Example:

Max. Flow rate from catchment area =0.25 m^3/s drain to road (one side road) having roof section with longitudinal slope=%1 , n=0.016, cross-section slope=%1, 24 m width of road, 0.15 m curb stone. Gutter data: 7 cm high of water, 4 m width of gutter.

1-What is the capacity (or Max. flow rate) for this road?

2- With 0.5 m^3/s is it flood?

3-Whate is the clear zone in case Q=0.5 m^3/s?

Classification the road depend on the width

Q_{inlet}

1-Main road > 40 m	*Depend on design*
2- Second road (25-16 m)	*2 car*
3- Local road (16-12 m)	
4- < 7 m 2 car	

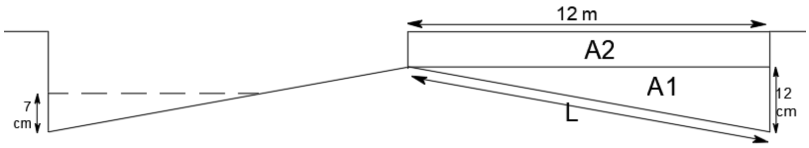
Ex 4: *Max. Flow rate from catchment area =0.25 m^3/s drain to road (one side road) having roof section with longitudinal slope=%1, n=0.016, cross-section slope=%1, 24 m width of road, 0.15 m curb stone. Gutter data: 7 cm high of water, 7 m width of gutter.*
1-What is the capacity (or Max. flow rate) for this road?
2- With 0.5 m^3/s is it flood?
3-Whate is the clear zone in case Q=0.5 m^3/s?

Solution: To find gutter $Q_{gutter}=k\frac{z}{n}\sqrt{s}\,y^{8/3} = 0.38\frac{100}{0.016}\sqrt{0.01}\ 0.07^{8/3} = 0.198\ m^3/s$

1-Qs(for each side)=0.25/2=0.125 $\therefore 0.198 > 0.125$ *not need for inlet system*

2-Qs(for each side)=0.5/2=0.25 $\therefore 0.198 < 0.25$ *ther is flood over gutter*

To check is there flood over curb stone? *Q1(for triangle area)*



$1\% \times 12 = 0.12\ m$

$Q_{A1}=k\frac{z}{n}\sqrt{s}\,y^{8/3} = 0.38\frac{100}{0.016}\sqrt{0.01}\ 0.12^{8/3} = 0.832\ m^3/s > 0.25\ m^3/s$

That's mean there is no flood over curb stone in this storm quantity and less than.
3- To find length of clear zone (dry zone) in situation Qs=0.5 m^3/s.

$Q_{storm}=k\frac{z}{n}\sqrt{s}\,y^{8/3} = 0.38\frac{100}{0.016}\sqrt{0.01}\ y^{8/3} = 0.25\ m^3/s \quad \rightarrow \quad y=0.07645m$

$\frac{1}{100}=\frac{y}{x} \quad \rightarrow \quad x=7.645\ m \qquad \therefore$ *clear zone=12-7.645=4.355 m on each side*

Ex 5: Estimate Q_{inlet} for curb inlet in sump, If y=5 cm, L=0.5 m and %10 clogging
Solution/

$Q_{inlet}=k\,L\,y^{3/2} = 1.66*0.5\,(0.05)^{3/2} = 0.0084\ m^3/s$

With %10 clogging $\rightarrow$ $Q_{inlet}=0.9*0.0084=0.0076\ m^3/s$

Ex 6: Estimate Q_{inlet} for grate inlet in sump, If w=0.3 m, L=0.5 m, y=5 cm and opining space 3 cm and bar width= 2cm %25 clogging
*Solution/ A=(3/5)*0.5*0.3=0.09 m^2*

$Q_{inlet}=k\,A\,y^{1/2} = 2.96*0.09*(0.05)^{1/2} = 0.0596\ m^3/s$

With %25 clogging $\rightarrow$ $Q_{active}=\%75*0.0596=0.0447\ m^3/s$

*Ex 7: Estimate Q_{inlet} for grating inlet on grade, without depression with following data: k=0.38 m, y=5 cm and inlet length and width=0.5*0.3 respectively*
3 cm open and 2 cm width bar, With %25 clogging
Solution/ 2+3= 5 cm

$A=0.5*0.3*(3/5)=0.09\ m^2$

$Q_{inlet}=k\,A\,y^{1/2} = 0.38*0.09*(0.05)^{1/2} = 0.0765\ m^3/s$

With %25 clogging $\rightarrow$ $Q_{active}=\%75*0.0765=0.00574\ m^3/s$

Ex 8: Estimate no. of inlet and the area that served by each inlet if the max.Q_{gutter}=0.05 m^3/s, A=20000 m^2, C=0.75, i=120 mm/hr.

Solution/ storm flow $Q=C\,I\,A=\frac{0.75*120*20000}{1000*3600}=0.5\ m^3/s$

Q_{storm}/Q_{gutter} = 0.5/0.05 =10 inlet

To find A served by each inlet $0.05\ m^3/s = A*\frac{0.75*120}{1000*3600} = 2000\ m^2$

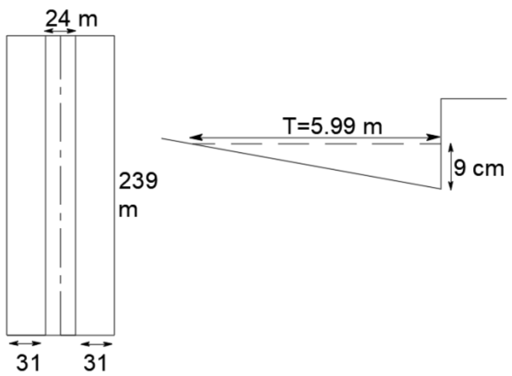
*Ex 9: Design the road drainage storm water with catchment area=86 m*239 m.*

