

Analysing a two span slab using Structural Toolkit

In this tutorial:

- Slab Member Analysis using Structural Toolkit Analysis
- Slab Member Moment Capacity check using Structural Toolkit
- Slab Member Deflection check using Structural Toolkit
- Slab Member Comparison using RAPT (Reinforced And Post-Tensioned Concrete design software)

This will be a two span continuous slab (4.9m in the left span and 4.2m in the right span) with office type loading

Step 1 – Slab Member Analysis using Structural Toolkit Analysis

Using Structural Toolkit Analysis we will determine the positive and negative moments using pattern loads.

We will determine the maximum positive moment from the live load in the larger left span, and maximum negative moment with live loads in each adjacent span.

To start, create a new Analysis in Structural Toolkit Analysis.

Select the predefined pattern loadcase combinations.

🖊 Model	Message	×
	Select combination set: 1.35 DL*g, 1.2 DL*g + 1.5 LL1, 1.2 DL*g + 1.5 LL2, 1.2 DL*g + 1. ▼	
	OK Cancel	

Figure 1 – Loadcase Combinations

Rename the document name to something sensible. (Remember to save the project also).

S Docum	ent Message	×
1	Enter the new document name for 'Analysis A01':	
	Slab Analysis SL1	
	OK Cancel	

Figure 2 – Analysis Name

Enter the frame geometry

Type Ctrl-D and then hit the "0" key to bring up the input coordinate dialog.







Figure 3 – Node Input Diaglog

Press enter to create the node, the type "@4.9" to create the next node relative to the first node.



Figure 4 – Node Input Dialog (after first node)

Repeat for the next span being 4.2m.

Right click and assign a **Pinned** restraint to the left end.

	Select	۲					
\mathbb{T}	Filter	۲					
뭄	Groups	٠					
	Selection (1N,0R,0M)	•					
Θ	Node Selection	►	7	Assign Restraint	•	-	None
	Drag Node		ŧ	Add Node Load	×		Pinned
	Rename Object			Clear Node Loads			Fixed
æ	Add Annotation		_				Pinned2D
5	Regenerate All						RollerX
		_					RollerX2D





Anthony Furr Software ABN 74 992 513 430



Assign restraints to the other two nodes using the RollerX2D. Remember to provide a pin for one support, and rollers for the others (this is not essential for a linear analysis that is horizontal, but good practise.)



Figure 6 – Beam geometry

Create the section

Enter the gross section shapes for each span. In this example we will use a 170mm thick section (x 1m strip).

First Rename the section for good practise.

Figure 7 – Rename Section Dialog

Change the **Material** to **CONCN32** (predefined value of Concrete with 32MPa strength) and change the **Input** to **Shape**.

Nections (1)	_
ID: Slab 🗸 📝 💽 🗖 🥖 💿 🔂 🛅	
Properties	
Material: CONCN32	
Input: Shape 💌 📝 🗌 Used by Haunch	
Library: Concrete 👻 Select	
Figure 8 – Section Properties (Material)	

Select the Rect shape for the Profile and assign a shape of:

D = 170mm Bf = 1000mm





<mark>∕ L</mark> Sect	ion Properti	es		×							
ID: S	lab	~ 📝 I	3 5 🕫 🕡 💿 🖪								
Proper	ties										
Materi	Material: CONCN32 V 📝 leff/lg: 1										
Input:	Input: Shape V 📝 Used by Haunch										
Librar	y: Steel	\sim	Select 🔺								
] Flip XX] Flip YY] Flip XY								
Name	:										
Desc:											
Values	: (Calculated	by shape)									
Profile	e: Rect	~									
D.	170.0	L	Df. [1000]								
<i>D</i> .	170.0]									
Values	: Shape										
A:	170000	mm²	qθ: 0.000 °								
bc:	409.4	x10 ⁶ mm⁴	ly: 14166.7 x10 ⁶ mm ⁴								
J:	23396556.4	x10³mm⁴	lw: 0.0 x10 ⁹ mm ⁶								
Zxt:	4816.7	x10³mm³	Zyr: 28333.3 x10 ³ mm ³								
Zxb:	4816.7	x10³mm³	Zyl: 28333.3 x10 ³ mm ³								
xcl:	500.0	mm	yct: 85.0 mm								
Fyf:	320.0	MPa	Fyw 320.0 MPa								

Figure 9 – Section Properties (Profile)

You may also want to open the **Material** properties and change the **Concrete Density** to 2500kg/m³ and open the **Cases** (Loadcases) and change within the **DL** case **Gravity** to **-10**m/s² (to have the results align with RAPT outputs for this example).



