

# User's Manual A.BEAM'S DETAILING







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The New Beam's Editor - "Detailing" of SCADA Pro is part of an innovative new group of tools that helps you manage the beams designing details.

Using the "Detailing" command you can edit, modify, and define cross-section's details and steel reinforcement. You can also display all the diagrams of the internal forces for each load or load combination or apply reinforcement techniques.

It is an integrated, flexible, easy and very useful tool that saves you a lot of time.

#### NOTE:

A Prerequisite for accessing the "Detailing" tool is the design of beams to be preceded.

There are two ways to access the "Detailing" tool:

1) Open the "Members Design>> Beams >> Results >> "Reinforcement Detailing" Unit





2) While "Members Design" unit is selected, right click on the beam in the interface and the following list opens:



Geometry Span Main Reinforcement Support Reinforcement Stirrups Additional Crack control Diagrams Retrofitting method

In the following chapters, the units are described one by one.

#### NOTE:

Prerequisite for the access to the tool "Beams Reinforcement Detailing" is the beam design check.

You can have access to the toll in 2 ways:



1) Following the path "Members Design>> Beams >> Results >> Reinforcement Detailing"

	Hide
<u>়া</u>	Isolate
	Match Properties
	Continuity Check-Reinforcement
T	Editor
	Results
	Exploration
	Diagrams
· · · · · · · · · · · · · · · · · · ·	Detailing



2) In "Members Design" field, right click on the member of the beam,

and the dialog window opens



The horizontal bar above the cad interface is used to manage the drawing.





Details:	
<ul> <li>This button is used to display beam reinforcement in 3D.</li> <li>Use mouse scroll to move, rotate and zoom the design.</li> </ul>	If differ flagooles, Casely         Image: Columbus         Image: Columbus <t< td=""></t<>
These buttons are used to These buttons are used to This is the "Pan" button.	zoom in, zoom out and zoom all respectively.
These buttons are the arr	ows to move the drawing in different directions.
Update OK Cancel "Update", to update the modifications you r "OK" to save the changes you made in the "Cancel" to turn back into SCADA Pro's inte editor.	on: nade e editor and turn back into SCADA Pro's interface. erface without saving the changes you made in the
a) COPY-PASTE REINFORCEMENT	
Copy Paste All	
The Copy and Paste or Paste All commands a span (Paste) or all spans of the beam contine	llow the (Copy) of a span's reinforcement to another uity (Paste all).
USE: Select a span by left clicking. (The selected s - Click on COPY and then by left clicking, poin and then click on PASTE. - Click on COPY and PASTE All in order the re spans of the beam continuity.	pan is displayed with red color) t the span to which the reinforcement will be copied inforcement of the selected span to be copied to all
- Click on COPY close the Details window an	d open the details of another beam continuity in the

- Click on COPY, close the Details window and open the details of another beam continuity in the same or a different level. By left clicking, point the span to which the reinforcement will be copied and then click on PASTE.



- Click on COPY, close the Details window and open the details of another beam continuity in the same or a different level and then click on PASTE ALL in order the reinforcement of the selected span to be copied to all spans of the new beam continuity.



## b) MULTI-SPAN REINFORCEMENT

Combinations	Slabe	Reame	Column	E Eootinge
Steel Reinforcement	Capacit	ty Design	Steel	Timber structures
Available Rebars				
Φ(mm) 0 +	6,8,10,12,	14,16,18,20,22	2,25,28,32,35,	Lmax(m) 12
labs Columns - Walls	Beams Foo	ting Connection	Beams Strip F	Footings Footings
Concrete Cover (mm)	30 R	ebar spacing (c	m) Max 🗄	20 Min 5
Web Reinforcement	lottom 🗌 Ext	tend	Update All	
2 φ 12 ×	4 Φ 1	.2 ∨ Φmax	20 V Crac	cking $\Phi$ 8 $\sim$
Side rebars	Φmin 1	l2 ∨ Φmax	20 ~	
Support rebars	Φmin 1	l4 ∨ Φmax	20 ~ max	Width (cm) 120
Same Reinforcement i	n Span-Suppo	ort		
Multi-Span Reinforcem	ient			
Shear (Stirrups)				
Min Spacing (cm)	10	Фmin Фma	ax Support	minΦ / (cm) 8 ∨ 20
Preference Stirrups (90)	) ~ {	3 ~ 12	Ƴ Span	8 ~ 20

If in the drawing parameters,

Multi-Span Reinforcement is not selected,

activating here

Multi-Span Reinforcement

the calculated reinforcement is placed uniformly within the beam, and vice versa (if it was common appears as not).

#### **ATTENTION:**

The reinforcement is not recalculated as Common; it simply places the already calculated non-common reinforcement as Common and vice versa.



## a) INCLINED REINFORCEMENT SPAN BOTTOM

Moreover, by activating the:

🔽 Inclined Reinforcement Span Bottc

Half of the bottom reinforcement is considered as inclined reinforcement, and as a result, it is added on the top of the supports and removed from the bottom of the supports.





1.	Geo	metry					
Beams Editor	🕎 🐔 Cor	y Paste Al Mult	i span Reinforcement Dindined Reinforcement Span B	ott: Update OK Cancel			<b>.</b> σ x
		<b>B2</b> 477549/10	inter/s inter/s	B1 53249/20 1	11140/0		
	- 1.69-   	6.00 6.00 0.00	0.55 - 0.35	9,40	0.50 -		
-						N         0         1         1.1         1.4         1.4           0         1         1.5         1.6         1.4         1.4           0         1         1.6         1.6         1.4         1.4           0         1         1.6         1.6         1.4         1.4           0         1         1.6         1.6         1.6         1.4           0         1         1.6         1.6         1.6         1.4           0         1.6         1.6         1.6         1.6         1.4           0         1.6         1.6         1.6         1.6         1.4           0         1.6         1.6         1.6         1.6         1.4           0         1.6         1.6         1.6         1.6         1.4           0         1.6         1.6         1.6         1.6         1.4           0         1.6         1.6         1.6         1.6         1.4           0         1.6         1.6         1.6         1.6         1.6           0         1.6         1.6         1.6         1.6         1.6           0         1.6	
-0.							
84.92 42.04		4.40 ©2412 1-7.37					
Geometry Span Main 5 General Data Number of Spans Cover (mm)	Reinforcement Support Span 25 Number Name b(on) h(on)	Reinforcement         Stimupe         Addition           1         Length         6.60           2         Lap.(cm)         666           25         h0(cm)         0           0         60         h1(cm)         0	el Ceck cimital Degrams Retroffing method Criscal angth Left (n) 0.9 Criscal angth Right (n) Retriforcament Pattern 2007 82 03 8405	0.9 Supports viridth (m) Left 40 Right 40			

The first unit of "Beams Editor" refers to the geometry. It includes information related to spans and supports of the beam continuity and general data.

