDING IS ARRANGED TO TAKE PLACE AT 90° TO THE DIRECTION OF ROLLING. WHERE PRACTICABLE, THE DIRECTION OF ROLLING SHOULD BE INDICATED ON THE DRAWING AS SHOWN IN FIG. 34.

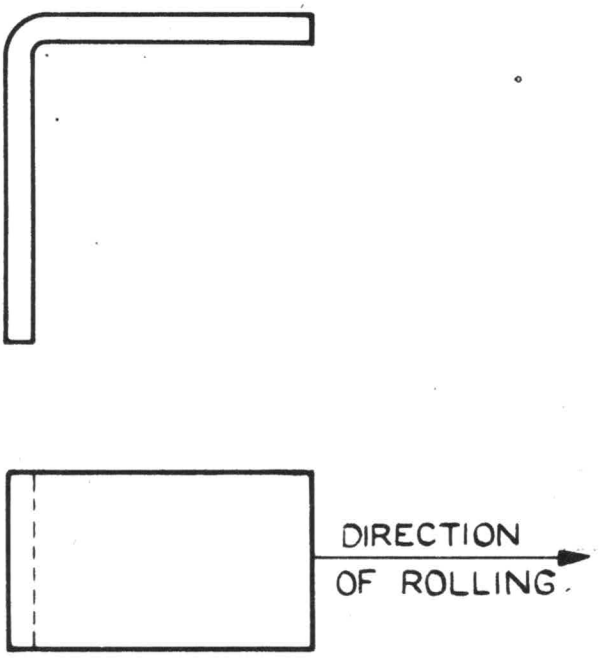


FIG. 34.

2. RADII FOR PRESSINGS & FOLDINGS.

IT IS IMPORTANT THAT THE INSIDE RADII OF BENDS FOR PRESSINGS AND FOLDINGS MUST NOT BE LESS THAN THE THICKNESS OF THE MATERIAL AND WITHIN REASONABLE LIMITS, SHOULD BE AS LARGE AS POSSIBLE.

26.A. FLAT BAR OR STRIP, NOTES ON

1, CROPPING OF ENDS.

FOR BRACKETS, CLIPS, AND OTHER PARTS MADE FROM FLAT BAR OR STRIP, THE GENERAL ACCEPTED PRACTICE FOR THE FINISH OF ENDS WILL BE BY A RADIUS AS SHOWN IN FIG. 34 A.

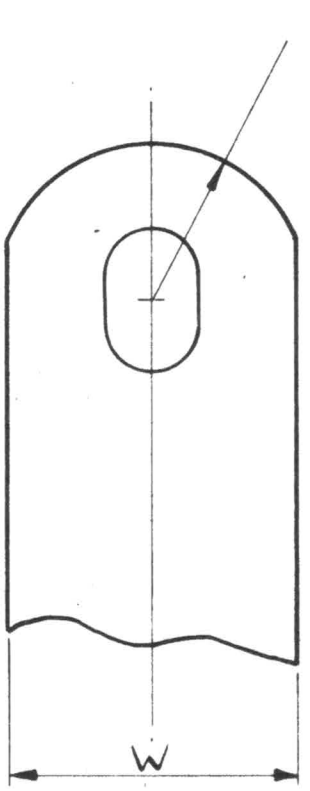


FIG. 34 A.

THE RADIUS, WHICH MUST BE STATED ON THE DRAWING, WILL BE MADE BY THE USUAL METHOD OF CROPPING AND MUST BE GREATER THAN HALF THE WIDTH OF THE MATERIAL.
AS A GUIDE FOR STANDARDISATION THE RADIUS SHOULD BE DETERMINED FROM THE DATA GIVEN IN FIG. 34 A.

26B MATERIAL FOR STEEL SHIMS.

ALL STEEL SHIMS WILL BE MADE FROM STRIP TO B.S. SPECIFICATION Nº. 1449 - LATEST ISSUE, AND WILL BE SPECIFIED IN THE EN. SERIES. SHIMS WILL BE DIVIDED INTO TWO CLASSES I.E. HARD STEEL SHIMS AND SOFT STEEL SHIMS, ACCORDING TO THE REQUIREMENT

HARD STEEL SHIMS.

THE STEEL MAKERS OF SHIM STEEL HAVE DIFFICULTY AT TIMES IN THE MANUFACTURE OF SHIMS TO ONE SPECIFIED SPECIFICATION. THIS MAY BE DUE TO THE SHAPE OR THICKNESS OF THE SHIM REQUIRED. IT WILL THEREFORE BE NECESSARY TO GIVE AS WIDE A RANGE OF MATERIAL AS POSSIBLE ON THE DRAWING TO COVER THIS CONTINGENCY.

THE MATERIAL TO BE QUOTED ON THE DRAWING TO BE "EN 42 OR 43" WITH BRINELL HARDNESS NUMBER "370 - 500".

SOFT STEEL SHIMS.

THESE WILL BE MADE FROM MILD STEEL AND THE DRAWING WILL QUOTE "EN 2" WITH BRINELL HARDNESS NUMBER "105 - 130".

PEN STEEL.

THIS SHOULD BE OMITTED IN FUTURE AND SPECIFIED AS "HARD SHIM STEEL"