Gutter data: y=0.09 m, n=0.018, k=0.38, slope=%1, Z=66.5

*Solution/ Total Area=86*239=20554* m^2 $Q_{storm}=C\,I\,A=\frac{0.8*100*20554}{1000*3600}=0.4568\ m^3/s$

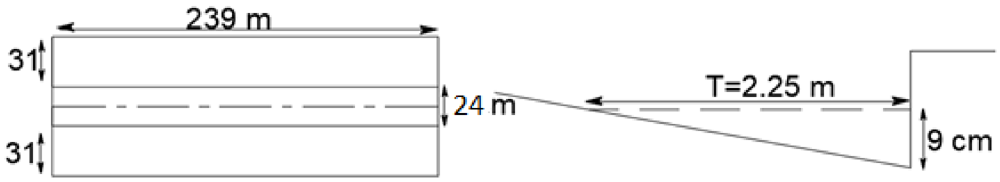
$Q_{gutter}=k\frac{z}{n}\sqrt{s}\,y^{8/3} = 0.38\frac{66.5}{0.018}\sqrt{0.01}\ 0.09^{8/3} = 0.22837\ m^3/s$

2* Q_{gutter} =0.45674 *for each side* ⟹ $Q_{storm=}\ Q_{gutter}$ *(on need for inlet)*



*Ex 10: Design the road drainage storm water with catchment area=86 m*239 m.*

Gutter data: y=0.09 m, n=0.018, k=0.38, slope=%1, Z=25.



*Solution/ Total Area=86*239=20554* m^2 ⟹ $Q_{storm}=C\,I\,A=\frac{0.8*100*20554}{1000*3600}=0.4568\ m^3/s$

$Q_{gutter}=k\frac{z}{n}\sqrt{s}\,y^{8/3} = 0.38\frac{25}{0.018}\sqrt{0.01}\ 0.09^{8/3} = 0.0859\ m^3/s$ ⟹ 2* Q_{gutter} =0.1717

$2Q_{gutter=}\ CIA$ ⟹ $0.1717\ m^3/s=\frac{0.8*100*A}{1000*3600}$ ⟹ $A=7726.5\ m^2$

First inlet length= $\frac{A}{X}=\frac{7726.5}{86}=89.84\ m$ ⟹ $\therefore 239-89.84=149.157\ m$ ∴

All the storm on gutter disposed of by inlet or some of it will be pass

A/ if all storm will disposal of by inlet $\therefore Q_{inlet} = Q_{gutter} = kA\sqrt{y}$

$\therefore 0.0859\ m^3/s=0.38\ (A\ inlet)\sqrt{0.09}$ *active* $A_{inlet}=0.754\ m^2$

If active A_{inlet} *=%60 from total* A_{inlet} ∴ *Total* A_{inlet}*= active A /0.6=0.754/0.6=1.257* m^2

Let it 2 inlet (Double inlet) $\therefore$ *Total* $A_{inlet}/2 = 0.6283\ m^2$

Let width of inlet=0.5 m, $\Longrightarrow$ *Length of inlet=1.26 m* m^3

-To Find how many inlet we need: $Q_{storm}/2 = 0.4568\frac{m3}{s}/2 = 0.2284\ \frac{m3}{s}$

Q_{storm}/Q_{gutter} *(for each side)* $= \frac{0.2284}{0.0859} = 2.7$ *inlet station*

Or by using road length: 239m/ 89.84m =2.7 inlet station

- Approximation: (1) 2.7 to 3 station $\Longrightarrow$ *239/3=79.67 m*

$\therefore$ *Catchment Area=* $79.67 \times 86 = 6851.33\ m^2$

Q_{storm} *for* $A_{catchment} = \frac{0.8*100}{3600*1000} \times 6851.33 = 0.1523\ m^3/s$

0.1523/2 =0.0761 m3/s = Q_{gutter} *for each side =* Q_{inlet}

$Q_{gutter} = k\frac{z}{n}\sqrt{s}\ \ y^{8/3}$ $\Longrightarrow$ $0.0761 = 0.38\frac{25}{0.018}\sqrt{0.01}\ \ y^{8/3}$ $\Longrightarrow$ *y=3.63 cm*

-To find A of inlet: %60 active $Q_{inlet} = k\ A\sqrt{y}$ $\Longrightarrow$ $(0.0761/2) = 0.38\sqrt{0.0363}\ A$

$A_{activate}$*(for inlet)* $= 0.5256\ m^2$ A_{Total}*(for inlet)* $= \frac{Aactivate(for\ inlet)}{0.6} = 0.5256/0.6 = 0.876\ m^2$

-If the width of inlet=0.5 m $\Longrightarrow$ *L=1.752 m* $\Longrightarrow$ *Let it be 2 inlet as double*

Area for each one = 0.438 $\Longrightarrow$ *: w=0.5 m & L=0.876 m*

-Thr second approximation: where number station=2

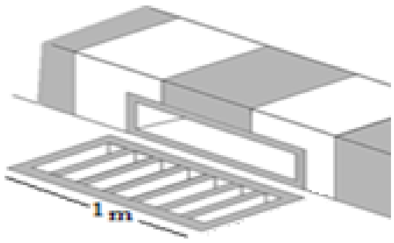
If the critical depth of water on curb ston < 13.5 cm then:Let no. of inlet stations (or location) or (position)=2 inlet position *Total A/2=239*86/2=10277* m^2

$Q_{storm} = CIA = \frac{0.8*100}{3600*1000} * 10277 = 0.2284\ m^3/s$

-To find water depth: Let $Q_{storm} = Q_{gutter} = k\frac{z}{n}\sqrt{s}\ \ y^{8/3}$ $0.2284 = 0.38\frac{25}{0.018}\sqrt{0.01}\ \ y^{8/3}$

