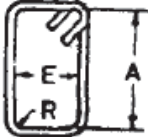# As per IS 2502- 1963- Cutting length, Hook length, Bend length, Radius etc of a Stirrups – A descriptive illustration:

Example - Column Section: 600 by 400, Clear Cover to Stirrups: 40mm, Stirrups Diameter = 10mm Tor Fe 500.

A) **Total Cutting Length of Stirrups**: As per Table VIII of IS 2502, Approx Cutting Length of Stirrups = 2(A+E)+24d

TABLE VIII MEASUREMENT OF BENDING DIMENSIONS FOR BINDERS, STIRRUPS, LINKS AND THE LIKE FOR REINFORCED CONCRETE

(Clauses 3.1 and 3.1.2)

Ref No.	Method of Measurement of Bending Dimension	Approx Total Length of Bar (L) Measured Along Centre Line	Sketch and Dimensions to be Given in Schedule
A		$2(A + E) + 24d$	(See Notes 1 and 3)

A = 600-40-40-10-10 =500
B = 400-40-40-10-10 = 300
D = 10
Hence CL = 2(500+300) +24*10 = 1840mm, (its simple)

But
What will be the R for bends at 3 corners?
What will be the bend lengths and
What will be the straight lengths and
What will be the Hook Length?
From which point it should be measured and how much be the bend length and straight length.
– In the Civil Design and Construction field various formulas, thumb rules, misinterpretation, doubts are seen.
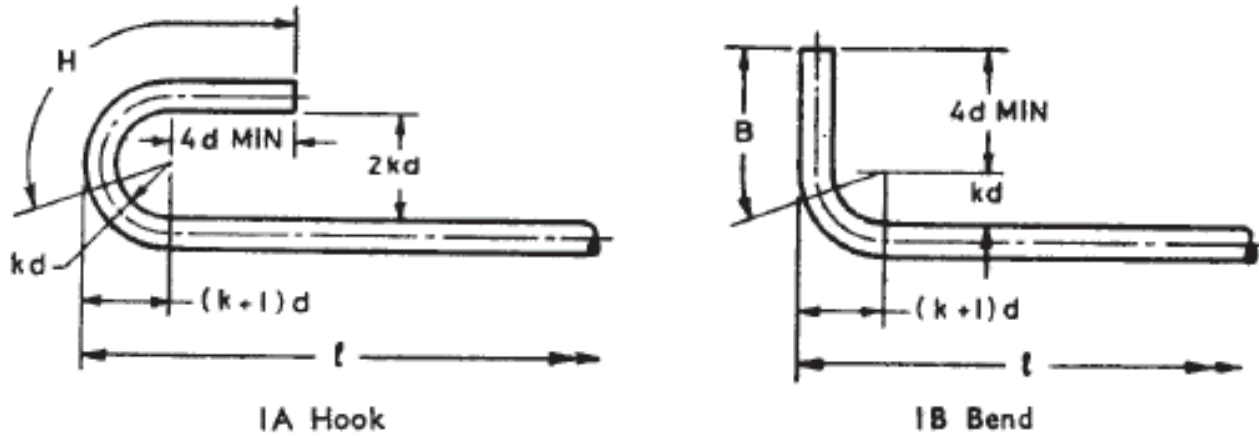In light of IS code let see one by one-

B) **R- Internal Radius of curved bend (arc)**
As per IS 2502, clause 3.2.1, R= Kd, Where values of K is given in this clause. And d is the diameter of bar.

3.2 Bends and Hooks Forming End Anchorages

3.2.1 *Dimensions of Bends and Hooks* — Unless otherwise indicated in the schedule, a semicircular hook or a bend forming an anchorage to a bar shall be bent with an internal radius in accordance with Fig. 1A and Fig. 1B, respectively. The hook and bend allowances shall be in accordance with Table II.

IA Hook

IB Bend

NOTE 1 — k has a value of 2, in the case of mild steel conforming to *IS: 432-1960 Specification for Mild Steel and Medium Tensile Steel Bars and Hard-Drawn Steel Wire for Concrete Reinforcement (*Revised*) or †IS: 1139-1959 Specification for Hot Rolled Mild Steel and Medium Tensile Steel Deformed Bars for Concrete Reinforcement; 3, in the case of medium tensile steel conforming to *IS: 432-1960 or †IS: 1139-1959; and 4, in the case of cold worked steel conforming to †IS: 1786-1961 Specification for Cold Twisted Steel Bars for Concrete Reinforcement. In the case of bars above 25 mm, however, it is desirable to increase the k value to 3, 4 and 6 respectively.

