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1. INTRODUCTION

PTsog is a Windows standalone program that designs Post-Tensioned and Reinforced Slabs-On-Grade (SOG)

Type of Designs:

- Warehouse Slabs-On-Grade
- Industrial Pavements
- Container Pavements
- Airport Pavements



Figure 1: The PTsog Program

2. DESIGN THEORY for the Slab-On-Grade (SOG)

Three design criteria for prestressed SOG are normally considered

Criterion 1

The effect of

- Loads (post, wheel)
- Subgrade reaction
- Subgrade friction
- Temperature
- Shrinkage
- Figure 2: Loading

o Creep

Are all considered and sufficient prestress is applied to keep the concrete tensile stresses to the allowable limit.

The relationship for a safe performance is as follows

$$f_t + f_p \ge f_{\Delta t} + f_F + f_L \qquad (1)$$

Where:

 f_t = Concrete Flexural Strength

 ${m f}_p\,$ = effective prestress at the slab critical point

 $f_{\Delta t}$ = temperature gradient stress

 f_F = Subgrade friction at slab critical point

 f_L = Load tensile stress at slab critical point

N = Life Load Repetitions

Criterion 2

A minimum residual compression level, in the concrete is maintained after all losses.

Criterion 3

Fatigue strength, or strength under repetitive loading is satisfied

Strength under repetitive loading is measured in terms of Stress Ratio (SR). The Stress Ratio is a measure of net working tensile stress to the net cracking stress

$$SR = \frac{Net Working Tensile Stress}{Net Cracking Stress} -----(2)$$

$$SR = \frac{f_{\Delta t} + f_L - f_p + f_F}{f_t + f_p - f_F}$$
 (3)

The allowable Stress Ratio ($old SR_{All}$) is defined as

$$SR_{All} = 0.73 - \left(0.0846\left(\frac{Ln(N)}{Ln(10)} - 3\right)\right)$$
 ------(4)

The Stress Ratio calculated (Equation 3) must be equal or less than the allowable (Equation 4) It should be noted that, the inverse of the SR is equal to the Safety Factor



3. SLAB DESIGN

3.1. Slab Design – Dialogue Window

The Slab Design Dialogue Window is displayed as shown in Figure 3.

ile: None Loaded						🛛 📐 🔀
Design	Utilities Dowel Des	ign Punching Shear Check	Tendon Spacing	RC Design	Heat Anal	ysis Analysis
Project	Material Properties	Losses	Loading	Analysis	s Results	Analised Tendon List
Project Title Project No. Slab / Pour Designer				Date	Wed, C	Det 30, 2013
Licensed to:	Steven S Gikas & A Sydney 02 95891133 8 Balandra Place KAREELA NEW SOUTH WALE AUSTRALIA sgikas@bigpond.net. www.pttanksoftware.	ssociates 5 S 2232 au com	PIson © 20:	13 Steven S	Gikas and J	Associates
1.5 <u>1.374</u> 1.2 1.318 0.9 0.6	Prestres	s & Subgrade Stress (M 1.360 Gross 2.360	Pa) Vs Slab Length (After Anchoring) Extension (mm)	(<u>m)</u>	2008 P.162 Temp	ge Movement (mm) Left End Right End stic 1.43 otal 18.38 10°C 3.00 IGNORE CHECKS District
0.3 0.018 (0,0) 0.000 P/A @ Live-End	0.173 Kink =14.419 m L.Edge/Slab K	ink Mid-Length	R.Slab/Ed	ge Dead-E		Slab Ends Slab Ends Slab Ends Structure Footing End Structure Foot
Distance 0.000m Effective 1.318 Residual 1.318	1.500m 14.4 1.374 1. 1.356 1. Slah Design Langth	419m 30.000m 439 1.360 266 1.000 (m) 50.00	58.500m 1.208 1.190	60.000r 1.162 1.162	n 1/12 2/12	2.7 Ø/0.568 m C 2.7 Ø/1.136 m C 2.7 Ø/1.705 m C
(mm) 105 Edge Leng 210	hab Design Lengtr h(mm) Slab Design Width 30 → Slab Thickness (r	(m) 60.00 <u>Minimum</u> (m) 60.00 nm) 150 1.00 0	Hesidual Criterion Edge Leng MPa MPa 1:	h (mm) 500	4/12 210 6/12	2.7 Ø/2.273 m C 2.7 Ø/2.841 m C 2.7 Ø/3.409 m C
Edge Depth (mm) Subg	rade Friction Coefficient	0.5 Subgrade Modu	ılus (kPa/mm) ^{25.0}	Edge Depth	(mm)	/iew <u>P</u> rint This Run
Strand Required	1.760 1	.760 COMPLE	0 Strands	Save Run		<u>E</u> xit