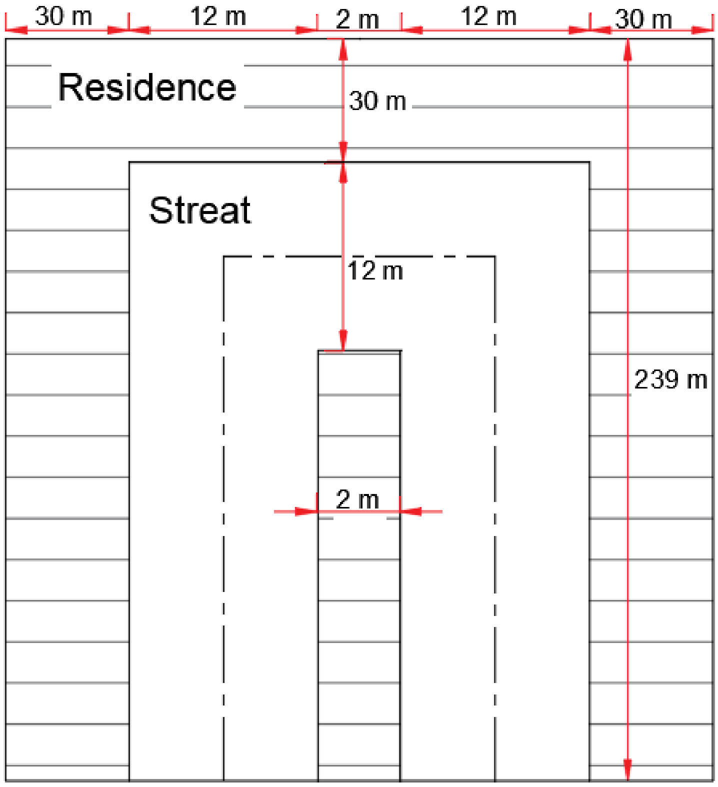
$\therefore$ *y=13 cm < 13.5 cm OK* *: L=239/2=119.5 m* *destance between 2 inlet or 2 station*

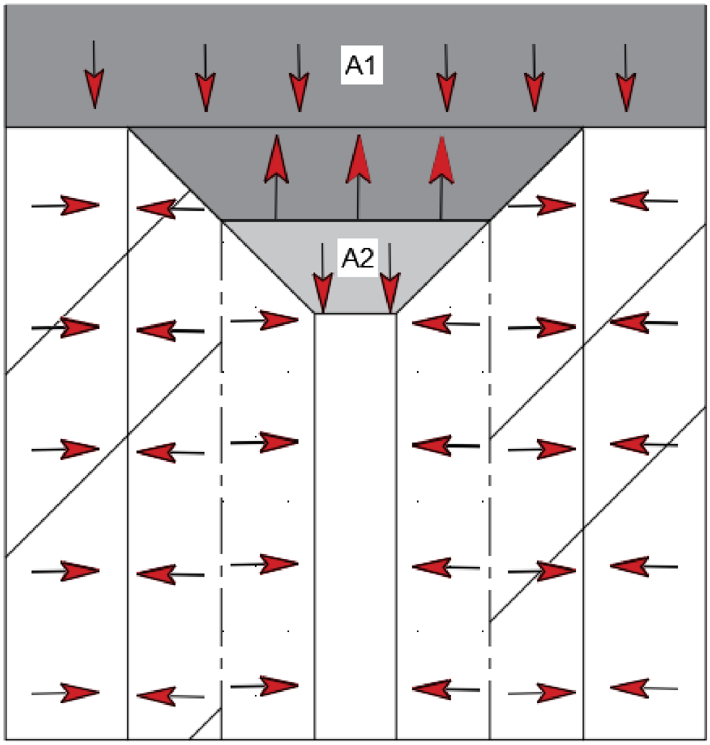
*Ex 11: Design inlet system for the road in figure below with catchment area=86 m*239 m. C=0.8, i=100 mm/hr, Gutter data: y max.=8cm, n=0.018, k=0.38, slope=%1, Z=25, %25 clogging, (space=bar=2 cm). Inlet type used (consists of tow part curb and grade inlet)* $Q_{curb\ inlet}=0.4Q_{gutter\ max.}$ $Q_{grad\ inlet}=0.6Q_{gutter\ max.}$



Solution: $(Q_S)_{Total}=CIA=\frac{0.8*100}{3600*1000}*(86*239)=0.457\ m^3/s$

$$Q_{gutter(Max.)}=k\frac{z}{n}\sqrt{s}\ y^{8/3}=0.38\frac{25}{0.018}\sqrt{0.01}\ 0.08^{8/3}=0.0627\ m^3/s$$

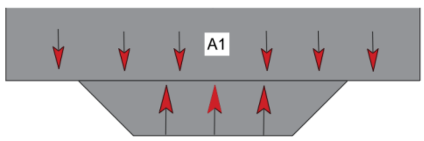




$A_1=[86\times 30+(6\times\frac{26+14}{2})]=2700\ \ m^2$

$Q_{storm1}=CIA_1=\frac{0.8\times 100}{3600\times 1000}\times 2700=0.06\ m^3/s$

*To find depth of water in A_1 $\Longrightarrow$ $Q_{storm1}=Q_{gutter}$



$$0.06=\frac{z}{n}k\sqrt{s}y^{8/3}=0.38\frac{25}{0.018}\sqrt{0.01}y^{8/3}\ \rightarrow\ y=7.87\ cm$$

-To find no. of inlet in A_1 $\Longrightarrow$ Let $Q_{storm1}/Q_{gutter}=\frac{0.06}{0.0627}=0.957\approx 1$

-To find $Area_{inlet}$ (grate in grade) in this gutter

$Q_{inlet}=\%60\ Q_{s1}$ $\Longrightarrow$ $Q_{inlet}=0.6\times 0.06=0.036\ m^3/s$ $\Longrightarrow$ $Q_{inlet}=k\,A\sqrt{y}$

