SNS COLLEGE OF TECHNOLOGY

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COIMBATORE

DEPARTMENT OF CIVIL ENGINEERING

19CET302-DESIGN OF RC STRUCTURAL ELEMENTS

III YEAR / V SEMESTER

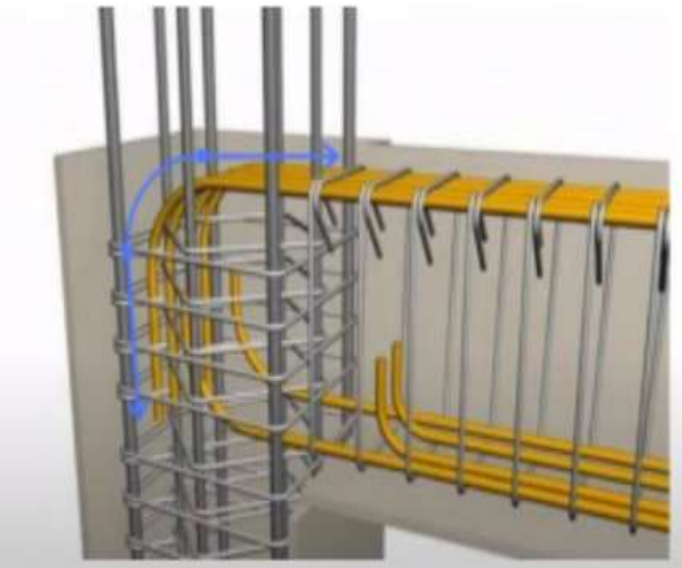
Unit 2 : Limit state design of Beams

Bond and Anchorage & Development length

What is Bond in R.C.C?

- When considering reinforced concrete design, “Bond” refers to the adhesion or the shear stress that is occurring between the concrete and the steel in a loaded member.
- This bond is the reason that makes the steel and concrete as a single unit without the cause of any slip.
- The assumption is simple beam theory that the plane sections remain plane after bending will be only satisfied if there is no kind of slip between the steel and the concrete.

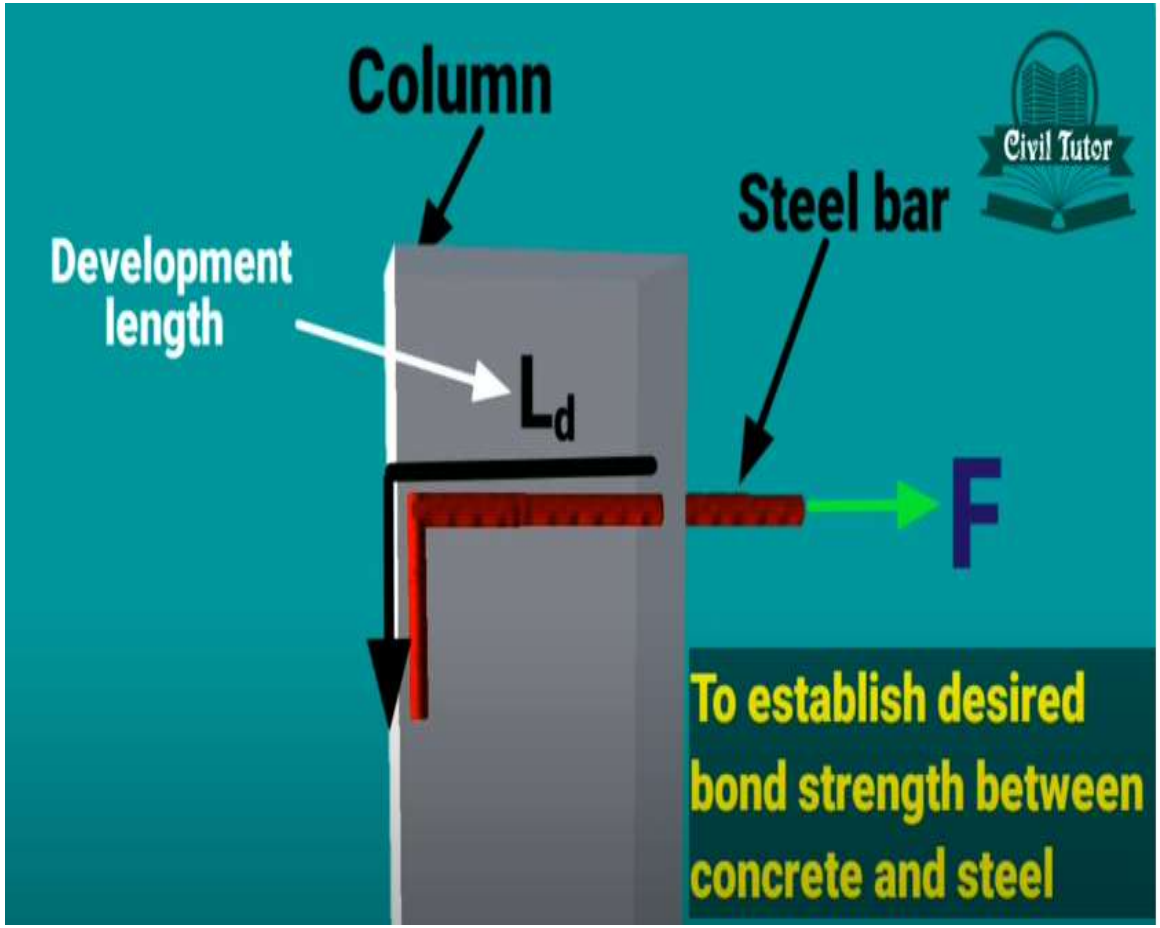
What is Development Length?