Anthony Furr Software ABN 74 992 513 430



<mark>∕</mark> Sect	tion Properti	es				×					
ID: S	lab	· 📝 🗄		90	d						
Proper	ties										
Mater	ial: CONCN	32 ~	2	leff/lg: 1							
Input:	Shape	~	7	Used b	y Haur 🖊	Materia	I Properties				×
Librar	y: Steel	\sim		Selec	t	ID: CON	CN32 ~		• •	900	
] Flip XX] Flip YY	Flip X	Y		Properties					
Name	c					E:	30406	MPa	G:	12669	MPa
Desc:						Density:	2500	kg/m³	Creep:	3.333333333	
Values	: (Calculated I	by shape)				Poisson:	0.2				
Profile	e: Rect	~	2			Thermal:	1E-05	L/L/°C	Fu:	32.0	MPa
D:	170.0] mm	Bf:	1000.0] mm	Desc:	32MPa Conc	rete			
						Render					
						Group:	Concrete		\sim		_
Values	: Shape						Concrete ind				1.2
A:	170000	mm²	qθ:	0.000	•		Concrete.jpg			1.4.4.4.4	100
bx:	409.4	x10 ⁶ mm⁴	ly:	14166.7	x10 ⁶ n	Scale:	1			ALC: NO.	
J:	23396556.4	x10³mm⁴	lw:	0.0	x10 ⁹ n				Ass	sian	Close
Zxt:	4816.7	x10 ³ mm ³	Zyr:	28333.3	x10 ³ n				1.00		
Zxb:	4816.7	x10 ³ mm ³	Zyl:	28333.3	x10 ³ mm	3					
xcl:	500.0	mm	yct:	85.0	mm						
Fyf:	320.0	MPa	Fyw	320.0	MPa						
	Sł	nape Editor	A	ssign	Close						

Figure 10 – Material Properties Dialog





Loadcases X
ID: DL 🗸 🗸 📝 💽 🗖 🚺 📴 🗐
Load Type
Type: Dead Incl. Swt 🗸
Gravity:
X: 0.000 Y: 10 Z: 0.000 m/s ²
Default Applied to Case
Description
Desc: Dead Load Case
Loads
NPLs: V
MPLs: V
MUDLs: V
Close

Figure 11 – Loadcases Dialog

Define the loads

Use the Load Definitions (below the Loads button) to define the loads.

```
Add a superimposed dead load of WsdI = -0.5kN, and a live load of WII = -(3.0 + 1.0)kN = -4.0kN
```

When applying these load definitions to members, this load can be either a point loads (kN), or a start or end distributed load (kN/m).



Anthony Furr Software ABN 74 992 513 430



🖊 Load Defi	nitions (0)				×
ID: Wsdl	•] 🗖 💆	3 🕕 🗟	
- Load Value	s				
FX:	0.00	kN	MX:	0.00	kNm
FY:	-0.5	kN	MY:	0.00	kNm
FZ:	0.00	kN	MZ:	0.00	kNm
Description					
Desc:					
		(
		l	Apply		llose

Figure 12 – Load Definitions Dialog

Change to the **DL*g** case in the Case selector in the ribbon to assign the **Wsdl**.

Restraints	📥 🔯 Cases:	DL *g 🗸 🗸
🗆 🗌 Prima	ary	
🗸 D	L*g	
LL	.1	
L	2	
	SWt *g (Auto)	
 ✓ ✓ 		Close

Figure 13 - Loadcases

NOTE: the "*g" is automatically added to cases where the gravity is applied.

Assign the load by first selecting the members, then **right click > Member Selection > Add Member UDL** and select the **WsdI** from the defined loads.

NOTE: If there are more than 10 loads defined, this right-click feature will not be available and you will need to define loads in the **Loads dialog**.



Anthony Furr Software ABN 74 992 513 430





Figure 14 – Assign Member UDL

NOTE: Remember to hit the Esc key between selections to cancel the previous selection set.

Change the Case to LL1 and assign the live load WII to the first span (M1).

Change the Case to LL2 and assign the live load WII to the second span (M2).

Check that all loads are correctly applied by toggling through the Cases selector.

Analyse

Press F5 to perform a linear analysis.

You may get a message regarding creep. This simply reminds you that the concrete long term deflections will not be calculated and the deflections are gross uncracked.





Λ	Model N	Nes	sage								×
	Frame Wa	ami	ngs							<u>^</u>	
	The follow	ing	warnings hav	ve been ident	ified:						
	Warning	: ;	Material	CONCN32,	Creep	not	applied	(Creep=3	.33)		
				E	Copy t	o clip	board		Continue	Abort	

Figure 15 – Creep Warning Dialog

Press F6 to show the Bending Moment diagram (this shows automatically on first analysis).



Figure 16 - Bending Moment Analysis

M*+ = 30.81kNm (first span) M*- = 23.85kNm (at central support)



Anthony Furr Software ABN 74 992 513 430 97 Mt Pleasant Road Nunawading, Victoria 3131 **P** 03 9878 4684 **F** 03 9878 4685 www.structuraltoolkit.com.au support@structuraltoolkit.com.au



Step 2 – Slab Member Moment Capacity check using Structural Toolkit

Now we have our maximum positive and negative design moments, we can use the **Structural Toolkit Concrete Member** to check the flexural capacity.

Create a new **Concrete Member** within **Structural Toolkit** and enter the Depth (170mm), concrete strength (32MPa) and web width of "S" type representing a slab.



Figure 17 - Concrete Geometry Inputs

Press the [Analysis] button in the side Notes section and create a linked analysis.

First, for the larger span enter a span of 4900mm, and the loads Wsdl = 0.5kN/m and the Wll = 4.0kN/m. Self weight is automatically calculated based on the thickness entered in the Design module.