General Data				
Number of Spans	3			
Cover (mm)	25			

General Data refers to the entire continuity of the beam and includes (i) the number of spans (non-modifiable) and (ii) the cover in mm.

## **ATTENTION:**

The Cover \* listed in General Data is purely designed. It means that it is not taken into account in the calculation of the reinforcement for this and is not mentioned in the issue. If you want to change the Cover, it is right to do it through the reinforcement parameters.

General Data		Span							Supports	
Number of Spans	3	Number	1	Length	2.25	Critical Length Left (m)	0.5 Critcal Length Right (m)	0.5	-Width (cm	)
Cover (mm)	25	Name	3	Lsp.(cm)	225	Reinforcement Pattern			Left Right	40
		b(cm)	25	h0(cm	0					
		h(cm)	50	h1(cm	0	1.90m	B3 (67) 0.40m			

"Span" and "Support" areas can be adjusted in the selected field. You can choose the span graphically by left clicking on the drawing or by typing directly the number in the "Number" field



Select the first span. In the selected span the main steel reinforcement and the symbol of the beam turn into red.





The "Span" area is shown on the right where the beam's data are filled in. You can modify the dimensions b, h of the beam's cross-section as well as the length and the height, according to the following design.

Span			
Number	1	Length	3.70
Name	9	Lsp.(cm)	370
b(cm)	20	h0(cm)	0
h(cm)	60	h1(cm)	0









#### **ATTENTION:**

Any geometrical modification concerns the design only and does not inform the model calculations.

The "Span" area includes the critical lengths as well, which you can edit and the drawing and the "Reinforcement Pattern" will be updated automatically.

Critical Length Left (m)	1.2 (	Critcal Length Right (i	m) 1.2
Reinforcement Patter	n ———		
	-		
0.40m	B9 (27)	0.40m	

In the picture below notice that the bars on the top, coming from the respective spans, enter the corresponding spans as opposed to the bars on the bottom.



It means that in the calculation of the support reinforcement, the program will consider the top two bars for both left and right span reinforcement, while at the bottom one bar for each span will be considered.



If you want to take into account the bottom bars of both spans, select the yellow lines and then left click (to select the left yellow line, select the left span and for the right yellow line, select the right span) to extend them. So the

program will take into account both bars, for top and bottom.





If you want to take into account the bars of one span only, reselect the yellow and the white lines, to produce the form shown in the figure on the left.

Γ	Supports Width (cm)	]
	Left	40
	Right	40

In the "Supports" field you can change the width of the supports on the left and the right, but remember that all geometric modifications concern only the drawing and don't update the model's mathematical calculations.



## 2. Span Main Reinforcement

E Beams Editor			↔ – □ X
	Paste Multi-Span Reinforcement	Inclined Reinforcement Span Bottc Update	OK Cancel
B2 13588//1 (1588/16	B1 122002/5 122002/2 531002/16		
		REINFORC. TABLE	TOTAL LENGTH
1.10	4.10 - 4.10 - 5.1	0.14 - 01.0 - 01	Φ         Φ
6.00 () 1911 (-0.01		000 00 1 14 2 4.42 2 14 3 4.44 1 14 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 - 24,-55
		1 14 4 14 14 14 14 1 3 16 1 14 14 14 14 14 14 14 14 14 14 14 14 1	
		1 12 2 7.33 1 12 2 1.45 2 5 246 1.464 ( 14 5 246 1.464 ( 14 6 4 1 1.464 ( 14 6 4 1.464 ( 14 6 1.46	35,14
5.9		keight per m (Kg) rotal weight / ⊕ (Kg) I rotal weight of keinford	8-40         8-45         11-21         27-50           12-51         2-101         145-51         27-50           12-51         2-103         27-50         27-50           1441         316-54         316-54         316-54
Q 24414 L-7.23	6.00.00 1.36	asta 5.001 Ameral Total	[87] 18.53 [89] 388.11
5.76 S.76			
- 0 1 + ( 1 - 4 )			
6.46 © 2002 16-1.37			
	() 1412 L-1, 1)		
Geometry Span Main Reinforcement Support Reinforceme	ent Stirrups Additional Crack control Diagrams	Retrofitting method	
Number 1 Bars Anch	orages  1  2 Left S	upport Span Right Support Right	1  2
Continuity 11 12 Top + 3 $\Phi$ 14 $\checkmark$ Node	√ 37 52 Required (cm2) 6.2	4 3.65 5.98 Continuity	V 90 0
Node 11 12 Side 0 φ 6 γ 90	✓ Calc 37 3 Placed (cm2) 6.6	3 4.62 9.24 No V Ca	alc 90 0
Side 1 Φ 12 V Bottor + 4 Φ 14 V Node	✓ 37 7 Required (cm2) 3.1 Required (cm2) 6.1	2 3.30 2.99 Continuity	✓ 40 0
Φ 6 ~ 90	✓ Calc 17 0 Placed (cli2) 6.1	No ~ Ca	alc 1/ 0

The "Span Main Reinforcement" unit consists of tools useful for the modification of the main steel reinforcement of the selected span.

You can choose the span graphically by left clicking on the drawing or by typing directly the

number in the following field



In the "Side" field there are the number and the diameter parameters of the side bars, where you can modify both parameters.

		_					_	
		ва	rs			Left Support	Span	Right Support
-		2	Φ 14	~	Required (cm2)	6.07	1.52	6.07
Top + 0 φ 6 Ψ	Placed (cm2)	6.16	3.08	6.16				
		4	Φ 14	~	Required (cm2)	3.04	6.07	3.04
Bottor	+	0	Φ6	~	Placed (cm2)	6.16	6.16	6.16

Span -

1

## 2.1 Bars

In the "Bars" field you define the number and the diameter of the main rebar of the beam at top and bottom and you can modify both of them. You may as well read the rebar area of the required and the placed reinforcement.