Length of steel bar needed to be embedded into the column to establish the desired bond strength between concrete and steel

Holds Two Concrete Members together

Beam, Column, Footing etc

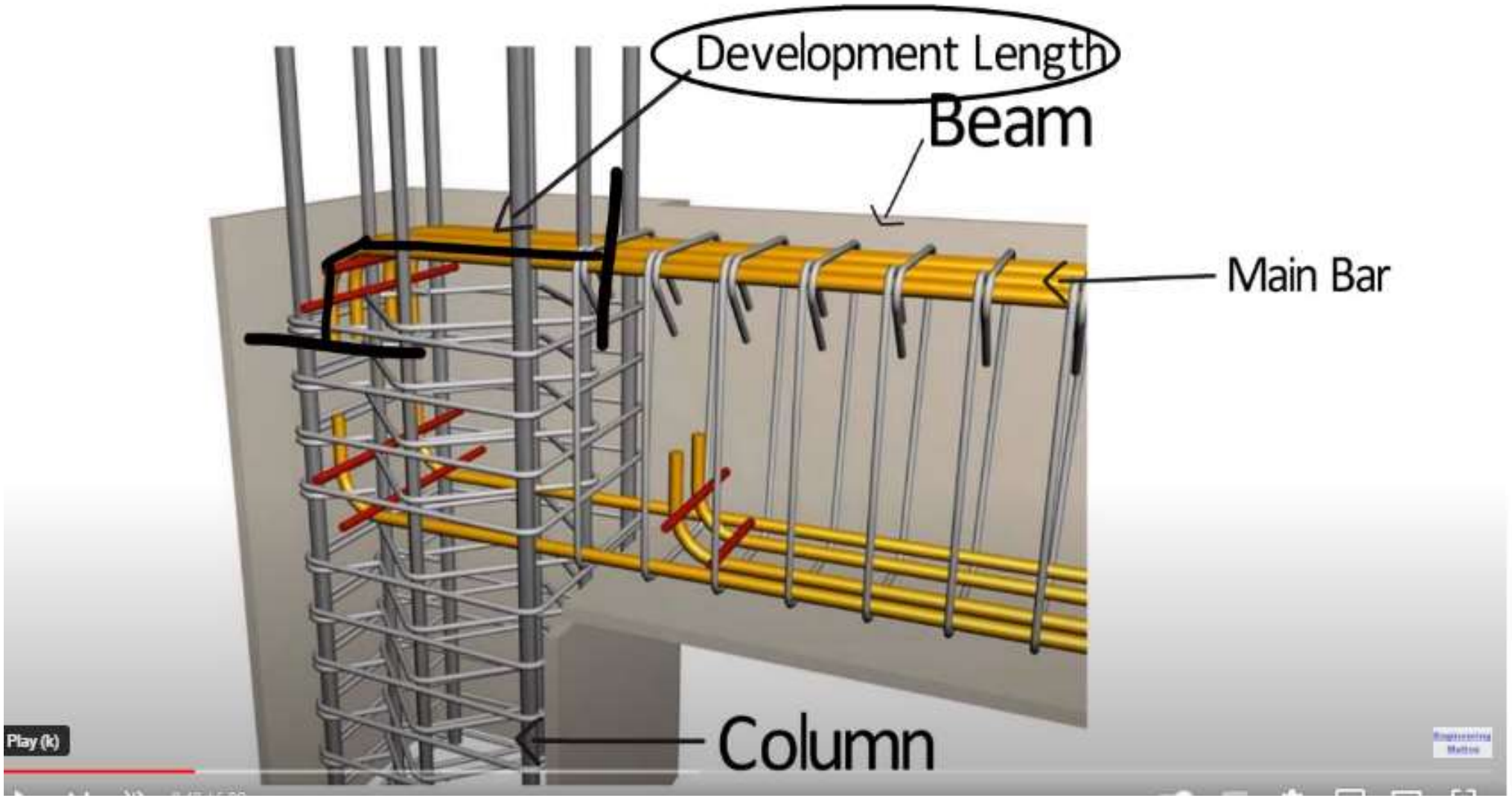


What is Development Length?

- Development length refers to the length of the bar embedded in the concrete beyond a point, preventing slippage and ensuring greater stability.
- It is necessary to embed this bar at the column footing or column beam joint to smoothly transfer the excess stress and reinforce the concrete bond.
- Development length does not carry any tension, but it dissipates the stress to create a stronger structure.

Importance and Purpose of Development Length:

- It is necessary and essential to provide a sufficient bond between reinforcement steel and concrete to act together without any slip.