Set the span type as "O" other to manually input the end moments and in the right side **M2***, enter the negative value at the central support. From the analysis, this is **-24.7kNm** corresponding to the greater sag case of **+23.9kNm**.





ts Anthony Furr Software				Pro Ado	dress of Proj Architect	ect ject	Page: Project No.: 15-0001 Designed: TF Concrete Member CB(
ALYSIS V5.0	00							Anthon	y Furr Softv	
ometry for (Co	oncrete Memb	er CB01): bean	n with end mon	nents						
	Description =	170mm thk sla	ıb			(x =	409.4	x10 ⁶ mm ⁴		
	Span (L) =	4900	mm			Ag =	170000	mm²		
	Span type =	0	(S)imple, (E)xte	rior, (I)nterior,		Density =	25.0	kN/m³ (Conci	rete)	
		(C)antilever, (F)ropped, (F)ixed	d, (O)ther		E =	30024	MPa		
ding										
		Uni	form loads (kN/	′m)				Point loads (kl	N)	
I	Uniform loads	UDL	Partial 1	Partial 2		Point loads	PL 1	PL 2	PL 3	
Dea	d load (wdl) =	0.50			D	ead load (pdl) =				
Li	ve load (wll) =	4.00				Live load (pll) =				
Start fro	m LHS (mm) =	0			Pos. fi	rom LHS (mm) =	0.00	0.00	0.00	
End fro	m LHS (mm) =	4900	kN/m		Ultir	nate load (p*) =	0.00	0.00	0.00	
l Iltima	=) w.c = (*w) beal at	4.25	0.00	0.00		Include S W/+ -	v	(V)es (N)o		
onina	(e 1080 (W-) =	11.70	0.00	0.00		menude 5.wt =		11/63/14/0		
Liv	/e Load type =	Floor	(Concrete)	1.00		oft and (M18)	0.0	khim		
Short te	erm LL (Ψsu) =	0.70	(Ψsp) =	1.00	L Di	eft end $(M1^{\circ}) =$	-24.7	kNm		
Long to	ualii (Ψiu) =	0.40	(ΨIp) = (ΨIa) =	0.40	n.i	gitt end (iviz ') =	-24.7	KINITI		
ults at midsp	an	0.70	(+10) -	0.40	Positio	on of result (x) =	2450	mm		
				1	.20*G+1.50	*Q analysed - 1.35	5*G case to b	e checked	_	
	Left	At x	Right	Max	At	Min	At	Units		
Rdl	9.59		13.68					kN		
RII	8.08		11.52					kN		
R*	23.62		33.71					kN		
M*	0.00	22.76	-24.70	23.85	2015	-24.70	4900	kNm		
V*	23.62	-5.04	-33.71	33.71	4900			kN	Span ,	
δdl	0.00	1.68	0.00	1.68	2450	0.00	0	mm	2923	
5.000	0.00	1.41	0.00	1.41	2450	0.00	0	mm	3471	
oai+Ψs*öll	0.00	2.66	0.00	2.66 δPII/δTot.II = (2450	0.00	0	mm	1839	
phs		* Deflections a	ire Gross Ig imm	nediate - assess	ment of long	; term effects to b	e considered			
-30.0				Bending (kNm)					
-20.0										
-10.0	500	1000	1500	2000	2500	3000 38	00 4	1000	800	
0.0								-9.6	++++	
10.0 00							4.7			
20.0	10,2	17.5			╺╪╼┿╾┿╸	12.2		+ $+$ $+$ $+$ $+$	+ $+$ $+$ $+$	
30.0			221	فالمووا	2.4	10.5				

Press the [Switch to Design...] button in the side Notes area to return to the Concrete Member design module.

Press the [Max M+*] to begin designing the section for the positive moment and enter bar sizes of 12mm and at centres of 250mm (N12-250) as the bottom reinforcement with 20mm bottom cover, and bar sizes of 12mm at centres of 300mm (N12-300) as the top steel, again with 20mm cover.