As per above note for Tor steel, Value of K = 4

Hence R = Kd = 4*10 = 40mm
At center line of bar R' will be Kd+d/2 = 45mm and Outer face of link = Kd+d = (K+1)d= 50mm

C) **Bend Lengths of 3 corners:**
As per above picture (I B Bend) Bend length at center line of each corner will be = 2^{π}(kd+d/2)/4 =2*3.14*45/4 =70.65mm at outer face.

D) **Straight Lengths**
From middle of the stirrups sides at outer face – straight length will be A/2- (k+1) d.
For 600 faces = (600-80)/2 –50 = 210 mm, Thus from one bend to another bend straight length will be 210*2 = 420 mm
For 400 faces = (400-80)/2 -50 = 110 mm, thus from one bend to another bend straight length will be = 220mm

One L length =2 half sides (A and E) and one bend (in between) = 210+70.65+110 = 390 mm (approx)
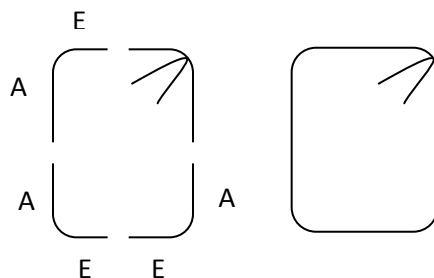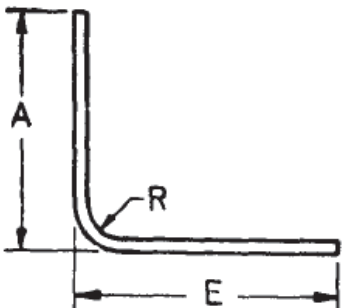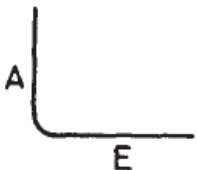
TABLE V MEASUREMENT OF BENDING DIMENSIONS OF BARS FOR REINFORCED CONCRETE

(Clauses 3.1 and 3.1.2)

REF. No.	METHOD OF MEASUREMENT OF BENDING DIMENSIONS	APPROX TOTAL LENGTH OF BAR (L) MEASURED ALONG CENTRE LINE	SKETCH AND DIMENSIONS TO BE GIVEN IN SCHEDULE
A		$A + E - \frac{1}{2}R - d$	 (*See* Notes 2 and 3)

As per above table V of IS 2502, cutting length of bend and 2 half legs L = A+E –(R/2)-d.
Thus the total length of a bend, and respective 2 half sides = (L/2 +W/2-R/2-d))
Will be = ((600-80)/2) + ((400-80)/2) - (4*10/2)-10} =390mm
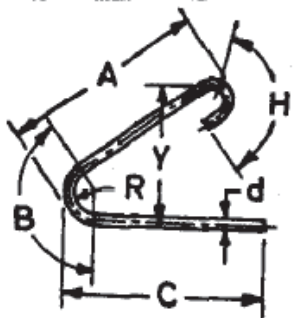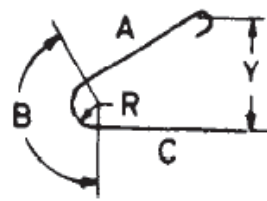
Thus for all 3 sets of 90degree bend (except both hook and hook side 2 half straight lengths)
Total length will be = 3*390 = 1170mm
Except both hooks Total length will be 1170+210+110 = 1490mm

E) **Total Hook Length and its bend length and straight length**
Total cutting length of stirrups as calculated in point (**A**) = 1840mm
Hence each hook length will be = (1840-1490)/2 = 175mm

TABLE VI MEASUREMENT OF BENDING DIMENSIONS OF BARS FOR REINFORCED CONCRETE

(Clauses 3.1 and 3.1.2)

REF No.	METHOD OF MEASUREMENT OF BENDING DIMENSIONS	APPROX TOTAL LENGTH OF BAR (L) MEASURED ALONG CENTRE LINE	SKETCH AND DIMENSIONS TO BE GIVEN IN SCHEDULE
D		If angle with horizontal is 45° or less $A + B + C + H - 2(R + d)$ If angle is greater than 45° and R exceeds 12d, L to be calculated	 (*See* Note 2)

In above table VI of IS 2502, Ref D example is the case of a hook bent at 135degree degree, which we needed here, to calculate bent length and straight length of hook of stirrups.