- Help to complete stress transfer to maintain the structure's integrity and enable it to carry the loads.
- The plane section of a structural beam remains plane even after bending by giving a perfect bond between them. The required length of the reinforcement bar to develop the entire bond is known as anchorage length.
- Development length becomes highly essential when such design involves the curtailment of reinforcement steel.
- It is crucial to check lap length and development length for structural stability, including tension reinforcement for continuous beams and cantilever supports.

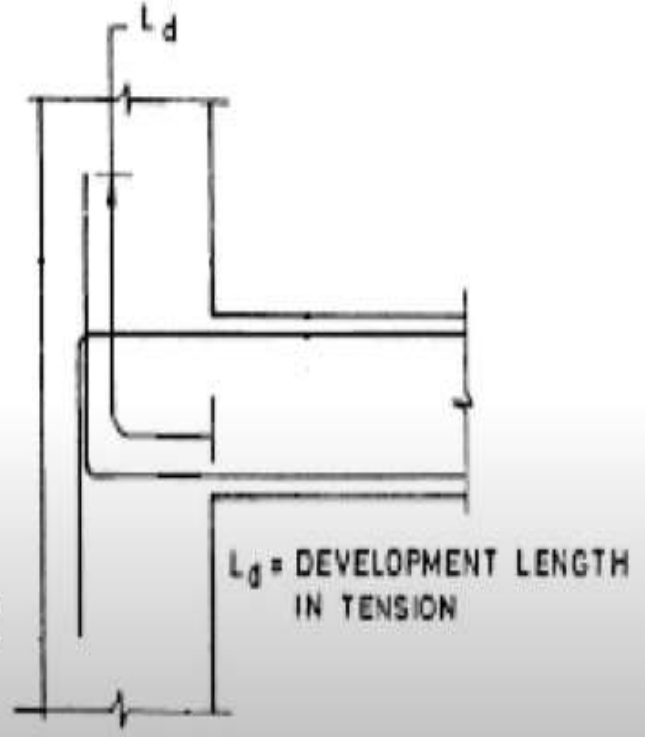

Development Length
Beam
Main Bar
Column
Play (k)

Why we provide Development Length?