	0	Pro	posed Proj	ect		Page:
ate	-	Ado	lress of Pro	ject		Project No.: 15-0001
ars	Anthony Furr Software		Architect			Designed: TF
					Cor	ncrete Member CB
CONCRETE M	IEMBER V5.00					Anthony Furr Softw
ection:	(Concrete Member CB01) 170m	n thk slab, f'c=32MPa				
leinf't:	N12-300 cts top, N12-250 cts bo	ttom, ku = 0.07				
trength:	(+ve M) M* = 23.9kNm < øMuo	= 24.8kNm (øMuo.min = 1	5.3kNm)			OK (0.96)
	Ast.req'd = 426mm ² (N12-260)					
racking:	fscr = 252MPa < Fscr = 297MPa	& fscr1 = 292MPa < Fscr1 =	400MPa			OK (0.73,0.85)
st.min:	Ast.min = 272mm² < Ast = 452m	m² (Minimum of Deemed a	nd actual)			OK (0.60)
ieometry	S.Wt =	4.25 kN/m			L/D ratio =	28.8
	Concrete strength (f'c) =	32 MPa				
	consistent strength (i of	0 111 0				
	Depth (D) =	170 mm				
	Web width (W) =	S mm, (S)lab				
						Comp.
						Tension
	Slab type =	0 (O)ne way, Two	way & (C)ol	s, (T)wo way & v	alls, (F)ooting	t.
				Formwork =	S	(S)tandard,(R)igid
	Concrete weight =	25.0 kN/m³		Exposure Top =	A1	Tab 4.10.3.2
	Fully enclosed =	N (Y)es,(N)o		Bottom =	A1	Tab 4.10.3.2
	Gross area (Ag) =	170000 mm ²				
nalysis: beam	with end moments at 2015mm fr	om LHS (Max +ve M)				
	Analysis values =	X (M)anual, (L)eft	Position (X) from analysis, (R)ight	
	Analysis values =	X (M)anual, (L)eft	, Position (X) from analysis, (R)ight	
	Analysis values = Refer to the analysis out	X (M)anual, (L)eft	Position (X) from analysis, (Max+	R)ight Right	Units
	Analysis values = Refer to the analysis out	X (M)anual, (L)eft put M*	Position (X Left 0.0) from analysis, (Max+ 23.9	R)ight Right -24.7	Units kNm
	Analysis values = Refer to the analysis out	X (M)anual, (L)eft put Ms1*	Position (X) Left 0.0 0.0) from analysis, (Max+ 23.9 17.8	R)ight Right -24.7 -18.5	Units kNm kNm
	Analysis values = Refer to the analysis out	X (M)anual, (L)eft put M* Ms1* Ms*	Position (X)) from analysis, (Max+ 23.9 17.8 15.4 426	R)ight -24.7 -18.5 -15.9	Units kNm kNm kNm
	Analysis values = Refer to the analysis out	X (M)anual, (L)eft put M* Ms1* Ms* Ast req d	Position (X Left 0.0 0.0 0.0 0) from analysis, (Max+ 23.9 17.8 15.4 426	R)ight -24.7 -18.5 -15.9 442 237	Units kNm kNm mm²/m
	Analysis values =	X (M)anual, (L)eft put M* Ms* Ast req d Ast req d Point sec id	Position (X Left 0.0 0.0 0.0 0 452) from analysis, (<u>Max+</u> 23.9 17.8 15.4 426 452 N13.360	Rjight -24.7 -18.5 -15.9 442 377	Units kNm kNm mm²/m mm²/m
	Analysis values = Refer to the analysis out	X (M)anual, (L)eft put M* Ms1* Ms* Ast req'd Ast Reinf't req'd	Position (X Left 0.0 0.0 0.0 0 452 -) from analysis, (R)ight -24.7 -18.5 -15.9 442 377 N12-250	Units kNm kNm mm²/m mm²/m
einforcement	Analysis values =	X (M)anual, (L)eft put M* Ms1* Ms* Ast req'd Ast Reinf't req'd	Position (X <u>Left</u> 0.0 0.0 0.0 452 -) from analysis, (R)ight -24.7 -18.5 -15.9 442 377 N12-250	Units kNm kNm mm²/m mm²/m
einforcement	Analysis values = Refer to the analysis out Bottom steel = <u>N1</u>	X (M)anual, (L)eft put M* Ms1* Ms* Ast req'd Ast Reinf't req'd 2-250 cts	Position (X Left 0.0 0.0 0.0 452 -) from analysis, (<u>Max+</u> 23.9 17.8 15.4 426 452 N12-260 Top steel =	R)ight -24.7 -18.5 -15.9 442 377 N12-250 N12-300 cts	Units kNm kNm mm²/m mm²/m
einforcement	Analysis values = Refer to the analysis out Bottom steel = N1 Bar size =	X (M)anual, (L)eft put M* Ms1* Ms* Ast req'd Ast Reinf't req'd 2-250 cts 12 mm Mesn	Position (X Left 0.0 0.0 0.0 452 -) from analysis, (23.9 17.8 15.4 426 452 N12-260 Top steel = Bar size =	R)ight Right -24.7 -18.5 -15.9 442 377 N12-250 N12-300 cts 12	Units kNm kNm mm²/m mm²/m