As per geometry above figure as of hook and as per figures of clause 3.2.1, B (bend length at
 Center line of the bar) will be
2pai (R +d/2)*3/8 = 2*3.14*(4*10+5)*3/8= 105.75 say **105mm**
Thus straight length of hook will be 175-105= **70mm**

If followed formula of table VI of IS 2502, in case of present example
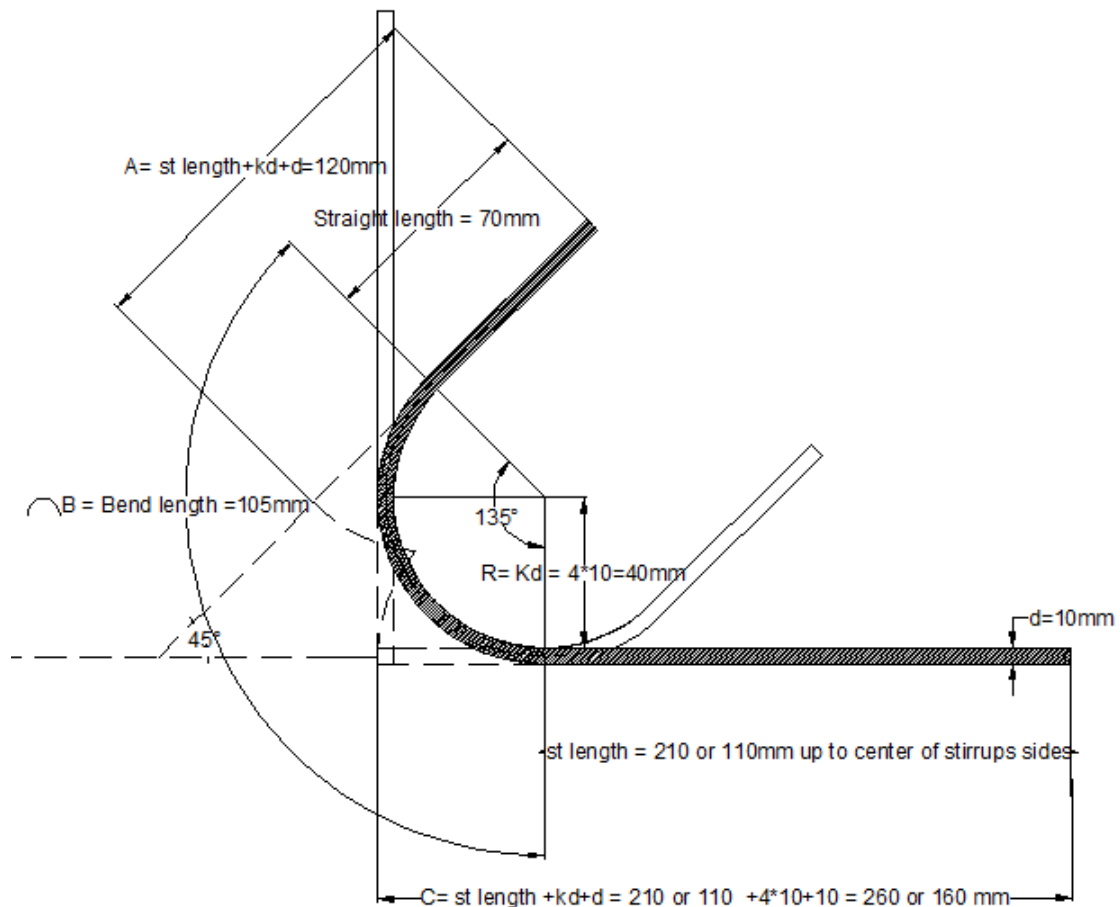A = straight length of hook + kd+d
B = total bent length
C = straight length of one side of stirrups +kd+d
H= N/A
R = internal radius of bend
d = dia of bar

A= st length+kd+d=120mm

Straight length = 70mm

B = Bend length =105mm

135°

R= Kd = 4*10=40mm

45°

d=10mm

st length = 210 or 110mm up to center of stirrups sides

C= st length +kd+d = 210 or 110 +4*10+10 = 260 or 160 mm

If we consider C = half length of stirrups side then it will be 210mm or 110mm +kd+d
Cutting Length of hook + an half stirrups side will be = 175+210 and 175+110
= A+ B +C – 2R- 2d
= A+105+210+40+10-80-20 and A+105+110+40+10-80-20
A = 120mm, hence hook straight length will be A-kd-d = 120-40-10 = **70mm** the same as above

At many You Tubes and web sites, stirrups cutting length, bend and hooks are explained in many ways following the thumb rules (of no basis) and many times with misconceptions which lead the questioners and seekers at no point and confused.

Some say for each 45 degree bend one D is deducted from overall length, some say it should be added, some say hook length will be 9d or 10d or 6d or anything.

Some say IS code gives insufficient information hence can't be followed exclusively.

This above illustration gives a complete picture how each and every length can be defined and calculated.

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