Creates a safe bond between Bar surface & Concrete

Reinforcement bars should not slip through the concrete

Transfers Stresses or Load from Beam to Column



Play (k)

Development length

26.2.1 *Development Length of Bars*

The development length L_d is given by

$$L_d = \frac{\phi \sigma_s}{4 \tau_{bd}}$$

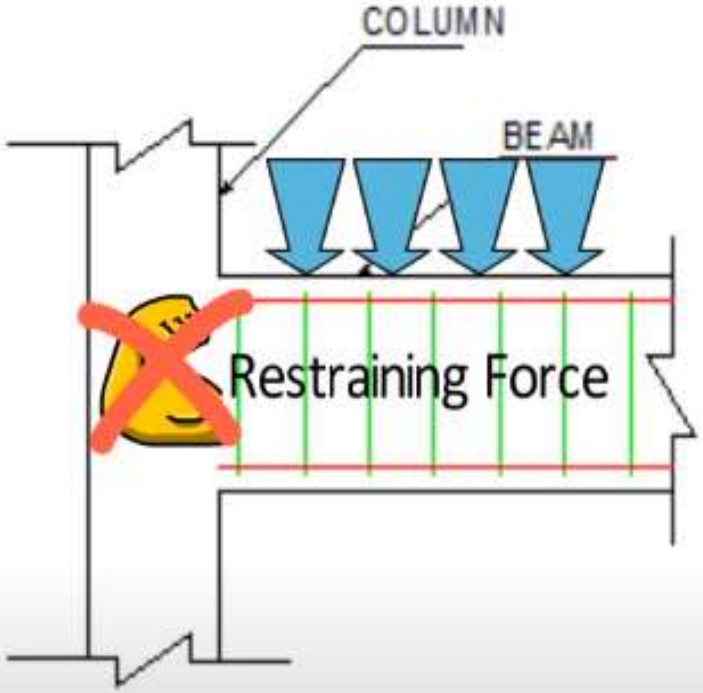
where

ϕ = nominal diameter of the bar,

σ_s = stress in bar at the section considered at design load, and

τ_{bd} = design bond stress given in **26.2.1.1**.

What will happen if we dont provide Development Length?

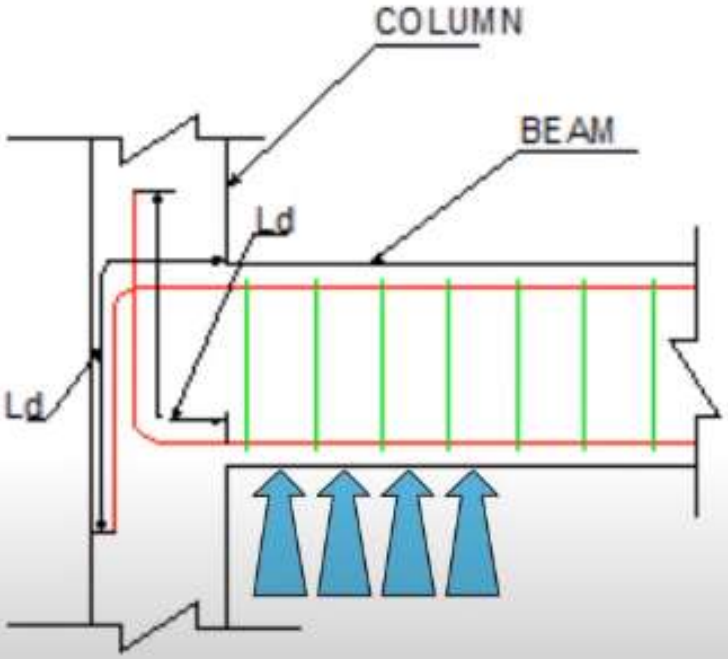


If we provide less development length

Bars will not break first

Reinforcement bars will split from Concrete

Beam will come out of the Concrete Column



It acts as a Supporting Member for the Reinforced Beam in the Concrete Column

How to Calculate Development Length?