einforcement	Analysis values = Refer to the analysis out Bottom steel = N1 Bar size = Bar cts/No/mm ² =	X (M)anual, (L)eft put M* Ms1* Ms* Ast req'd Ast Reinf't req'd 2-250 cts 12 mm Mesn.	Position (X Left 0.0 0.0 0.0 452 - Ba) from analysis, (23.9 17.8 15.4 426 452 N12-260 Top steel = Bar size = r cts/No/mm ² =	R)ight Right -24.7 -18.5 -15.9 442 377 N12-250 N12-300 cts 12 300	Units kNm kNm mm²/m mm²/m
einforcement	Analysis values = Refer to the analysis out Bottom steel = N1 Bar size = Bar cts/No/mm ² = Yield strength (fsy) =	X (M)anual, (L)eft put M* Ms1* Ms* Ast req'd Ast Reinf't req'd 2-250 cts 12 mm Mesh 500 MPa	Position (X Left 0.0 0.0 0 452 - Ba Yield s) from analysis, { Max+ 23.9 17.8 15.4 426 452 N12-260 Top steel = Bar size = r cts/No/mm ² = strength (fsyc) =	R)ight Right -24.7 -18.5 -15.9 442 377 N12-250 N12-300 cts 12 300 500	Units kNm kNm mm²/m mm²/m mm Mesn ◄
einforcement	Analysis values = Refer to the analysis out Bottom steel = N1 Bar size = Bar cts/No/mm ² = Yield strength (fsy) = Bottom cover to steel =	X (M)anual, (L)eft mut M* Ms1* Ms* Ast req'd Ast Reinf't req'd 2-250 cts 12 mm 2500 ▼m 500 MPa 20 mm	Position (X Left 0.0 0.0 0 452 - Ba Yield s Top) from analysis, { Max+ 23.9 17.8 15.4 426 452 N12-260 Top steel = Bar size = r cts/No/mm ² = trength (fsyc) = cover to steel =	R)ight Right -24.7 -18.5 -15.9 442 377 N12-250 N12-300 cts 12 300 500 20	Units kNm kNm mm²/m mm²/m mm Mean (4) MPa mm
einforcement	Analysis values = Refer to the analysis out Bottom steel = N1 Bar size = Bar cts/No/mm ² = Yield strength (fsy) = Bottom cover to steel = Steel area (Ast) =	X (M)anual, (L)eft put M [*] Ms1 [*] Ms [*] Ast req'd Ast Reinf't req'd 2-250 cts 12 mm Mesh. 250 ▼m 500 MPa 20 mm 452 mm ² /m	Position (X Left 0.0 0.0 0 452 - Ba Yield s Top St) from analysis, { Max+ 23.9 17.8 15.4 426 452 N12-260 Top steel = Bar size = r cts/No/mm ² = itrength (fsyc) = cover to steel = teel area (Asc) =	R)ight Right -24.7 -18.5 -15.9 442 377 N12-250 N12-300 cts 12 300 500 20 377	Units kNm kNm mm²/m mm²/m mm Mean 4 mm MPa mm mm²/m
einforcement	Analysis values = Refer to the analysis out Bottom steel = N1 Bar size = Bar cts/No/mm ² = Yield strength (fsy) = Bottom cover to steel = Steel area (Ast) = Ductility class =	X (M)anual, (L)eft mut M [*] Ms1 [*] Ms [*] Ast req'd Ast Reinf't req'd 2-250 cts 12 mm Mesh 500 MPa 20 mm 452 mm²/m A (N)ormal,(L)ow,	Position (X Left 0.0 0.0 0 452 - Ba Yield s Top St (A)uto) from analysis, (Max+ 23.9 17.8 15.4 426 452 N12-260 Top steel = Bar size = r cts/No/mm ² = itrength (fsyc) = cover to steel = iteel area (Asc) = Ductility class =	R)ight Right -24.7 -18.5 -15.9 442 377 N12-250 N12-300 cts 12 300 500 20 377 A	Units kNm kNm mm²/m mm²/m mm MPa mm MPa mm mm²/m (N)ormal,(L)ow,(A)uto
<u>einforcement</u>	Analysis values = Refer to the analysis out Bottom steel = N1 Bar size = Bar cts/No/mm ² = Yield strength (fsy) = Bottom cover to steel = Steel area (Ast) = Ductility class = Reinf't ductility class =	X (M)anual, (L)eft M* Ms1* Ms* Ast req'd Ast Reinf't req'd 2-250 cts 12 mm Mesh 250 m 500 MPa 20 mm 452 mm²/m A (N)ormal,(L)ow, N (N)ormal,(L)ow	Position (X Left 0.0 0.0 0.0 452 - Ba Yield s Top St (A)uto Reinf't) from analysis, (Max+ 23.9 17.8 15.4 426 452 N12-260 Top steel = Bar size = r cts/No/mm ² = itrength (fsyc) = cover to steel = ieeel area (Asc) = Ductility class =	R)ight Right -24.7 -18.5 -15.9 442 377 N12-250 N12-300 cts 12 300 500 20 377 A N	Units kNm kNm mm²/m mm²/m mm MPa mm MPa mm mm²/m (N)ormal,(L)ow,(A)uto (N)ormal,(L)ow