Figure 3: Slab Design Dialogue Window

Dialogue Window is divided into several Primary Tabs, as Shown in Figure 4. These are:

- Design
- Utilities
- Dowel Design
- Punching Shear Check
- Tendon Spacing
- RC Design
- Heat Analysis (Not available for this version)
- Analysis (Not available for this version)

Design	Utilities	Dowel Design	Punching Shear Check	Tendon Spacing	RC Design	Heat Analysis	Analysis

Figure 4: Primary Control Tabs

3.2. The Design (Primary Tab)

The Design Primary Tab, as shown in **Figure 5**, is sub-divided into Six Tabs. These are:

- Geometry and Subgrade
- Slab Material Properties (Tab 1)
- Tendon Losses (Tab 2)
- Loading (Tab 3)
- Loading Analysis Results (Tab 4)
- Edge Bars and Utilities (Tab 5)
- Analysed Tendon List

	Design	ĭ	((Ĭ	
ſ	Project	Material Properties	Losses	Loading	Analysis Results	Analised Tendon List

Figure 3: Design Tab

3.2.1. Geometry, Subgrade and Prestress Level

This Part of the Design Tab, as shown in Figure 4

Anchor Depth	Slab Design Length (m)	60.00	Minimum Residual		Anchor Depth
(mm) 105	Edge Length (mm) Slab Design Width (m) ← 1500 ≯ Slab Thickness (mm)	60.00 150	Prestress Criterion 1.000 MP a	Edge Length (mm)	(mm) 105
210	93999 93999				210
Edge Depth (mr	n) Subgrade Friction Coefficient 0.5	5 Sub	grade Modulus (kPa/	mm) 25.0 Ed	ge Depth (mm)

Figure 4: Geometry, Subgrade and Prestress Level Input

The user required input or confirm the:

<u>The Slab Geometry</u>

- Design Length (Length of Tendon-Default of 60m)
- Design Width (With of slab to place and space the tendons-Default 60m)
- Slab Thickness(Default 150mm)

There is a practical minimum to the thickness of a prestressed slab on grade, which depends on the size of the prestressing hardware to be used. Given that generally the anchorages are cast into the edge thickening, 130 mm is normally considered to be the minimum achievable slab thickness

- Edge Geometry
 - Depth of Edge. (Default 1.4xSlab Depth)
 Normally proportioned as 1.4 x the Slab Depth
 - Length of Edge
 Normally proportioned with
 Level Length of 0.5m to 1.0m
 Inclined Length of 0.8m to 1.0m
 - Tendon Anchor Location from top of Slab Normally located at Mid-Edge Depth

• Minimum Residual Prestress (Default 1.000 MPa)

The level of prestress to be present at the critical section (normally mid-length) of the slab, after all losses, and subgrade friction, is normally proportioned to be not less than 1.0 MPa. In order to improve the waterproofing properties of the slab, a level of 2.0 MPa may be more appropriate.

• Subgrade Friction Coefficient (Default 0.50)

The subgrade friction is the restrained offered by the subgrade when the slab is contracting due to climatic variations, shrinkage and prestressing. Values for the friction coefficient may vary from 0.2 to 2 or more.

Important to note, that the subgrade friction is caused by the self-weight of the slab. On the very rare occasion that static superimposed loads are great in number and magnitude, their inclusion in the friction loss calculations may be warranted.

The most practical method of base treatment is to use 25mm to 50mm san layer, covered by two layers of membrane. This is placed between the subgrade and the concrete slab. For this arrangement a coefficient of subgrade friction of 0.5 is generally adopted.

Where an accurate assessment is critical, the subgrade friction should be experimentally determined and then confirmed in the field.

Project	Material Properties	Losses	Loading	Analysis Results	Analised Tendon List
Project Title					
Project No.					
	mmmm				
Designer				Date Wed,	Oct 30, 2013
Tendon ID					
Licensed to:	Steven S Gikas & A Sydney 02 9589113	ssociates 5			
00	8 Balandra Place KAREELA				
COC.	NEW SOUTH WALE	S 2232			
GIKAS	sgikas@bigpond.net. www.pttanksoftware.	au com	PTsog © 201	3 Steven S Gikas and	Associates

3.2.2. Project

Figure 5: Project Tab

The project Tab displays the License detail, as shown in **Figure 5** User needs to complete all the fields, especially when saving the design.