The square centimeters of the placed reinforcement are updated automatically according to the user's choice. You can change the number and the diameter or insert two different rebars on the top or bottom.



Ва	rs			Left Support	Span	Right Support
2	Φ 14	~	Required (cm2)	6.07	1.52	6.07
1 φ	Ф 10	~	Placed (cm2)	6.94	3.86	6.94
4	Φ 14	~	Required (cm2)	3.04	6.07	3.04
0	Φ6	¥	Placed (cm2)	6.16	6.16	6.16

If the area of provided reinforcement is less or equal to the required, the number of placed square centimeters appears in the table magnified and colored red.

## 2.2 Anchorages

After you define the main steel reinforcement you must calculate the anchorages.

Node	•	
Side		
Node		

First choose the extension limit from the drop-down list  $\boxed{Continuity}$  according to the following drawing for the calculation of the L<sub>1</sub>, on left and right support, separately.

Then select the angle for the calculation of the  $L_2$  (for the side,  $L_2 = 0$ ), on the left support and the right support, separately.

For the calculation of the  $L_1$  and  $L_2$  click the following button  $\square$ . The program considers all the imposed parameters and the position of the rebar and fills in the following table.

		Bars	Anchorages Left l1 l2			Anchorages Right	11	12
Тор	+	2 ⊕ 14 ▼ 1 ⊕ 10 ▼	Node  90	37 37	29 10	Continuity  No	20 14	0 0
Bottoi	+	4 Φ 12 ▼ 0 Φ 6 ▼	Node     90	40 28	22 0	Continuity  No	34 17	0

90 💌	
No	i
Vertical	
45	
90	
135	İ
180	I
-Vertical	
-45	
-90	
-135	
-180	

The drawing and the table are updated automatically considering any performed change.

13Σ <b>Φ</b> 8/1	<b>∆9</b> .0 125 <b>+</b> 8/10	132 <b>+</b> 8/10 132 <b>+</b> 8/10	<b>∆6</b> 10∑‡8/10	13 <b>2</b> 48/10
<u> </u>	20 1.30	-1.20	0 1.10	1.20
40		40		
0.32	3.70	0.40.20		
0.34	<pre>①2Φ14 L=4.99 3.70</pre>	0.40.14		
	2)1¢10 L=4.73	0.20.40		
			(3)2¢14 L=4.77	
ဖ ၀ို့ 32		0.400.40		
ef 34	(4)4014 L=5.16 3.70	0.400.28		
	(5)1¢10 L=4.87			
		0.400.40	3.50 6 4014 L=4.97	0.67



## Anchorage length lbd calculation process

The total lbd is calculated and divided into l1 and l2. L1 is the linear anchorage length, and l2 is rotated into the node.

## **NODE:**

EC2 instead of providing a minimum linear anchorage length provides a minimum TOTAL anchorage length (l1+l2) which is also called lb, min. EC8 in paragraph 5.6.2, among others, provides only for the DCH the anchorage length to be linear only(exaggerating). According to the above:

- 1. For the EC2 w / o scenario and all EC with DCL and DCM ductility categories, EC8 does not obey to the minimum linear anchorage length of lb, min but the total length lbd is compared to lb, min  $\sigma$  according to 8.4.4 of the EC2. Therefore, there will never be an error message because, because in case that the anchorage length is greater than the width of the support minus the cover, the rebar will reach the alignment and then return to the node.
- 2. For the EC with a high ductility, EC8 obeys obeys to the minimum linear anchorage length according to EC8's paragraph 5.6.2.

## **IMPORTANT NOTE:**

In the implementation process of **single beams reinforcement with common rebars of a specific length**, the program places the additional rebars in the supports under criteria.

There are two ways to place the additional supports reinforcement.

- The first way is additional rebars coming from each aperture on either side and positioned on the respective side of the opening.
- The second way is to place a common support rebar.







A. The first criterion is the <u>width of the support</u>, as determined by the parameters of beams reinforcement.

Structural Component Para	meters				×
Combinations Steel Reinforcement	Slabs Capacit	Beams y Design	Column Steel	s Footings Timber structures	;
Available Rebars Φ(mm) 0 +	6,8,10,12,1	14, 16, 18, 20, 22, 2	5,28,32,35,	Lmax(m) 12	
Slabs Columns - Walls Concrete Cover (mm)	Beams Foot	ing Connection B ebar spacing (cm)	eams Strip F	ootings Footings	1
Web Reinforcement Top DExtend 2 0 14 V Side rebars	Bottom Ext 4 0 1 0 min 1 0 min 1	end 4 v	Update All 20 V Crac 20 V	king Φ 8 ~	
Same Reinforcement	in Span-Suppo	rt	20 0/5 (1183)		
Shear (Stirrups) Min Spacing (cm)	10 0	Φmin Φmax	Support	minΦ / (cm) 8 ∨ 10	
Preference Stirrups (90	) ~ 8	12 ~	Span	8 ~ 10	
				OK Cano	el

If it exceeds the max support width (see Figure 1), then support reinforcement is placed separately per side.

If the width of the support is less than max width, then a common rebar to all the support is placed (see Figure 2).



## NOTE:

Changing this parameter after the creation of the continuity of the beams requires deletion and re-creation.

B. The second criterion has to do with the <u>width of the beams</u> in the support. If this width is different for the two beams, then placed separately additional support rebars. Otherwise, place a common rebar.

## **CONCLUSION:**

Common rebar placed only if satisfied both criteria:

- A. Support width <max width in parameters
- B. Same beams width

## 3. Support Reinforcement



The "Support Reinforcement" tab contains tools useful for the modification of the steel reinforcement of the supports of the selected beams.



Choose the span graphically by left clicking on the drawing or by typing directly the number in the following field.

12. 112 Supprt Left Support Right 11 11 Right Top Top Left 1Φ10 Right Left Calc • • No No Bars 1 12 1 12 Bottom Bottom 1Φ10 8 0 Φ 10 8 0 1 • 8 0 8 0 0 Φ 6 Ŧ

There are two support areas, Left Support and Right Support.