The summary at the top indicates that the section capacity is **OK** for the positive moment case.

For the negative bending, we can not simply transfer the moment, because the pattern load we have input into the Analysis module was for the maximum deflection and sage case. So we need change the **Analysis values** to "M" manual method and enter the –ve moment of $M^* = -30.8$ kNm.





The Essential Design Tool For Australian Structural Engineers

CONCRETE	MEMBER V5.00						Furr Consulting Pty Ltd
Section:	(Concrete Member (801) 17	0mm thk slab.	f'c=32MDa				
Reinf't:	N12-200 cts top. N12-400 ct	s hottom, ku =	0.09				
Strength:	$(-ve M) M^* = 30.8kNm < dN$	1uo = 31.0kNm	(«Muo min = 16	(AkNm)			OK (0.99)
Strengtin	$Ast reg/d = 556 mm^2 (N12-20)$	100 - 51.0000	(pivido.iiiii - 10				01 (0.55)
Cracking	for = 264MDa + Ecc = 297M	10) 102 8. feer1 - 20	MADa + Eccel -	400MD>			04 (0.76 0.89)
Actimin	$Act min = 272 mm^2 < Act = 570$	Factisci = 50	wm of Doomod r	400 WiFa			OK (0.78,0.85)
Ast.min:	Astimin - 272mm- < Ast - 5	minim) -mmce	um or Deemed a	ind actual)			OK (0.48)
Geometry	S.Wt =	4.25	kN/m			L/D ratio =	47.1
	Concrete strength (f'c) =	32	MPa	_			
	Span (L) =	8000	mm				
	Depth (D) =	170	mm				
	Web width (W) =	5	mm (S)lab				
	tres triatin (tr) =	J	mm, (o)nuo				Comp
							Tension
							Tension
	Slah tune -	0	(O)ne way Two	way & (Clok	(T)wo way & w	valle (E)opting	
	Siab type =	0	(Office way, 1wo	way a (c/oi:	Eormwork -	ans, (P)ooting	(S)tandard (B)igid
	Concrete weight -	25.0	kN/m ³		Exposure Top =	۵1 ۵1	Tab 4 10 3 2
	Eully enclosed =	23.0 N	(V)es (N)e		Bottom -	A1	Tab 4.10.3.2
	Gross area (Ag) =	170000	(T/es,(N/O		Bottom =	~	140 4.10.3.2
Decign action	Gross area (Ag) =	170000	mm				
Design action	3						
	Analysis values -	М	(M)anual (L)eft	Position (V)	from analysis /	P)ight	
	Analysis values =	141	(wi)anual, (c)erc	, Position (A)	from analysis, (() BIL	
	Manual value			Manual	Unite		
	Design (M*) - 20.8	kNm/m	M*	20.9	kNm		
	Design (Ms1*) =d	kNm/m	M-18	-30.0	kNes		
	Design (Ms1) = d	kNm/m	Mc*	-25.1	kNes		
	Design (Mis-) = a	KNM/m	Act roald	-20.0	mm ²		
			Astrequ	550	mm ²		
			Ast Deinfit regid	205 N12 200	mm-		
	Fatimeter for Matt and Matter	ad To be used	Keinittregia	N12-200			
Dainfanaanaa	Estimates for Wist and Wish us	ed - To be verif	ieu				
Kennorcemen							
	Pottom stool =	N12 400 ctc			Ton steel =	N12 200 etc	
	Bottom steel -	12-400 Cts	Mesh	4 b	Par size =	12-200 Cts	mm Meth
	Dar size =	12			Bar size =	12	
	Bar cts/No/mm ⁻ =	400	mm MB-	Violder	cts/NO/mm =	200	mm MP-
	rield strength (tsy) =	500	IVI Pa	Teld S	trength (fsyc) =	500	MPa
	Bottom cover to steel =	20	mm 2 (lop	cover to steel =	20	mm
	steel area (Asc) =	283	mm ⁻ /m	(A)ut=	eel area (Ast) =	565	mm*/m
	Ductility class =	A	(N)ormal,(L)ow,	(A)uto	Ductility class =	A	(N)ormal,(LJow,(A)uto
	Reinfit ductility class =	N	(N)ormal,(L)ow	Reinfit d	suctility class =	N	(Njormal,(Ljow
Depth	to bottom steel layer (ds.max) =	144	mm	Depth to t	op steel layer =	26	mm
	Depth to bottom steel (ds) =	144	mm	Dept	h to top steel =	26	mm
	D-ds =	26	mm		D-ds =	144	mm
	No. bars =	2.5	No.	Nogethie	No. bars =	5.0	No.
	Fig	uie 20 – COľ		(iveyalive l		y	

Enter the top reinforcement of 12mm bars at 200mm centres (N12-200), and the bottom reinforcement of 12mm bars at 400mm centres (N12-400) (cover as previous).

The summary at the top indicates that the section capacity is **OK** for the negative moment case.



Anthony Furr Software ABN 74 992 513 430



Step 3 – Slab Member Deflection check using Structural Toolkit

To check the deflections, we first we need to set up the reinforcement again for this span.

Enter the N12-250 bars in the bottom and N12-200 bars in the top on the [Design] sheet.

Go to the [DefI] tab and press the [Max. Deflection] button in the Notes.

Press the **[Transfer Reinf't]** to transfer the reinforcement to the Defl tab. Note that some of the reinforcement areas do not transfer as the steel is in a compression zone which is in tension.

NOTE: If you enter the value manually in the middle span top reinforcement you will notice an error message further down advising that the top compression reinfrocement is actually in tension and should be ignored.

NOTE: Ensure you go to the **[Shrink & Creep]** tab to set the exposure and location of the slab (ie. Environment and City) which will affect the σcs which in turn affects Mcr which then alters the deflections.