3.2.3. Slab Material Properties



PTsog displays default values for all material properties, as shown in Figure 6.

Figure 6: Slab Design – Material Properties

User needs to confirm/amend the:

• Concrete Properties

- Compressive Strength
 - At 28 days (Default 40 MPa)
 - At Transfer this is when tendons are stressed (Default 22 MPa) This is specified by the PT system used, and normally is
 - 22 MPa for 12.7mm Strands
 - 25 MPa for 15.2mm Strands
- o Density
- o Modulus of Elasticity
 - o At 28 days
 - At 2Transfer

The Values are automatically generated by PTsog, as a function of Concrete strength and density, in accordance with AS3600.

The user can overwrite these values

- Thermal Conductivity (Default 10)
- Poison Ratio (Default 0.2)

• Concrete Flexural Strength (Default 4.427 MPa)

There are three options (criterions) that can be used to define the Concrete Flexural Strength, as shown in **Figure 7**.

- \circ $\;$ To AS3600 which gives a value of 0.6(fc) $^{1/2}$
- $\circ~$ To Cement and Concrete Association of Australia, Floor and Pavements Which gives a value of 0.7(fc) $^{1/2}$
- \circ User Defined, by entering the required value at the Flexural Strength Field
- Flexural Strength Age Factor (Default 1.10)

This is the Concrete Flexural Strength that PTsog uses to design the Slab. It should be the value at the time of slab loading, which normally is taken as 90 days



Figure 7: Flexural Strength – Material Properties

• Strand Properties

User selects the strand size to be used in the design, as shown in Figure 8

- Strand Diameter (Default 12.7mm)
 Options are 12.7mm and 15.2mm
- Associated Strand Properties
 - Area
 - Breaking Force
 - Jacking Force
 - Young's Modulus

Strand Properties			Strand Area Ap (mm²)	100.1
Strand Diameter (mm)	12.70 💌 🗕	-	Breaking Force Pu (kN)	184.0
			Jacking Force Pj (kN)	156.4
			Youngs Modulus E (MPa)	195000

Figure 8: Strand – Material Properties

3.2.4. Tendon Losses

Here is where PTsog evaluates the Slab:

- Tendon Force Profile
- Tendon Extension (After Anchoring)

The Force Profile is evaluated taking into account all the Tendon Losses, which are:

- Immediate Loss of Prestress due to:
 - o Elastic deformation of concrete
 - Friction along duct
 - o Anchoring
- Time-Dependent Loss of Prestress due to:
 - Shrinkage of Concrete
 - Creep of Concrete
 - Tendon Relaxation



Figure 9: Slab Design – Tendon Losses

PTsog performs the Loss Analysis using:

- The loss values as defined in AS 3600-2009, Section 3.4, assuming
 - o For the Time-Dependent Losses
 - Age of Concrete as (30 years x 365) 10950 days
 - Age of concrete at time of loading as 90 days
 - Basic Tendon Relaxation of 2.5
- Default Tendon values for
 - o Coefficient of friction
 - Wobble Factor
 - o Draw-in
 - Anchor Force Loss %

User needs to confirm these loss parameters and make sure the Tendon related values, are applicable to the Prestress System used.

3.2.5. Tank Slab Loading

This is where user enters all loadings, as applicable to the top and bottom of slab Applied Loads can be:

• Post, Wheel or UDL

These are added in the form of Moments kNm/m

Also required are the associated values for:

- Stress Fatigue Ratios
 This is evaluated from the Total (Life) Load Repetitions
 Default Values:
 - Post 1 for No Repetitions
 - Wheel
 0.5 for Unlimited Repetitions
 - UDL
 0.75 for 580 Repetitions

PTsog evaluates the Fatigue Factor based on the user selected Life Load Repetitions

- Material Safety Factors
 Reference: Cement and Concrete Association of Australia
 Industrial Pavements
- Temperature Gradient (Default 0.02 °C/mm for tension bottom) Uniform temperature changes produce stresses, only because of frictional restraint. As a result of temperature gradient within the slab, the slab tends to warp, thereby resulting in longitudinal and transverse stresses.

Common Values for industrial floors are:

- For Internal Environments 0.02 °C/mm
- For External Environments 0.04 °C/mm



Figure 10: Tank Slab Loading

3.3. The Slab Design

PTsog designs the slab, satisfying the three criteria described in Section 2 of this Manual.