$$L_d = \frac{\phi \sigma_s}{4 \tau_{bd}}$$

Ld = Development Length

Ø = Nominal Dia of Reinforcement Bar

σ_s = Stress in bar at the section considered at design load

τ = Design Bond Stress

Limit State Method

Working State Method

Factors that affect Development Length

1. Compressive Strength of Concrete : –

$$\text{Development Length} \propto \frac{1}{\text{Compressive Strength}}$$

2. Density of Concrete : –

If Lightweight Concrete is used, Development Length must be increased

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3. Rebar Clear Cover : –

Development Length will decrease

4. Rebar Center to Center Spacing : –

Then More Concrete will be available per Rebar to Resist Horizontal Splitting

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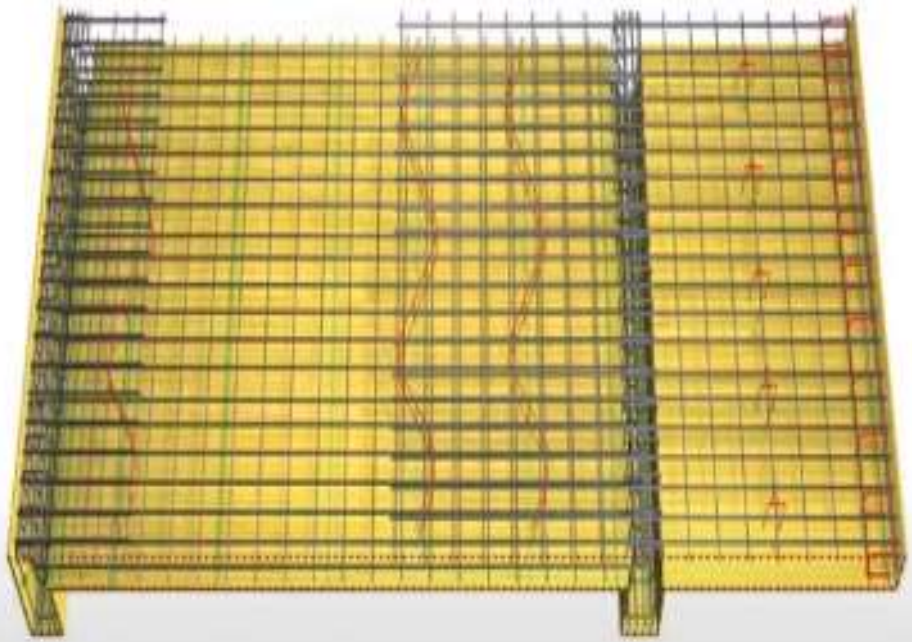

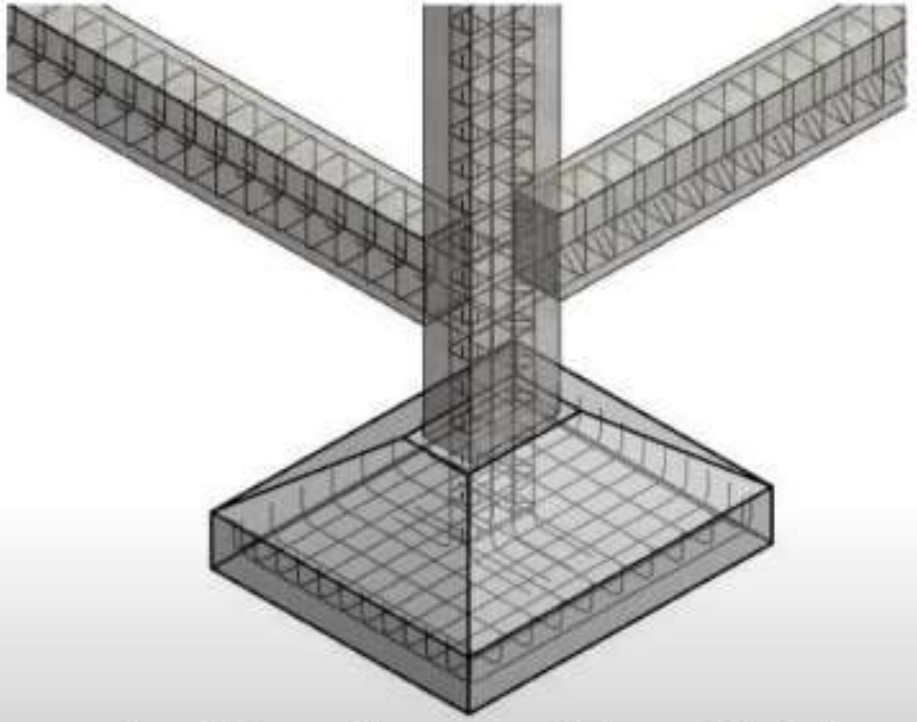

Bar Spacings are typically Higher & thus required Development Length is Less

5. Coating of Rebar : –

Bond Strength Reduces

Hence More Development Le

6. Rebar Diameter : –

Smaller Diameter bars require
Lower Development Length

ANCHORAGE LENGTH

It is provided to slippage of the bar from the ends of concrete portion. The length of the bar available for anchorage is insufficient , the reinforcement can be bent or a hook may be formed to provide required anchorage

Anchorage bars in Tension, compression & Anchoring shear reinforcement

26.2.2 ***Anchoring Reinforcing Bars***

26.2.2.1 ***Anchoring bars in tension***

a) Deformed bars may be used without end anchorages provided development length requirement is satisfied. Hooks should normally be provided for plain bars in tension.

b) *Bends and hooks* — Bends and hooks shall conform to IS 2502

1) *Bends*—The anchorage value of bend shall be taken as 4 times the diameter of the bar for each 45° bend subject to a maximum of 16 times the diameter of the bar.