		Pr Ad	oposed Proj dress of Pro Architect	i ect ject	Page: Project No.: 15-0001 Designed: TF
				C	Concrete Member CB01
CONCRETE MEMBER V5.00					Anthony Furr Software
Section: (Concrete Member CB01) 1 Reinf't: N12-200 cts top, N12-250 c Defl'n: $\delta.dl = 6.4$ mm, $\delta.ll = 1.9$ mm, ocs for Interior environmen Deflections: C1 8 - 2 Aeaa with and magnetized	70mm thk slab, ts bottom (Addit δ.inc = 10.4mm t with εcsd.b*=1	f'c=32MPa tional reo speci , δtotal = 13.6n 000x10 ⁻⁶ ±30% 4ax +ye Def)	fied) nm (span / 3 , ɛcs*=672x1	59) 0 ⁻⁶	ок
Concerts density (s)	at muspan (n	ha (m3 cl 2 1 2		(1-) 1700	100 mm²
Concrete density (p) Use formi : formi : Deflection at Position (x) : Span type :	= 2400 = Y = 35.3 = X = 2450 = O	kg/m² Cl 3.1.3 (Y)es,(N)o MPa (M)anual, (C)rii mm Mod. of ela	G Uncr.g. ne Gros tical, (L)eft, P Stee Stee St. (Ec = p ¹⁻⁵ Modular ra	rross area (Ag) = 1700 utral axis (NA) = is Stiffness (ig) = 4 tosition (X) from analysis, (R I Modulus (Es) = 2000 *0.043*Vfcmi) = 300 tito (n = Es/Ec) = 6.6	000 mm² 85 mm from top 109 x10° mmª (w/o reinf't) 1jght 000 MPa Cl 3.2.2 024 MPa ± 20% Cl 3.1.2 561
Deflection calculation					
Manual (M*) : Manual (Ms*) : Analysis (M*) : Analysis (Ms*) :	Left 	At x 22.8 14.7	Right -24.7 -15.9	Units kNm kNm kNm Red values kNm	manually input
Top Steel: Ast req'd : Design Ast : Ast :	= 0 = 565 = 0	0	442 565 565 N12-200	mm²/m mm²/m Short ter	m LL factor (ψs) = 0.7
Design Ast req u Design Ast : Ast :	= 452 = 0	400 452 452 N12-250	0	mm²/m mm²/m mm²/m	OS PCP 1 1/11 5/2 2
Uncracked IXA	= 1.000	1.021	1.027	x10 ⁶ mm ⁴	O2 KCP-1.1(1) Fig 2.3
luncrk = uk*W*D3/12	409	418	420	x10 ⁶ mm ⁴	OS RCB-1.1(1) Eq 7.2(2)
Tensile steel (Ast) Depth to ds	= 0 = 144	452 144	565 144	mm ² /m mm (From comp. face)	
Comp. steel (Asc)	= 0	0	0	mm ² /m mm (From comp. face)	
Cracked k = Depth to cracked NA = k*ds Use Comp. steel	= 0.000 = 0.0	0.185 26.6	0.204 29.4	mm mm (From top)	OS RCB-1.1(1) Fig 5.7
yt : Design shrinkage ecs* W (slab) : Tension steel ratio (pw=Ast/(ds*W)) Comp. steel ratio (pcw=Asc/((D-dc)*W))	= 85 = 672 = 1000 = 0.0000 = 0.0000	84 672 1000 0.0031 0.0000	84 672 1000 0.0039 0.0000	mm (From tensile fibre) x10 ⁻⁶ ±30% Interior en mm	v. refer Shrinkage tab
ocs -	= 0.00	0.91	1.10	MPa	< 0.00 MD-
wicr = (Fct.f-dcs)*1g/γt Cracked κc icr=κc*W*ds ³ /12: jef.max:	= 0.000 = 0 = 246	0.192 48 246	0.233 58 246	x10 ⁶ mm ⁴	OS RCB-1.1(1) Fig 5.7
lef	0	246	193	x10 ⁶ mm ⁴	
lav : Patio lunoch / iau -	= (M + R) / 2 valu	ue = 220x10 ⁶ m Juncrk at positi	m⁴ on x		
kcs = [2-1.2*(Asc/Ast)] ≥ 0.8	= 2.000	kcs at position	x		CI 8.5.3.2
Deflection summary - Located at midspan (N	lax +ve Def)				
Gr G Short term δ.short = [δdl.g+ψs*δl	oss δdl.g.imm = ross δll.g.imm = .g]*luncrk/lef =	1.7 1.4 5.1	mm mm	Manual Va Gross ठdl.g.imr Gross ठll.g.imr Short term ठdl.shor	n = 1.26 mm n = 1.47 mm rt = 3.2 mm
Sustained δ.sus = [δdl.g+ψl*δl Long term δ.lo Incremental δ.inc = δ.lo	l.g]*luncrk/lef = ng = kcs*δ.sus = ong + δll.short =	4.3 8.5 10.4	mm mm mm	Short term öll.shor Long term ödl.lon Long term öll.lon Total ödl.tota	rt = 1.9 mm g = 6.4 mm g = 2.2 mm al = 11.7 mm
Total δ.total = δ. Deflection limits	short + δ.long =	13.6	mm	Span / 359	
EDI II.				SDI Har	20
οUL lim. = Span/ 25 δLL lim. = Span/ 30) = 20mm or) = 16mm or		mm mm	οDL lim. = δLL lim. =	20 mm 16 mm
δinc lim. = Span/ 256 δTot. lim. = Span/ 256	0 = 20mm or 0 = 20mm or		mm mm	δLL inc. = δTot. lim. =	20 mm 20 mm

Figure 21 – Concrete Module, Deflections



Anthony Furr Software ABN 74 992 513 430



The Concrete Member module calculates a total deflection of 13.6mm. This compares to the RAPT output of 14mm total deflection (see Appendix A).

END OF TUTORIAL

V5.0.1.2



Anthony Furr Software ABN 74 992 513 430 97 Mt Pleasant Road Nunawading, Victoria 3131 **P** 03 9878 4684 **F** 03 9878 4685 www.structuraltoolkit.com.au support@structuraltoolkit.com.au