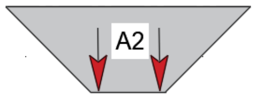
$\therefore\ 0.036=0.38\ A_{inlet}\sqrt{0.0787}$ $\Longrightarrow$ $A_{inlet(Active)}=0.3377\ m^2$

%25 clogging $\Longrightarrow$ $A_{Active}=\%75\ A_{Total}$ $\Longrightarrow$ $A_{Total}=0.3377/0.75=0.4503m^2$

%50 Space/bar $\Longrightarrow$ $Ainlet=0.4503/0.5=0.9005\ m^2$

L=1 m $\Longrightarrow$ W=90 cm $\Longrightarrow$ use 2 grate inlet (L=1, W=0.45 m)& one curb inlet

*To find depth of water in A_2 $\Longrightarrow$ $A_2 = \left[\left(6 \times \frac{14+2}{2}\right)\right] = 48\ m^2$



$Q_{storm2} = CIA_2 = \frac{0.8\times100}{3600\times1000} \times 48 = 0.00107\ m^3/s$ $\Longrightarrow$ Let $Q_{storm2} = Q_{gutter}$

$0.00107 = \frac{z}{n} k\sqrt{s} y^{8/3} = 0.38 \frac{25}{0.018} \sqrt{0.01} y^{8/3} \rightarrow y2 = 1.74\ cm$

-To find no. of inlet in A_2 $\Longrightarrow$ Let $Q_{storm\ 2} / Q_{gutter} = \frac{0.00107}{0.0627} = 0.0171$

*we will put One grate inlet in grade $\therefore$ To find $Area_{inlet}$ in this gutter

$Q_{inlet} = k\,A\sqrt{y}$ $\Longrightarrow$ $0.00107 = 0.38\, A_{inlet} \sqrt{0.0174}$ $\Longrightarrow$ $A_{inlet(Active)} = 0.0214\ m^2$

%25 clogging $\Longrightarrow$ $A_{Active} = \%75\ A_{Total}$ $\Longrightarrow$ $A_{Total} = 0.0214/0.75 = 0.0285\ m^2$

%50 Space/bar $\Longrightarrow$ $Ainlet = 0.0285/0.5 = 0.057\ m^2$

L=1 m $\Longrightarrow$ $W = 0.06\ m \approx 10\ cm$

$A_3 = [(14\times203) - A_2]/2 = 1397\ m^2$

$Q_{storm\ 3} = CIA_3 = \frac{0.8\times100}{3600\times1000} \times 1397 = 0.03104\ m^3/s$

*To find depth of water on gutter in each side of A_3 $\rightarrow$ $Q_{storm3} = Q_{gutter}$

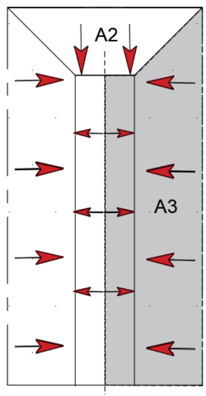
$0.031 = \frac{z}{n} k\sqrt{s} y^{8/3} = 0.38 \frac{25}{0.018} \sqrt{0.01} y^{8/3} \rightarrow y3 = 6.15\ cm$

$Q_{S3} / Q_{gutter\ max.} = 0.03104/0.0627 = 0.45$ $\rightarrow$ put one duble inlet

-To find $Area_{inlet}$ in this gutter $\rightarrow$ $Q_{grate\ inlet} = \%60\ Q_{s3} = 0.01863\ m^3/s$

$Q_{inlet} = k\,A\sqrt{y}$ $\Longrightarrow$ $0.01863 = 0.38\, A_{inlet} \sqrt{0.0615}$

$A_{inlet(Active)} = 0.1976\ m^2$



%25 clogging $\Longrightarrow$ $A_{Active} = \%75\ A_{Total}$ $\Longrightarrow$ $A_{Total} = 0.01976/0.75 = 0.264\ m^2$

%50 Space/bar $\Longrightarrow$ $Ainlet = 0.264/0.5 = 0.527\ m^2$

L=1 m $\Longrightarrow$ $W = 0.527\ m \approx 54\ cm$

For Area 4 (On each side)

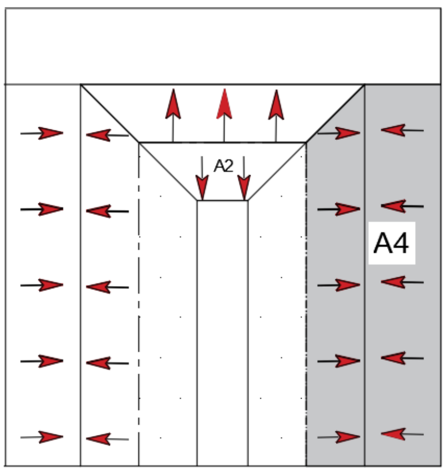
$A_4 = [36 \times 209 - (\frac{6\times6}{2})] = 7506\ m^2$

$Q_{storm\ 4} = C\,I\,A_4 = \frac{0.8\times100}{3600\times1000} \times 7506 = 0.1668\ m^3/s$

-To find y on gutter $\Longrightarrow$ Let $Q_{storm\ 4} = Q_{gutter}$

$0.1668 = \frac{z}{n} k\sqrt{s} y^{\frac{8}{3}} = 0.38 \frac{25}{0.018} \sqrt{0.01} y^{\frac{8}{3}}$

$y4 = 11.55\ cm > 8\ cm$ $\therefore$ we need inlet system



-To find no. of station $\Longrightarrow$ $Q_{S4} / Q_{gutter\ (max.)}$

$= 0.01668/0.0627 = 2.66\ m^3/s$ (between 2 and 3)

<u>1- Let it 3 station</u>

*To find first inlet station in A_4 (on each side)

$Q_{gutter\ max.} = Q_{storm\ 4}$ $\rightarrow$ $0.0627 = C\,I\,A$ $\quad 0.0627 = \frac{0.8\times100}{1000\times3600} A$ $\quad \therefore A = 2821.5\ m^2$