Each one is divided into Top and Bottom, which means Top support rebar and Bottom support rebar, respectively, and contains three tabs that represent the position of the rebar to the support:

## 3.1 Additional support rebar

- 1. Common to both spans
- 2. Only in the left span
- 3. Only in the right span



If there is no additional rebar to the support in the specific position, the tab is empty, otherwise, the tab indicates the number and the diameter of the bar in the relative position (e.g.  $1\Phi10$  on the top, common, in the left support).





When the buttons are empty it means that there are no additional bars in the respective positions.

- To modify an existing additional bar or to add a new one, on the top or bottom, on the left or right support:
- 1. First, click on the respective tab (e.g.

Supprt	Left	
Тор —	1Φ10	١







Beams Editor	- D X
The span Reinforcement to the span Reinforcement	Update OK Cancel
Geometry Span Main Reinforcement Support Reinforcement Stirrups Additional Crack control Diagrams Retrofitting method	
Number     1     Left support     Span     Right Support       Rebars $\Phi$ $8 \lor /$ 10 $\Phi$ $8 \lor /$ 10	
Type dL 0 0 v section dR 0 0 v section	
Req.(cm2)         2.86         1.79         2.52           Placed(cm2)         10.05         10.05         10.05	
□ Same Φ/per cm in all span Same type of stirrup in all span	

The "Stirrups" tab contains useful tools for the modification or the addition of stirrups on spans and supports of the selected beam.

Choose the span graphically by left clicking on the design or by typing directly the number in the

following field 1 to update the corresponding area:

Geometry	Span	Main Reinfor	ceme	ent	Support	Reinford	emer	nt	Stirrups	Additio	onal	Cra	ck control	Diagrams	Retrofitting method
Number	1		Le	ft Si	upport		Sp	an			R	ight S	Support		
		Rebars	Φ	8	~ /	10	Φ	8	~ /	10	Φ	8	~ / I	10	
Туре			dL	0	2 ~	section		2	√ sec	tion	dR	0	2 ~ 5	ection	
Regular	$\sim$	Dec (cm2)			2.00				1 70				2 52		
Regular Bidiagonal		Placed(cm2)			10.05				10.05				10.05		
				Sam	e Φ/per	cm in all s	span		6	∠ Same	type	ofs	tirrup in al	span	

## EXAMPLE:

The span with the number "2", contains only one type of stirrups 🗹 Same type of stirrup in all span



"Normal" stirrups , with "2 sections" and "Placed" area greater than the "Required" area.

You can modify the existing stirrups or insert new ones.



If you decide to use the same stirrups in all spans, activate the corresponding checkboxes
Same $\Phi/\text{per in all span}$ and and span and span, and type the characteristics in the span and the same are applied in the supports:
Bars $\phi$ 8 $\checkmark$ / 10 $\phi$ 8 $\checkmark$ / 10 $\phi$ 8 $\checkmark$ / 10
dL 0 2 v section 2 v section
Req.(cm2) 1.43 1.43 1.43 Placed(cm2) 10.05 10.05
Same Φ/per in all span
5. Additional



Beams Editor					– 🗆 X
	२ 👋 🗙 🕸 🕸	Multi-Span R	einforcement		Update OK Cancel
	5 - 4.15 .77 4.15 (1) 3414 1=6.14 (2) 3414 1=6.14 (2) 4414 1=5.40 1.00 1.00 (3) 1410 1=2.00 1=1.45	0.60 0.45 0.48 0.40 0.48 0.40	4.10 4.10 (2) 3414 L=6.05 4.10 (3) 4414 L=5.25 0.60 (3) 1414 L=1.	-45 -45 	$\begin{array}{c c c c c c c c c c c c c c c c c c c $
Geometry Span Main Rei	nforcement Support Reinforcement	Stirrups Additional Crack cont	rol Diagrams Retrofitting meth	od	
Number 1 Additio	ed cm2 0.00 Sp	an Right Support 0.00 0.00	Span Additional Steel Rein	forcement Button1	11 11
Rebars	cm2 0.50 ; 1 Φ 8 ✓ (	$0.00 \Phi_{6} = 0 \Phi_{6}$	Top         1         Φ         10         ∨           Bottom         0         Φ         6         ✓	Required (cm2) Placed (cm2) Required (cm2) Placed (cm2)	4.30 100 100 5.40 3.30 0 0
resistance, on s Choose the spa the following fin <b>5.1 Additi</b>	relation contains use spans and supports an graphically by le eld to updat conal bars for Si Rebars (Indined)	s of the selected b eft clicking on the se the correspond <b>hear effects (In</b>	drawing or by t ing area: clined)	yping the r	number directly in
	Left Support	Span	Right Support		
Required cm2 Placed cm2	0.00	0.00	0.00		
Rebars	1 <sup>0</sup> 8 ~	0 0 6 ~	0 <sup>Ф</sup> 6 ~		
The field "Shea reinforcement f	r Additional" is au for shear effects.	tomatically updat	ed considering t	he required	and placed stee

You can intervene by changing the number and the diameter in both supports and span. Placed reinforcement is automatically updated.

**5.2 Additional bars for bending effects** 



Span Additional Steel Rein				
	Button 1		1	1
Top 1 0 10 V	Required (cm2)	4.30	100	100
	Placed (cm2)	5.40		
Pottom 0 d 6 v	Required (cm2)	3.30	0	0
	Placed (cm2)	6.16		

The "Additional Span Reinforcement" field is automatically updated considering the required and placed steel reinforcement for bending effects, in the top and bottom.