2) *Hooks*—The anchorage value of a standard U-type hook shall be equal to 16 times the diameter of the bar.

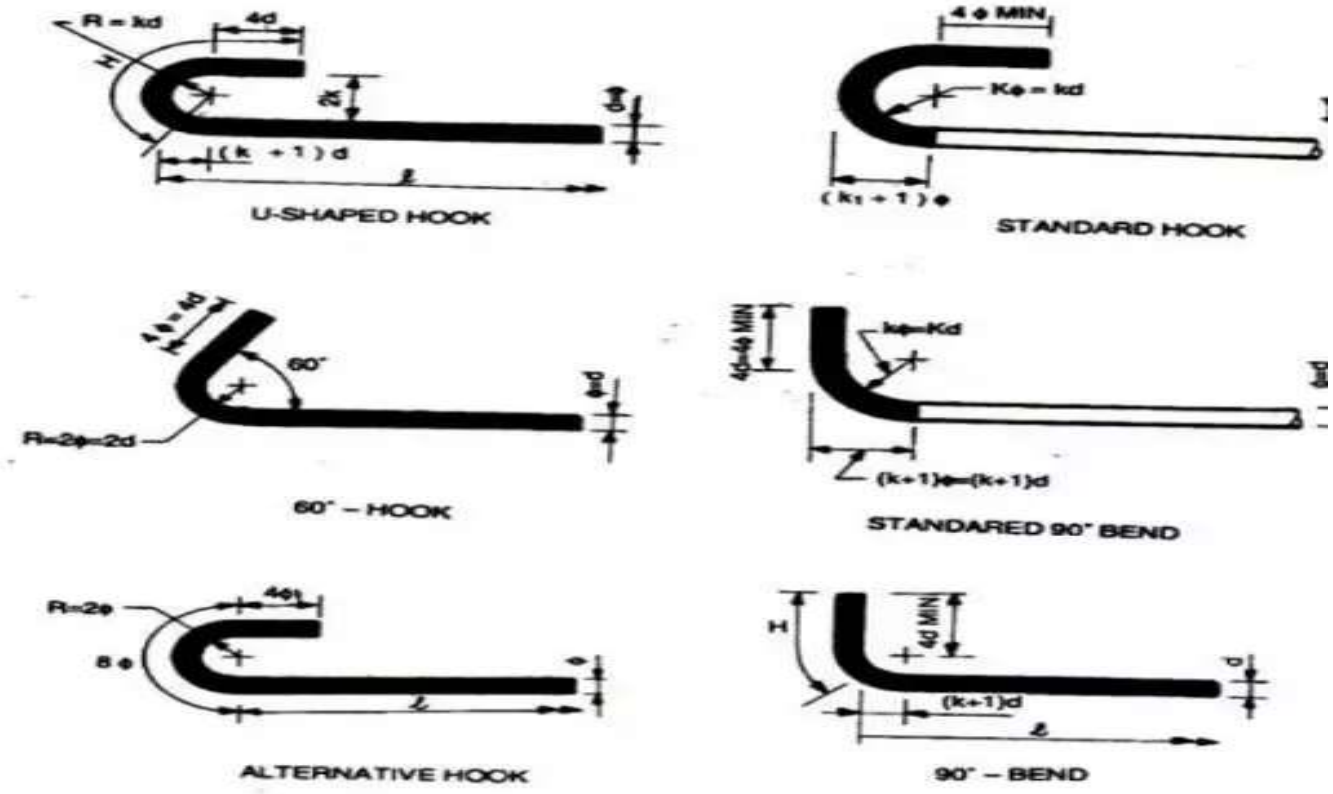

Fig.1: Standard Hooks and Bends in Reinforcement

THANK YOU