$L = \frac{A}{6+30} = 78.375\ m$ not true valuein this situation

نحسب المساحة الغير منتظمة فاذا كانت اصغر من المساحة المستخرجة ← اذن موقع اول inlet خارجها

$$At = \frac{6\times 6}{2} + (36\times 6) = 198\ m^2 \quad < \quad 2821.5\ m^2 \quad \rightarrow \quad \therefore 2821.5 - 198 = 2623.5\ m^2$$

$$L1 = 6\ m + \frac{2623.5}{36} = 6 + 72.875 = 78.88\ m$$

-To find inlet second position

$Q_{gutter\ max.} = C\ I\ A \Longrightarrow \quad 0.0627 = \frac{0.8\times 100}{1000\times 3600}\ A(for\ second\ inlet) \rightarrow \quad A = 2821.5\ m^2$

$$L2 = \frac{2623.5}{36} = 78.375\ m \qquad \rightarrow \quad Third\ postion \quad L3 = (209 - 78.88) - 78.375 = 51.745\ m$$

-To find Area$_{inlet}$ in postion 1&2 on this gutter $\rightarrow$ $Q_{grate\ inlet} = \%60\ Q_{g\ max.} = 0.03762\ m^3/s$

$Q_{inlet} = k\ A\sqrt{y} \Longrightarrow \quad 0.03762 = 0.38\ A_{inlet}\sqrt{0.08} \Longrightarrow \quad A_{inlet(Active)} = 0.35 m^2$

%25 clogging $\Longrightarrow$ $A_{Active} = \%75\ A_{Total} \Longrightarrow \quad A_{Total} = 0.35/0.75 = 0.47\ m^2$

%50 Space/bar $\Longrightarrow$ $Ainlet = 0.47/0.5 = 0.933\ m^2 \Longrightarrow$ *use 2 grate inlet (L=1m & W=0.5m)*

-To find Area$_{inlet}$ in A4 postion 3 on this gutter $\rightarrow$ *where* $A = 36\times 51.745 = 1862.82\ m^2$

$\rightarrow\ Q_{storm\ 4\ p3} = CIA = \frac{0.8\times 100}{3600\times 1000}\times 1862.82 = 0.041396\ m^3/s$

$Q_{grate\ inlet} = \%60\ Q_{s4} = 0.025\ m^3/s$

**To find depth of water on gutter in each side of* $A_{4\ p3} \rightarrow \quad Q_{storm\ 4p3} = Q_{gutter}$

$$0.025 = \frac{z}{n} k\sqrt{s} y^{8/3} = 0.38\frac{25}{0.018}\sqrt{0.01}y^{8/3} \quad \rightarrow \quad y3 = 5.65\ cm$$

$Q_{inlet} = k\ A\sqrt{y} \Longrightarrow \quad 0.025 = 0.38\ A_{inlet}\sqrt{0.0565} \Longrightarrow \quad A_{inlet(Active)} = 0.277\ m^2$

%25 clogging $\Longrightarrow$ $A_{Active} = \%75\ A_{Total} \Longrightarrow \quad A_{Total} = 0.277/0.75 = 0.369\ m^2$

%50 Space/bar $\Longrightarrow$ $Ainlet = 0.369/0.5 = 0.738\ m^2 \Longrightarrow \quad L = 1\ m \Longrightarrow \quad W = 0.74\ m$

No. of inlet: 14 curb inlets on each side & 9 grate inlets

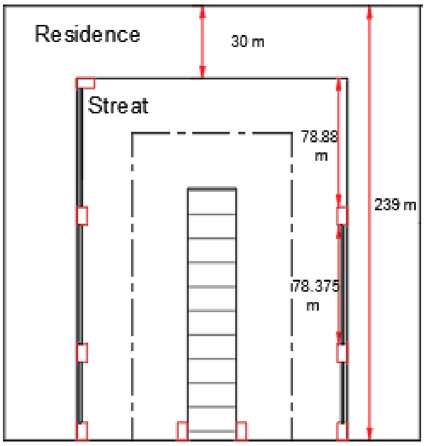
Area no.	No. of station	A m^2	Q_{storm} m^3/s	Q_{gutter} m^3/s	$Q_{for\ curb\ inlet}$ m^3/s	$Q_{for\ grate\ inlet}$ m^3/s	$A_{grate\ inlet}$ m^2	No. of grate inlt	No. of curb inlt	y cm
1	1-1	2700	0.06	0.06	0.024	0.036	0.9 (1×0.45)	2	1	7.87
2	1-1	48	0.00107	0.00107	0	0.00107	0.23(1×0.25)	1	0	1.74
3	1-1	1397	0.03104	0.03104	0.01241	0.01863	0.53(1×0.45)	1	1	6.15
4	1-3	2821.5	0.1668	0.0627	0.0251	0.03762	0.933(1×0.5)	2×2	1	8
4	2-3	2821.5		0.0627	0.0251	0.03762	0.933(1×0.5)	2×2	1	8
4	3-3	1862.8		0.0414	0.0166	0.025	0.74(1×0.74)	1×2	1	5.65

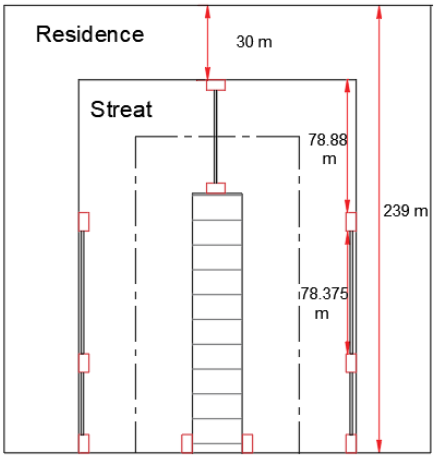
-<u>2- Let it 2 station</u> *(2 > 2.66 in this step we must check water depth)*