6. Crack control



Beams Editor						– 🗆 X
	<mark>×</mark> 庫 庫	🕸 🐔 🕬	L) ulti-Span Reinforcement		Update	e OK Cancel
73998/10	<b>B61</b> 29308/10 7308/10	a 21098/10 2	B53			
- 85 - 85 - 77 - 75	2.95. 0.69 4.15. 11 4.15 () 918 1.46.18	5.6 	2.10 0.60 40 4.10 0.51 40 4.10 0.51	REINFORC. TJ 3 00 000 000 000 000 000 000 000 000 00	ABLE TOTA 0 0 0 0 0 0 0 0 0 0 0 0 0	L LENGTH
0.40 (0.17) (0.10) (0.10) (0.10)	4.15 <b>0.4</b> 0.4 0.4 0.4 0.4	(2).45 (2).45 (2).45 (2).45	4.10 5.48 4 los.35 0.60 0.46 Ø1414 los.5	0     1.2     2.0       10     1.0     1.0       Fortal Length     0       Notal Margin     0       Fortal Margin     0	.90 64 279.61 279.61 279.61 0.40 0.62 (Kg) (Kg) (Kg) (Kg) (Kg)	9.80 19.70 80.71 1.58 0.89 1.22 2.60 17.53 97.77 31.6 11.55 241.83
Geometry         Span Main Reinforcement         Top           Number         1         Top         Left Support         0.07           0.00 <t< td=""><td>Support Reinforcement Span 0.03 0.00</td><td>Stirrups Additional Right Support 0.02 0.00 0.00 0.00 0.00 0.00</td><td>Crack control Diagrams F Calcul. Wk(mm) Required cm2 Final Wk(mm) Bars</td><td>Retrofitting method Bottom Left Support 0.00 0.00 0.00 0.00 0.00</td><td>0.03 0.00 0.00 0.00 0.00 0.00</td><td>Right Support 0.00 0.00 0.00 0.00 0.00 0.00</td></t<>	Support Reinforcement Span 0.03 0.00	Stirrups Additional Right Support 0.02 0.00 0.00 0.00 0.00 0.00	Crack control Diagrams F Calcul. Wk(mm) Required cm2 Final Wk(mm) Bars	Retrofitting method Bottom Left Support 0.00 0.00 0.00 0.00 0.00	0.03 0.00 0.00 0.00 0.00 0.00	Right Support 0.00 0.00 0.00 0.00 0.00 0.00

"Crack control" unit contains tools useful for the modification or addition of rebar against the concrete cracking, on spans and supports of the selected beam, on the <u>top</u> and <u>bottom</u>. Choose the span graphically by left clicking on the design or by typing directly the number in the

p				Bottom		
Left Support	Span	Right Support		Left Support	Span	Right Support
0.07	0.03	0.02	Calcul.Wk(mm)	0.00	0.03	0.00
0.00	0.00	0.00	Required cm2	0.00	0.00	0.00
0.00	0.00	0.00	Placed cm2	0.00	0.00	0.00
0.00	0.00	0.00	Final Wk(mm)	0.00	0.00	0.00
0 <sup>Φ</sup> 6 ∨	0 <sup>Φ</sup> 6 ~	0 <sup>Φ</sup> 6 ∨	Bars	0 Φ 6 ~	0 Φ 6 ~	<mark>0</mark> Φ6 ~

The calculated  $W_k$ , the required and the placed steel reinforcement, the final  $W_k$  and the characteristics of the placed rebar in the correspondent position are updated automatically. You can intervene by changing the number and the diameter in both supports and the span, on the top and the bottom. Placed steel reinforcement is automatically updated.

Left Support 0.07	Span 0.03	Right Support 0.02
0.00	0.00	0.00
0.28	0.00	0.28
0.00	0.00	0.00
1 <sup>Φ</sup> 6 ~	0 <sup>Φ</sup> 6 ~	1 0 € ∨
7. Diagran	าร	

following field 1 to update the corresponding area:



Beams Editor			↔	
€ € 🕀 🧌	Copy     Paste     Paste All     Multi-Span Reinforcement     Indined Reinforcement Span Bottx     Update	OK Cancel		
	3			
151.10				
(2.46				
-74,80				
a.n				
-2.66				
-11.41				
1.11				
1.30				
-6.16				
201.60				
36.56				
-140.60				
Geometry Span Main Reinforcement	Support Painforcement Struing Additional Crack control Diagrams Batrofittion method			
acoment partman remotement	under and the second se			
Envelope		m) MZ(KINM)		
Bending Moments	+ 1.35LC1 + 1.50LC2 0.00 -0.00 50.32 0.00 -0	.36 27.78		
Snear Forces	Reinforcement Pattern 0.99 -0.00 40.09 0.00 -0	.36 6.82		
Maceu Remorcement As		.36 -11.60		
Unumate Moment Resistance		-25.54 76 -73.84		
Bending Moments - Resistance	0.40m B2 (39) 0.40m <	>		

In the "Diagrams" unit you can find useful information about the:

- Envelope diagrams of Bending Moments, Shear Forces, Placed Reinforcement, Ultimate Moment Resistance, Bending Moments Resistance of all spans.
- Internal forces for each load and each combination, by specifying the path ("Per Length").

## 7.1 Diagrams

Envelope Bending Moments Shear Forces Placed Reinforcement As Ultimate Moment Resistance Bending Moments - Resistance

Activate a checkbox so that the corresponding diagram to be displayed on the cad interface:

1. Bending Moments





The color bar on the left helps you to easily find the corresponding values of the diagrams.



# 7.2 Internal Forces

Choose the span graphically by left clicking on the drawing or by typing directly the number in

1 the "Number" field ✓ Per Length (cm) 50 • 1 Combination Number 1 Load Case + 1.35Lc1 + 1.50Lc2 Combination choose the load case

In the following area

or the load combination and the corresponding number, and type the length of the beam where the inertial forces will be calculated.

You can read the values of all the internal forces, calculated for the specific Load Case or Load Combination, in the corresponding length in the table below.