Appendix A - RAPT Comparison



Figure A1 – Rapt Frame Geometry







Figure A2 – Shear Force Diagram







Figure A3 - Deflections





	_ 0 🚺
E File Edit View Tools Report Window Help	- 8
Detailed Reinforcement	
Input I Input	of Sets
Image: Max Max Max Section 2 legs 2 legs </td <td>egs 2 legs Shear</td>	egs 2 legs Shear
→ Frame Graphics Locat Size Space Area Depth Width Rebar Regd Area N10 N1 hand mm mm mm mm mm A mm mm mm A mm A mm A	I2 N16 Comments m mm A
U Load Draphics 100 0 0 0 26 1000 No Steel Added 40 300 278.33 144 1000 3 N12 @ 406 0 0	0 0
☑ Warnings 136 0 0 26 1000 No Steel Added 40 300 278.33 144 1000 3 N12 @ 406 0 0	0 0 No shear stee
□ Frame Properties 317 U U U U 20 1000 No Steel Addeed 34 300 276.33 144 1000 3 N12 02 406 U U U	0 0 No shear steel
	0 0 No shear steel
E = Load Combinations 660 0 0 2/26 1000 No Steel Added 16 174.2 321.18 144 1000 3 N12 @ 351.8 0 0	0 0 No shear steel
Column Actions 1041 0 0 0 20 1000 No Steel Addeed to 175.3 355.51 144 1000 4 N12 (2037).3 0 0 0 ■ Uter Steel Addeed to 175.3 355.61 144 1000 4 N12 (2037).0 0	0 0 No shear steel
1633 0 0 0 26 1000 No Steel Added 16 179.3 416.08 144 1000 4 N12 @ 271.6 0 0	0 0 No shear stee
Graphics 2041 0 0 0 26 1000 No SteelAdded 16 180.9 426.55 144 1000 4 N12 @ 264.9 0 0	0 0 No shear steel
Comparison of the second	0 0 No shear steel
Benvice Service 3267 0 0 241.68 26 1000 3 N12 @ 467.6 20 213.1 278.33 144 1000 3 N12 @ 406 0 0	0 0 No shear steel
□ All Spans Loaded 3675 40 300 241.88 26 1000 3 N12 @ 467.6 40 300 278.33 144 1000 3 N12 @ 406 0 0	0 0 No shear stee
Even Spans Loaded 3650 40 300 278.33 26 1000 3 N12 @ 406 40 300 241.68 144 1000 3 N12 @ 467.6 0 0 0 241.68 144 1000 3 N12 @ 467.6 0 0	0 0 No shear steel
Dod spars Loaded Coaded Coaded <thcoadd< th=""> <th< td=""><td>0 0 No shear steel</td></th<></thcoadd<>	0 0 No shear steel
e ➡ Flexural Design 4375 20 202.4 339.91 26 1000 4 N12 @ 332.4 0 0 0 144 1000 No Steel Added 0 0	0 0 No shear stee
Constant 4550 16 17.2.5 442.22 26 1000 5 N12 @ 255.5 0 0 0 144 1000 No Steel Added 0 0 Constant 4764 12 1679 553.49 € 1000 5 N12 @ 255.5 0 0 0 144 1000 No Steel Added 0 0	0 0 No shear steel
a preprince 4899 12 167.2 554.89 26 1000 5 N12 @ 203.6 0 0 0 144 1000 No Steel Added 0 0	0 0
Service Design Comments:-	proement than calculated
 Zemanent Source 1 - Source 1	or cement than calculated.
Span - 1 - Reinforcement added at richt span contrafiexure point for Offset of Bending Moment Diagram for Shara - 45.46mm2 Span - 1 - Reinforcement added at richt span contrafiexure point for Offset of Bending Moment Diagram for Shara - 45.46mm2	
Graphics Span 2	
e Deflections 100 kentorcement Stream Strea	of Sets
Image: Section Max Section Max Max 2 legs 2 legs<	egs 2 legs Shear
Locat Size Space Area Depth Width Rebar Read Size Space Area Depth Width Rebar Read Area N10 N1	I2 N16 Comments
Even Spans Loaded 112 167.2 554.94 26 1000 5 N12 @ 203.6 0 0 0 144 1000 No Steel Added 0 0	0 0
Image:	0 0 No shear steel
and the second sec	
☑ Detailed Feniforcement 288 16 171.4 486.04 26 1000 N12 232.5 0 0 144 1000 No Steel Added 0 0 0 1444 1000 No Steel Added 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 No shear steel
Image: Detailed Reinforcement 288 16 171.4 486.04 26 1000 5 N12 @ 232.5 0 0 1 144 1000 No SteelAdded 0 0 Image: Detailed Reinforcement Layout Image: Detailed Reinfor	0 0 No shear stee 0 0 No shear stee 0 0 No shear stee
☑ Detailed Reinforcement 288 16 171.4 486.04 26 1000 5 N12 @ 232.5 0 0 0 144 1000 No SteelAdded 0 0	0 0 No shear stee
	0 0 No shear stee
	0 0 No shear stee
	0 0 No shear stee
	0 0 No shear stee
	0 0 No shear stee
	0 0 No shear stee
288 16 171.4 486.04 26 1000 5N12 223.2 0 0	0 0 No shear stee
288 16 171.4 486.04 26 1000 5N12 223.2 0 0	0 0 No shear stee
288 (6) 171.4 486.04 26 1000 5N12 223.2 0 0	0 0 No shear stee
288 16 171.4 486.04 26 1000 5 N12 @ 232.5 0 0 0 144 1000 No SteelAdded 0 0 282 0 0 0 144 1283 26 0 100 105 188 278.33 26 0 12 0 0 0 0 0 0	0 0 No shear stee
■ Detailed Reinforcement Layout ■ Text = Text = 12	0 0 No shear stee 0 0 No shear stee <td< td=""></td<>
	0 0 No shear stee 0 0 No shear stee <td< td=""></td<>
	0 0 No shear stee 0 0 No shear stee <td< td=""></td<>
	0 0 No shear stee 0 0 No shear stee <td< td=""></td<>
Pateled Reinforcement Layout 288 16 171.4 486.04 26 1000 5412 223.2 0 0 144 1000 No Steel Added 0 0 Image: Second S	0 0 No shear stee 0 0 No shear stee <td< td=""></td<>

Figure A4 – Reinforcement Output







Figure A5 – Reinforcement Diagram