Qs=0.6618 /2=0.0834 m^3/s $\Longrightarrow$ *let* $0.0834 = Qg = \frac{z}{n} k\sqrt{s} y^{\frac{8}{3}} = 0.38 \frac{25}{0.018}\sqrt{0.01} y^{\frac{8}{3}}$

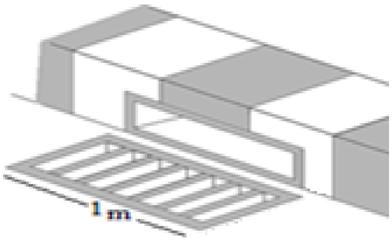
Y=8.9 cm > 8 cm not check $\Longrightarrow$ *we need to use 3 inlet position in each side*

Or change road slope design and direction



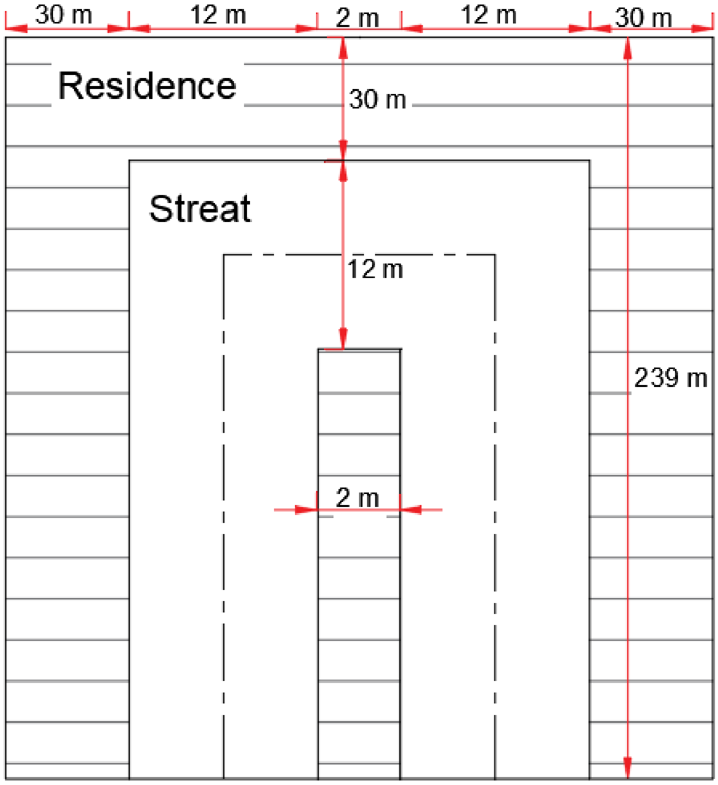


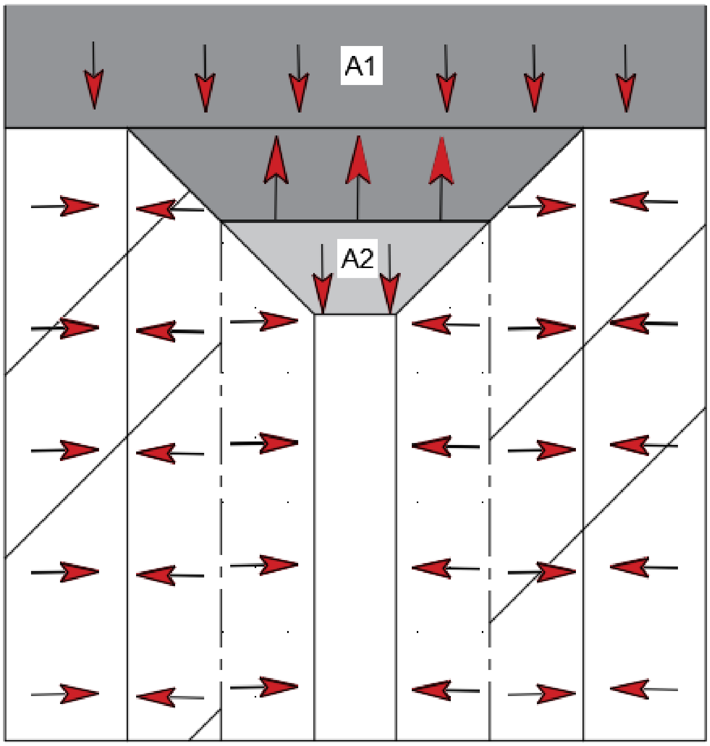
*Ex 12: Design inlet system for the road in figure below with catchment area=86 m*239 m. C=0.8, i=100 mm/hr, Gutter data: y max.=8cm, n=0.018, k=0.38, slope=%1, Z=25, %25 clogging, (space=bar=2 cm). Inlet type used (consists of tow part curb and grade inlet)* $Q_{\text{curb inlet}}=0.6Q_{\text{gutter max.}}$ $Q_{\text{grad inlet}}=0.4Q_{\text{gutter max.}}$

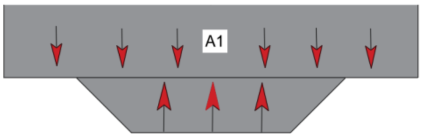


Solution: $(Q_S)_{Total}=CIA=\frac{0.8*100}{3600*1000}*(86*239)=0.457\ m^3/s$

$Q_{gutter(Max.)}= k\frac{z}{n}\sqrt{s}\ y^{8/3} = 0.38\frac{25}{0.018}\sqrt{0.01}\ 0.08^{8/3} = 0.0627\ m^3/s$







$A_1=[86\times 30+(6\times \frac{26+14}{2})]=2700 \quad m^2$

$Q_{storm1}=CIA_1=\frac{0.8\times 100}{3600\times 1000}\times 2700=0.06\ m^3/s$

*To find depth of water in A_1 $\Longrightarrow$ $Q_{storm1}=Q_{gutter}$

$0.06=\frac{z}{n}k\sqrt{s}y^{8/3}=0.38\frac{25}{0.018}\sqrt{0.01}y^{8/3}\ \rightarrow\ y=7.87\ cm$