L <b>(</b>	N(	Vy(	Vz(k	Mx(k	Mz(k	My(k	
0.00	0.00	50.70	-0.00	-0.02	34.23	-0.00	
0.51	0.00	39.43	-0.00	-0.02	11.44	-0.00	
1.00	0.00	28.44	-0.00	-0.02	-5.31	0.00	
1.51	0.00	17.17	-0.00	-0.02	-16.85	0.00	
2.00	0.00	6.18	-0.00	-0.02	-22.61	0.00	
2.50	0.00	-5.09	0.00	-0.02	-22.89	0.00	
3.00	0.00	-16	0.00	-0.02	-17.66	0.00	-



# 8. Retrofitting methods

Beams Editor			↔	$\times$
€ € 🖤 🌇 Сору	Paste Paste All Multi-Span Reinforcement	Indined Reinforcement Span Bott: Update OK Cancel		
B2 ****/*	B1	REINFORC. TABLE		
	0.10 - 0.	Image: constraint of the second sec		
Q 344 64.83		$\begin{array}{c c c c c c c c c c c c c c c c c c c $		
Est Øtetr (a1,27		Name         parts         parts <thp< td=""><td></td><td></td></thp<>		
-22 - 9-10 				
-3 © 2413 (c1.33				
Geometry Span Main Reinforcement Support Reinfor	cement Stirrups Additional Crack control Diagra	ms Retrofiting method		
Number of Span         1           General Data	Material         Input data           Concrete : C8/10         Left supp           Steel (Main) :S220         Span           Steel (Stirrups) :S220         Right supp           Bolts - Hangers :S220         Performance level	ort		

The "Retrofitting methods" section contains the tool for the seismic reinforcement and rehabilitation of the beams according to the Code of Structural Interventions.

First, the calculated steel reinforcement is adjusted to the existing one, then you proceed with the definition of the structural reinforcing techniques.

Select the span graphically or by left click on the span in the cad interface. Otherwise, set the

number of the span in the "Number of Span" field

In the "Beams editor", the beam is always depicted by the input step direction. To quickly locate the beam of interest among the rest structural elements, the numbering and the visibility of the local axes for all beams is suggested. You can select the corresponding beam by setting its serial number in the editor utility. To define the left and right support of the beam, use the direction of the local axis xx'. The start and the end of the beam element in the editor's interface are defined concerning the local axis xx' direction, without considering the beam's orientation in the plan view.

## "General Data"

Select from the drop-down list the structural reinforcing method applied to the selected beam.





- The activation of the "Uniform reinforcement in the total length" checkbox/means that the reinforcement, applied in each critical cross-section, will be designed (supports, span) considering the less favorable values of the inertial forces. The less favorable inertial forces are derived from the comparison of the inertial forces in all cross-sections of the beam. Otherwise, if the checkbox remains inactive, the inertial forces of each critical region examined will be used for the design of the corresponding retrofitting method.
- 2. In both options above, the structural reinforcement must be applied in the three critical sections of the beam (left/right support and span).
- 3. In case of the concrete jacket and additional concrete layers, type a value in the field "Cover (mm)" to define the concrete cover of the cross-section.
- 4. Activate the checkbox "T" and type the thickness of the plate in the "Plate thickness (cm)" field in case of a T-shaped cross-section. For a Γ-shaped cross-section, type the thickness of the plate without activating the checkbox "T".
- 5. For zero value as plate thickness, a rectangular cross-section will be considered, no matter of the checkbox "T" status.

"Performance level": Define the performance level of the structure.

			A - DL
			B - SD
Performance level	A - DL	<b>~</b>	F - NC *******

"Accessibility": Define the accesibility of the area where the reinforcement is applied according to the § 4.5.3.2 of the Structural Interventions Code.





# 8.1 Additional concrete layers – concrete jackets

"Materials": Select the type of material for each structural component of the reinforcing

Material	method.	
Concrete : C8/10	Concrete ×	
Steel (Main) :S220	Type C20/25 ✓	
Steel (Stirrups) :S220	Constants Fck (Mpa) 20	Steel (Stirrups) ×
Bolts - Hangers :S220	γcu 1.5 γcs 1	Type S220 ✓ Constants
	Fctm (Mpa) 2.2	Es (Gpa) 200 Fyk (Mpa) 220
	Max Deformations	γsu 1.15 γss 1
	εc (N) 0.002	Max Deformations
	OK Cancel	OK Cancel

"Input Data": Define the input data of the concrete jacket in the two supports and the span of the beam.

I	nput data
	Left support
	Span
	Right support

✓ The same in both sides The side rebars are taken into consideration → The additional rebars are taken into	Top flange Length (cm) 120 Thickness (cm) 0 Do not participate in the bending resistance check	Sika Cancel
Consideration	4 $\Phi$ 6 $\checkmark$ 0 $\Phi$ 6 $\checkmark$ d1(cm)     0	Rehabilitation Protection
Left side Length (cm) 120	• •	Right side Length (cm) 120
Do not participate in the bending resistance check		Do not participate in the bending resistance check
Corner		Corner Internediate Design Charler
Diameter (mm) 6 V	Bottom flange	Report
Stirrups $\Phi = 6  \forall  /  0  cm$	Do not participate in the bending resistance check	
Ultimate Moment Resistance	$ \begin{array}{c} 4 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0$	



In the dialog box "Beam structural reinforcement" that appears, you add the concrete jacket per side (top, bottom, left the side, right side). There is also a preview window, part of the dialog box, where the settings are depicted.

The calculations and the design checks of the beam are the same with the checks of the column presented in the relative chapter.

For the existing side rebars to be taken into consideration, in the calculation of the ultimate moment resistance of the cross-section, you activate the following checkbox:

The side-rebars are taken into consideration

For the existing additional steel reinforcement in the supports of the beam to be taken into consideration, in the calculation of the ultimate moment resistance of the cross-section, you activate the following checkbox:

The additional rebars are taken into consideration

If you activate the following checkbox The same in both sides then, the "Right Side" field is deactivated and receives the same input parameters as they are defined in the "Left Side" field.

Right side				
Length (cm)	)	120		
Thickness (cn	1)	0		
Do not particip bending resist	ate	e in ti e chi	he eck	
Rebars				
Corner	Φ	6	$\lor$	
Internediate 0	Φ	6	$\lor$	

**If you select the button "Default"**, then, the corresponding length of the supports and the span are automatically defined. The support's length is the critical length and the span's length is the total length of the beam minus the critical of the two supports. The calculated lengths correspond to the reinforcing length.

In the "Ultimate Moments Resistance" field, if you select the button "Initial" or "Reinforced", then the ultimate bending resistance of the existing or the reinforced cross-section, respectively, is calculated.

## NOTES:

- Beams reinforcement offers two options concerning the calculation of the Ultimate Moment Resistant: "Initial" and "Reinforced". Press the "Reinforced" button to calculate the new M-N diagrams and update also the relative λ ratios.
- A When you finish with the reinforcement, go back to the Analysis field and open the Checks, to update also the print outs with the new  $\lambda$  ratios.



