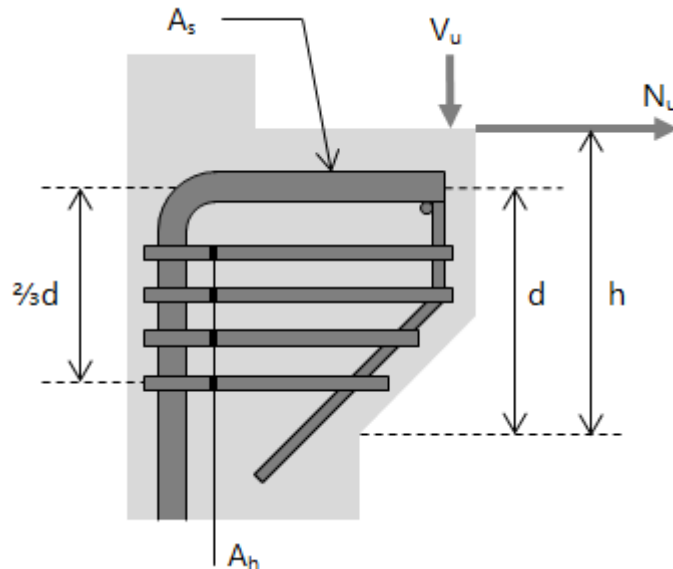


# Concrete Corbel to ACI 318-19 & IBC 2018

This application designs a reinforced concrete corbel, and determines if the specified reinforcement is sufficient.



## Parameters

Concrete strength (ksi)	$f_c := 5$
Rebar yield stress (ksi)	$f_y := 60$
Factored shear load (k)	$V_u := 80$
Factored tensile load (k)	$N_u := 40$
Width (in)	$b := 15$
Effective Depth (in)	$d := 20$
Overall depth (in)	$h := 22$
Shear span (in)	$a := 4$
Edge depth (in)	$h_c := 12$

Strength reduction factor  $\phi := 0.75$

Friction coefficient  $\mu := 1.4$

Primary reinforcements  $N_{\text{primary}} := 3$        $\text{number}_{\text{primary}} := 7$

Closed stirrups  $N_{\text{closed}} := 3$        $\text{number}_{\text{closed}} := 3$

Rebar data

rebar :=

"Bar #"	"Dia (in)"	"As (in^2)"
3	0.375	0.110
4	0.5	0.200
5	0.625	0.310
6	0.750	0.440
7	0.875	0.600
8	1.000	0.790
9	1.128	1.000
10	1.270	1.270
11	1.410	1.560
14	1.693	2.250
18	2.257	4.000

## Dimensional Requirements (ACI 16.5)

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$$\left\{ \begin{array}{l} \text{"Satisfactory"} \quad \frac{a}{d} < 1 \\ \text{"Unsatisfactory"} \quad \text{otherwise} \end{array} \right. = \text{"Satisfactory"}$$

$$\left\{ \begin{array}{l} \text{"Satisfactory"} \quad \frac{N_u}{V_u} < 1 \\ \text{"Unsatisfactory"} \quad \text{otherwise} \end{array} \right. = \text{"Satisfactory"}$$

$$\left\{ \begin{array}{l} \text{"Satisfactory"} \quad h_c > 0.5 \cdot d \\ \text{"Unsatisfactory"} \quad \text{otherwise} \end{array} \right. = \text{"Satisfactory"}$$

## Section (ACI 16.5.2)

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Vu shall not exceed the smallest of

$$Vu_1 := \phi \cdot 0.2 \cdot f_c \cdot b \cdot d = 225.000$$

$$Vu_2 := 0.8 \cdot \phi \cdot b \cdot d = 180.000$$

$$\text{ifelse}(Vu < \min(Vu_1, Vu_2), \text{"Pass"}, \text{"Fail"}) = \text{"Pass"}$$

## Reinforcement

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Required reinforcement to resist tension alone ACI 16.5.3

$$A_n := \max\left(\frac{N_u}{\phi \cdot f_y}, \frac{0.2 \cdot V_u}{\phi \cdot f_y}\right) = 0.889$$

Shear friction reinforcement ACI 22.9.4.2

$$A_{vf} := \frac{V_u}{\phi \cdot \mu \cdot f_y} = 1.270$$

Flexure reinforcement ACI 20 & 22 (kip-ft)

$$M_u := \frac{1}{12} \cdot (V_u \cdot a + N_u \cdot (h - d)) = 33.333$$

$$A_f := \frac{0.85 \cdot b \cdot d \cdot f_c}{f_y} \cdot \left(1 - \sqrt{1 - \frac{12 \cdot M_u}{0.383 \cdot b \cdot d^2 \cdot f_c}}\right) = 0.373$$

Required main reinforcement ACI 16.5

$$A_{s_1} := A_f + A_n = 1.262$$

$$A_{s_2} := \frac{2}{3} \cdot A_{vf} + A_n = 1.735$$

$$A_{s_3} := 0.04 \cdot \frac{f_c}{f_y} \cdot b \cdot d = 1.000$$

$$A_s := \max(A_{s_1}, A_{s_2}, A_{s_3}) = 1.735$$

Provided main reinforcement

$$A_{s\_provided} := N_{\text{primary}} \cdot \text{rebar}(\text{ListTools}:-\text{Search}(\text{number}_{\text{primary}} \text{rebar}[\dots, 1]), 3) = 1.800$$

$$\text{ifelse}(A_{s\_provided} > A_s, \text{"Satisfactory"}, \text{"Unsatisfactory"}) = \text{"Satisfactory"}$$

Required horizontal reinforcement ACI 16.5.5

$$A_h := 0.5 \cdot (A_s - A_n) = 0.423$$

Provided horizontal reinforcement

$$A_{h\_provided} := N_{closed} \cdot 2 \cdot \text{rebar}[\text{ListTools:-Search}(\text{number}_{closed}, \text{rebar}[\dots, 1]), 3] = 0.660$$

$$\text{ifelse}(A_{h\_provided} > A_h, \text{"Satisfactory"}, \text{"Unsatisfactory"}) = \text{"Satisfactory"}$$