-To find no. of inlet in A_1 $\Longrightarrow$ Let $Q_{storm1}/\,Q_{gutter}=\frac{0.06}{0.0627}=0.957\approx 1$

-To find Area$_{inlet}$ (grate in grade) in this gutter

$Q_{inlet}=\%40\ Q_{s1}$ $\Longrightarrow$ $Q_{inlet}=0.4*0.06=0.024\ m^3/s$ $\Longrightarrow$ $Q_{inlet}=k\,A\sqrt{y}$

$\therefore\ 0.024=0.38\ A_{inlet}\sqrt{0.0787}$ $\Longrightarrow$ $A_{inlet(Active)}=0.2251\ m^2$

%25 clogging $\Longrightarrow$ $A_{Active}=\%75\ A_{Total}$ $\Longrightarrow$ $A_{Total}=0.2251/0.75=0.3002\ m^2$

%50 Space/bar $\Longrightarrow$ $Ainlet=0.3002/0.5=0.6004\ m^2$

$L=1\ m$ $\Longrightarrow$ $W=0.6\ m$

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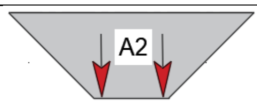
*To find depth of water in A_2 $\Longrightarrow$ $A_2=\left[\left(6\times\frac{14+2}{2}\right)\right]=48\ m^2$



$Q_{storm2}=CIA_2=\frac{0.8\times 100}{3600\times 1000}\times 48=0.00107\ m^3/s$ $\Longrightarrow$ Let $Q_{storm2}=Q_{gutter}$

$0.00107=\frac{z}{n}k\sqrt{s}y^{8/3}=0.38\frac{25}{0.018}\sqrt{0.01}y^{8/3}\ \rightarrow\ y2=1.74\ cm$

-To find no. of inlet in A_2 $\Longrightarrow$ Let $Q_{storm\ 2}/\,Q_{gutter}=\frac{0.00107}{0.0627}=0.0171$

*we will put 0ne grate inlet in grade $\therefore$ To find Area$_{inlet}$ in this gutter

$Q_{inlet}=k\,A\sqrt{y}$ $\Longrightarrow$ $0.00107=0.38\ A_{inlet}\sqrt{0.0174}$ $\Longrightarrow$ $A_{inlet(Active)}=0.0214\ m^2$

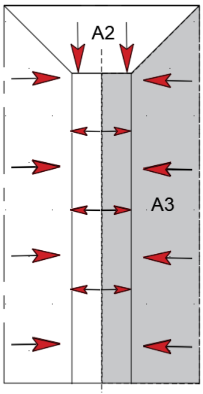
%25 clogging $\Longrightarrow$ $A_{Active}=\%75\ A_{Total}$ $\Longrightarrow$ $A_{Total}=0.0214/0.75=0.0285\ m^2$

%50 Space/bar $\Longrightarrow$ $Ainlet=0.0285/0.5=0.057\ m^2$

$L=1\ m$ $\Longrightarrow$ $W=0.06\ m\approx 10\ cm$

A_3= [(14×203) – A_2]/2 =1397 m^2

$Q_{storm\ 3}=CIA_3=\frac{0.8\times100}{3600\times1000}\times 1397=0.03104\ m^3/s$



*To find depth of water on gutter in each side of A_3 → $Q_{storm3}= Q_{gutter}$

$$0.031=\frac{z}{n}k\sqrt{s}y^{8/3}=0.38\frac{25}{0.018}\sqrt{0.01}y^{8/3}\quad\rightarrow\quad y3=6.15\ cm$$

$Q_{S3}/ Q_{gutter\ max.}$ =0.03104/0.0627 =0.45 → put one duble inlet

-To find Area$_{inlet}$ in this gutter → $Q_{grate\ inlet}$ =%40 Q_{s3} =0.0124 m^3/s

$Q_{inlet}=k A\sqrt{y}$ ⟹ $0.0124=0.38\ A_{inlet}\sqrt{0.0615}$

$A_{inlet(Active)}$ =0.1316 m^2

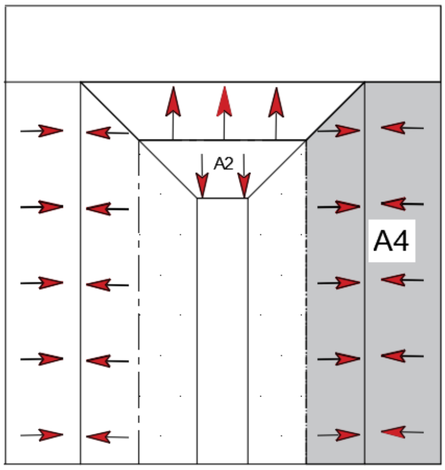
%25 clogging ⟹ A_{Active}=%75 A_{Total} ⟹ A_{Total}=0.0124/0.75=0.1757 m^2

%50 Space/bar ⟹ Ainlet=0.1757/0.5=0.3513 m^2

L=1 m ⟹ W=0.3513 m ≈ 35 cm

For Area 4 (On each side)

$A_4=[36\times209-(\frac{6\times6}{2})]=7506\ m^2$



$Q_{storm\ 4}=C\ I\ A_4=\frac{0.8\times100}{3600\times1000}\times 7506=0.1668\ m^3/s$

-To find y on gutter ⟹ Let $Q_{storm\ 4}= Q_{gutter}$

$$0.1668=\frac{z}{n}k\sqrt{s}y^{\frac{8}{3}}=0.38\frac{25}{0.018}\sqrt{0.01}y^{\frac{8}{3}}$$