In the "Dowels - Suspensors" field you define the input parameters of the dowels or the suspensors; diameter and anchorage length.

Dowels - Suspensors			
Diameter (mm)	16	~	
Anchorage Length (mm)	100		

In the "Stirrups" field, set the diameter and the spacing of the stirrups of the concrete jacket.

Stirru	lps				
Φ	8	~	1	10	cm

#### Input parameters in the fields "Top" and "Bottom"



If you activate the "Not considered in the bending resistance check" checkbox, then the corresponding concrete jacket or the additional concrete layer are not taken into consideration in the calculation process of the reinforced cross-section.

In the first line of the input parameters of the steel reinforcement, you define the number of the rebars of the first/basic rebars' layer and their diameter. For more than one layers of rebars, you define in the second line, the number of the rebar layers, the diameter of the rebars and the spacing  $d_1$  between the rebar layers.

The rebar layers have always two rebars.

The activation of the checkbox, on the right of the diameter's

drop-down list  $\bigcirc 20 \frown 10^{\circ}$ , means that the corresponding steel reinforcement is not taken into account in the calculation of the ultimate moment resistance.

#### Input parameters in the fields "Left Side" and "Right Side"

Left side	
Length (cm) 50	
Thickness (cm) 10	· ·
Do not participate in the bending resistance check	•
Rebars	•
Corner	•
Intermediate 3 $\Phi$ 14 $\vee$	• • • • •



In the "Rebars" field you define the diameter of the corner rebars of the corresponding side, as well as, the number and the diameter of the intermediate rebars. The rest parameters are the same as the parameters of the top and bottom of the cross-section.



Select the "Design checks" command and the program performs all the design checks for the concrete jacket in every reinforced side with a concrete jacket (according to the Code of Structural Interventions) and so the appropriate number of dowels is calculated. The design checks and their corresponding results are similar to those considered for the columns. The results of the design checks are presented on the bottom of the window.

Finally, select the "Report" command and the results of the design checks will be added in the corresponding chapter of the Report.

After any modification on the parameters of the concrete jacket, select the command "Report", so that the report will be updated with the new data as appropriate.



Furthermore, in SCADA Pro, the techniques and the material considered in each retrofitting method are enriched with the corresponding material and techniques of the company Sika and EM4C. The user has direct access to the library of Sika and/or EM4C materials by pressing the

Sika EM4C relative button , which appears in the dialog boxes related to beam reinforcement. The buttons "Rehabilitation" and "Protection" correspond to a dialog box each with tools related to the rehabilitation and protection of the beam structural elements according to the Code of Structural Interventions. (КАN.ЕПЕ). Rehabilitation - Protection × 2 Concrete Repair Rehabilitation Corrosion Protection Materials used on the surface that act as corrosion inhibitors for the steel reinforcement of the reinforced concrete structures and applied by impregnation Protection Concrete Repair Repairing mortars for the structural rehabilitation of concrete members. Crack Filling Cementitious binding materials for the structural rehabilitation of the concrete cracking, welded and / or infilled. EM4C Sika Rehabilitation - Protection × Printout The user can select one of the three Add Delete Concrete Repair rehabilitation and protection Corrosion Protection Materials used on the surface that act as corrosion inhibitors for the steel reinforcement of the reinforced concrete structures and applied by impregnation. Protection methods by activating the Fire Protection Lavers corresponding checkbox. Concrete Repair Repairing mortars for the structural rehabilitation of concrete members. Concrete layers or coating By selecting the command Repairing mortars of one or more component protective coating. Crack Filling Cementitious binding materials for the structural rehabilitation of the concrete cracking, welded and / or Printout Paint Protection Add EM4C Sika the corresponding Printout EM4C Sika Add Delete information will be imported in the ОК final report of the study. Protection Fire Protection Layers Fire resistant mortars applied by using epoxy resin. Concrete layers or coating Repairing mortars of one or more components for final protective coating. Paint Protection Plastic-elastic paint protection for concrete and coatings. EM4C Sika OK Cancel



# 8.2 Steel laminates – fiber reinforcement polymers (FRP)

For these two retrofitting methods, the same procedure is followed as previously. For the steel laminates or FRPs, select the corresponding layer from the drop-down list.

General D	Data	
Туре	Steel Plates	4
🖌 Unifo	Concete Jacketing Steel Plates	
Cover	Fiber Reinforced Polymers	

"Material": Select the type of the steel for the laminates and the fiber reinforced polymers.

Steel (St	tirrups) ×		
Туре	S235(Fe360 ∨		
Constants			
Es <mark>(</mark> Gpa)	210		
Fyk (Mpa)	235		
γsu	1.15		
γss	1		
Max Deform	Max Deformations		
εs	0.02		
ОК	Cancel		

The performance objective and the accessibility level are defined following the same procedure as for the definition of the concrete jacket.

Input data "Input data": Set the input data for the "Steel Laminates" or the "FRPs" for the Left support supports and the span of the beam. Span Beam structural reinforcement Top flange Length (cm) 0 Right support Thickness (mm) 0 Sika The same in both sides Report Width (cm) 0 Anchorage (cm) 0 The side-rebars are taken into consideration The additional rebars are taken into consider Number of layers 1 Rehabilitation Default Not participate in bending Protection Right side Left side Length (cm) 0 Thickness (mm) 0 Length (cm) 0 Thickness (mm) 0 Width (cm) 0 Anchorage (cm) 0 Width (cm) 0 Anchorage (cm) 0 Number of layers 1 Number of lavers 1 Not participate in bending Not participate in bending Strips' data Strips' data Continuous placement Continuous placement Width (cm) 0 Spacing (cm) 0 Width (cm) 0 Spacing (cm) 0 Automatic thickness calculation Design Checks Bottom flange Length (cm) 0 Thickness (mm) 0 Width (cm) 0 Anchorage (cm) 0 Number of layers 1 Not participate in bending Ultimate Moment Resistance Initial Reinforced ОК Cancel



In the dialog box "Beam Reinforcement" that appears, the input data per side of the cross-section (top, bottom, left the side, right side) are defined. There is also a window in the dialog box, where the results of the design checks are summarized.

The calculations and the design checks of the beam are the same with the checks for the column presented in Chapter A.