$y4=11.55\ cm\ >\ 8\ cm$ ∴ we need inlet system

-To find no. of station ⟹ $Q_{S4}/ Q_{gutter\ (max.)}$ =0.01668/0.0627 =2.66 m^3/s (between 2 and 3)

<u>1- Let it 3 station</u>

*To find first inlet station in A_4 (on each side)

$Q_{gutter\ max.}= Q_{storm\ 4}$ → 0.0627 = C I A $0.0627=\frac{0.8\times100}{1000\times3600}A$ ∴ $A=2821.5\ m^2$

$$L=\frac{A}{6+30}=78.375\ m$$ not true valuein this situation

نحسب المساحة الغير منتظمة فاذا كانت اصغر من المساحة المستخرجة ← اذن موقع اول inlet خارجها

$$At=\frac{6\times6}{2}+(36\times6)=198\ m^2\ <\ 2821.5\ m^2\quad\rightarrow\quad\therefore 2821.5-198=2623.5\ m^2$$

$$L1=6\ m+\frac{2623.5}{36}=6+72.875=78.88\ m$$

-To find inlet second position

$Q_{gutter\ max.}$ = C I A ⟹ $0.0627=\frac{0.8\times100}{1000\times3600}A(for\ second\ inlet)\ \rightarrow\ A=2821.5\ m^2$

$$L2=\frac{2623.5}{36}=78.375\ m\quad\rightarrow\quad Third\ postion\quad L3=(209-78.88)-78.375=51.745\ m$$

-To find Area$_{inlet}$ in postion 1&2 on this gutter → $Q_{grate\ inlet}$ =%40 Q_{s4} =0.0251 m^3/s

$Q_{inlet}=k A\sqrt{y}$ ⟹ $0.0251=0.38\ A_{inlet}\sqrt{0.08}$ ⟹ $A_{inlet(Active)}$ =0.233 m^2

%25 clogging ⟹ A_{Active}=%75 A_{Total} ⟹ A_{Total}=0.233/0.75=0.311 m^2

%50 Space/bar ⟹ *Ainlet=0.311/0.5=0.622* m^2 ⟹ *L=1 m* ⟹ *W=0.63 m*

-To find $Area_{inlet}$ *in A4 postion 3 on this gutter* → *where* $A=36\times51.745=1862.82\ m^2$

→ $Q_{storm\ 4\ p3}=CIA=\frac{0.8\times100}{3600\times1000}\times1862.82=0.041396\ m^3/s$

$Q_{grate\ inlet}$ =%40 $Q_{s4}=0.0166\ m^3/s$

**To find depth of water on gutter in each side of* $A_{4\ p3}$ → $Q_{storm\ 4p3}=Q_{gutter}$

$$0.0166=\frac{z}{n}k\sqrt{s}y^{8/3}=0.38\frac{25}{0.018}\sqrt{0.01}y^{8/3} \quad \rightarrow \quad y3=4.86\ cm$$

$Q_{inlet}=kA\sqrt{y}$ ⟹ $0.0166=0.38\ A_{inlet}\sqrt{0.0486}$ ⟹ $A_{inlet(Active)}=0.198m^2$

%25 clogging ⟹ A_{Active}=%75 A_{Total} ⟹ A_{Total}=0.198/0.75=0.264 m^2

%50 Space/bar ⟹ *Ainlet=0.264/0.5=0.528* m^2 ⟹ *L=1 m* ⟹ *W=0.53m*

No. of inlet: 9 curb inlet on each side & 10 grate inlet 0n each side

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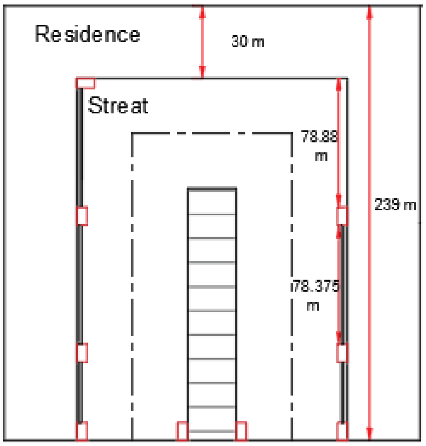
Area no.	No. of station	A m^2	Qstorm m^3/s	Q for curb inlet	Q for grate inlet m^3/s	A grate ilet	y cm		
1									
2									
3									
4									

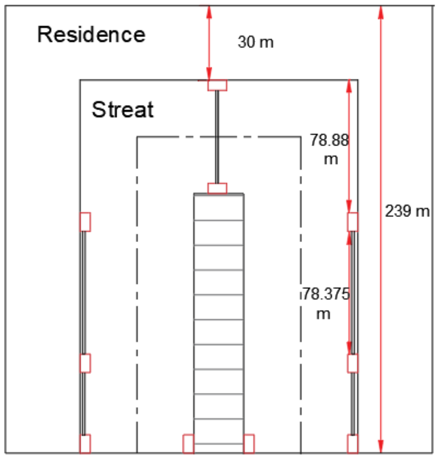
-<u>2- Let it 2 station</u> *(2 > 2.66 in this step we must check water depth)*

Qs=0.6618 /2=0.0834 m^3/s ⟹ *let* $0.0834=Qg=\frac{z}{n}k\sqrt{s}y^{\frac{8}{3}}=0.38\frac{25}{0.018}\sqrt{0.01}y^{\frac{8}{3}}$

Y=8.9 cm > 8 cm not check ⟹ *we need to use 3 inlet position in each side*

Or change road slope design and direction





*Ex 13 (HW): Design inlet system for the road in figure below with catchment area=86 m*239 m. C=0.8, i=100 mm/hr, Gutter data: y max.=8cm, n=0.018, k=0.38, slope=%1, Z=25. Inlet type used (consists of tow part sump and grade inlet)* $2Q_{\text{sumb inlet}}=0.5Q_{\text{gutter max.}}$ $2Q_{\text{grad inlet}}=0.5Q_{\text{gutter max.}}$ *(note: these is crosswalk in this road)*