For the existing side rebars to be taken into consideration in the calculation of the ultimate moment resistance of the cross-section, you activate the following checkbox:

The side-rebars are taken into consideration

For the existing additional steel reinforcement in the supports of the beam to be taken into consideration in the calculation of the ultimate moment resistance of the cross-section, you activate the following checkbox:

The additional rebars are taken into consideration

If you activate the following checkbox The same in both sides then, the "Right Side" field is deactivated and receives the same input parameters as they are defined in the "Left Side" field.

Right side					
Length (cm)	120				
Thickness (cm) 0					
Do not participate in the bending resistance check					
Rebars					
Corner d	6 🗸 🗌				
Internediate 0 d	6 🗸 🗌				

If you select the **"Default"** button, then, the corresponding length of the supports and the span are automatically defined. The support's length is the critical length and the span's length is the total length of the beam minus the critical of the two supports. The calculated lengths correspond to the reinforcing length.

Ultimate Moment Resistance				
Initial	Reinforced			

In the "Ultimate Moments Resistance" field, if you select the button "Initial" or "Reinforced", then the ultimate bending resistance is calculated of the existing or the reinforced cross-section, respectively.



#### Input parameters in the fields "Top" and "Bottom"

Top flange Length (cm Width (cm)	) 50 25	Thickness (m Anchorage (	im) 1 icm) 40			
Number of l	Number of layers 1					
Not part	icipate in	bending				
	•	• •				

If you activate the "Not considered in the bending resistance check" checkbox, the corresponding concrete jacket or the additional concrete layer are not taken into consideration in the calculation process of the reinforced cross-section.

The length of the laminate is defined as the length of the concrete jacket. The width of the laminate is defined at first equal to the width of the corresponding side. The definition of the anchorage length is mandatory and the program at first sets a value by default and it can be modified by the user. The number of the layers is the number of the layers of the reinforcement.

Left side Length (cm) 40 Thickness (mm) 1 Width (cm) 50 Anchorage (cm) 33	· · ·
Number of layers 1	
Strips' data	
Continuous placement	
Width (cm) 0 Spacing (cm) 0	

Input parameters in the fields "Left Side" and "Right Side"

The definition of the reinforcement's geometry is defined with a similar way to the one of placing reinforcement on the top and the bottom of the cross-section. The checkbox about the non-consideration of the laminates of the left and right side in the bending resistance of the cross-section is already activated because they provide strength to the cross-section mainly against shear failure.



The placement of the laminates can be uniform or in strips; continuous or discontinuous with intermediate spacing. Activate the "Continuous Formulation" in the "Strips' data" field and define the width of the laminate. For considering the discontinuous formulation, deactivate the previous checkbox and define the spacing between the strips.

By selecting the "Design checks" command, the program calculates and presents the minimum thickness  $t_1$  and  $t_2$  per side, in the checks' results concerning the cross-section of the laminate and the type of the material. Then, the thickness  $t_1$  and  $t_2$  are calculated again concerning the minimum values of  $t_1$  and  $t_2$  and the design checks have to be repeated. Since the calculation of the thickness  $t_1$  and  $t_2$  is an iterative method, select the button "Automatic calculation of the

thickness" Automatic thickness

Then the program calculates automatically the final minimum thickness  $t_2$ , which is presented in the window in the bottom of the dialog box. Then, you have to set this calculated value in the corresponding field and repeat the final design checks.

▲ The structural adequacy of the laminate or the FRP is reached with the increase of the thickness or the number of the layers.

**Report** Finally, select the command "Report" and the results of the design checks will be added in the corresponding chapter of the Report.

For each modification in the steel laminate or the FRPs, repeat the selection of the command "Report" in order the final report of the study to be updated.

## NOTES:

Furthermore, in SCADA Pro, the techniques and the material considered in each retrofitting method are enriched with the corresponding material and techniques of the company Sika and EM4C. The user has direct access to the library of Sika and/or EM4C materials by pressing the

relative button **EM4C**, which appears in the dialog boxes related to beam reinforcement. The buttons "Rehabilitation" and "Protection" correspond to a dialog box each with tools related to the rehabilitation and protection of the beam structural elements according to the Code of Structural Interventions.

Rehabilitation
Protection

Sika



Concrete Repair		
	1/5	
Corrosion Protection Materials used on the surface that act as c	orrosion	
inhibitors for the steel reinforcement of the concrete structures and applied by impregr	reinforced hation.	
Concrete Repair		The user can select one of the th
Repairing mortars for the structural rehabi concrete members.	litation of	rehabilitation and protection
Crack Filling		methods by activating the
Cementitious binding materials for the struct rehabilitation of the concrete cracking, well	:tural ded and / or	corresponding checkbox
Infilied.		
Printout	Rehabilitation - Protection	By selecting the command
Add Delete	Concrete Repair	Printout
Protection	Corrosion Protection     Materials used on the surface that act as corrosion	
Fire Protection Layers	inhibitors for the steel reinforcement of the reinforced concrete structures and applied by impregnation.	the correspondi
Fire resistant mortars applied by using epo:	Concrete Repair	information will be imported in t
Concrete layers or coating	Repairing mortars for the structural rehabilitation of concrete members,	information will be imported in t
Repairing mortars of one or more compone protective coating.	Crack Filling	final report of the study.
Paint Protection	Cementitious binding materials for the structural rehabilitation of the concrete cracking, welded and / or	
Plastic-elastic paint protection for concrete	and infilled.	
	EM4C Sika	
EM4C Sika	Printout Add Delete	
OK	Aud Delete	
UK	Protection Fire Protection Lavers	
	Fire resistant mortars applied by using epoxy resin.	
	Concrete layers or coating	
	Repairing mortans of one or more components for final	
	protective coating.	
	Plastic-elastic paint protection for concrete and coatings.	
	EM4C Sika	
	OK Cancel	
he corresponding str		
he corresponding str		



The following definition takes place according to the local axes of the beam (according to the direction that it was drawn: from left to right and vice versa). For that reason always activate the view of the local axes before the input of the reinforcing method.

	Input data
	Left support
13	Span
	Right support

A Prerequisite for the appearance of the label is that you have first selected the "Report" button in the dialog box of the corresponding beam reinforcing method.