The design of the slab is in two steps. These are:

- Determining The Minimum Number of Strands required
- Completing Design, using the determined strand or the user modified number of strands

3.3.1. Determining Number of Strands

PTtank evaluates and displays the minimum required number of strands when user presses the **Get Min No of** Command Button, **Strand Required**

The required number of strand is displayed as shown in **Figure 11**, and the user has the option to:

- Accept and continue with finalizing design
- Increase number and finalize design



Figure 11: Slab Design – Strands required and Used

3.3.2. Complete Design using Number of Strands

PTtank completes the Slab Design, using the Strands to be Used value, when user presses the

COMPLETE DESIGN Command Button with 1.760 Strands

Note: The **COMPLETE DESIGN** Command button contains the number of strands used

3.3.3. Slab Design Results

On completion of the Slab Design, PTsog displays and plots:

- Analysis Results at each critical section, in Tabulated Form
- Tendon/Subgrade Stress Profile Plot
- Slab Edge Movements
- Tendon Design Options
- No of Tendons and Tendon spacing for the specified slab width

3.3.3.1. Slab Design – Analysis Results

PTsog Tabulates the Controlling Location and condition as shown in Figure 12

- Post
- Wheel
- UDL

For Slab Top and Bottom

Figure 12 shows:

- The Controlling Criterion (Residual Prestress in this example)
- Critical Location (At Slab mid-length for this example)

This is expected as there is no Post, or Wheel loads

Proje	ct Material Prop	perties	Los	ses:		Ĺ	oading	Ana	lysis Results
RESULTS	AT CRITICAL SECTIONS		Top	ST Bot		WHE	EL Bot		Bot
Concrete	Applied Negative	Moment	-0.267	0.267		-0.267	0.267	-0.267	0.267
Stress	Applied Positive	e Moment	0.267	-0.267	ĺ	0.267	-0.267	0.267	-0.267
(MPa)	Subgrade Frid	ction Loss	-0.360	-0.360	Í	-0.360	-0.360	-0.360	-0.360
	Temperature	Top Hot	0.640	-0.640		0.640	-0.640	0.640	-0.640
	Temperature T	op Cold	-0.320	0.320		-0.320	0.320	-0.320	0.320
	Allowable	Tension	3.896	3.896		4.383	4.383	3.896	3.896
	Controlling Net	Applied	2.949	2.629		3.436	3.116	2.949	2.629
Required	Required Prestress for Crac	k Control	0.000	0.000		0.000	0.000	0.000	0.000
Prestress	Required Prestress for Str	ress Ratio	0.000	0.000		0.000	0.000	0.000	0.000
Cricerion	Required Prestress for	r Residual	1.360	1.360		1.360	1.360	1.360	1.360
Prestress	Required Effect	ctive P/A	1.360	1.360		1.360	1.360	1.360	1.360
P/A	Used Effec	tive P/A	1.360	1.360		1.360	1.360	1.360	1.360
Design	Required SI	trands/m	1.760	1.760		1.760	1.760	1.760	1.760
Results	Used St	rands/m	1.760	1.760	Í	1.760	1.760	1.760	1.760
	Net Top/Soffit Stres	s (MPa)	0.413	0.093		0.413	0.093	0.413	0.093
	Calculated Stre	ess Ratio	0.000	0.000		0.000	0.000	0.000	0.000
	Calculated Safet	y Factor	Infinite	Infinite		Infinite	Infinite	Infinite	Infinite
	Controlling Co	ondition	Min P/A						
	Critical Locati	on X=	Length/2	Length/2		Length/2	Length/2	Length/2	Length/2

Figure 12: Slab Design – Analysis Results

The controlling Location and Condition are tabulated in red

3.3.3.2. Slab Design – Tendon/Subgrade Friction Plot

PTsog plots as shown in Figure 13, the:

- Tendon and Subgrade Friction Stress as a function of Slab Length
- Values at all critical points
- Tendon Extension (After Anchoring)



Figure 13: Slab Design – Tendon/Subgrade Friction Stress Vs Slab Length

The Lengths (m) and associated stresses (MPa) are plotted and tabulated. These are:

- Beginning of Slab (Live End)
- Left Edge/Slab transition
- Tendon Force Kink (due to Anchor Draw in or Anchoring)
- Mid-Slab Length
- Right Edge/Slab transition
- Slab Length

The Blue Line represents the Tendon Stress Profile in MPa The Red Line represents the Subgrade Stress Profile in MPa The controlling P/A is highlited

3.3.3.3. Slab Design – Edge Movement

PTsog evaluates and displays as shown in **Figure 14**, the Movement of the Slab Ends The Movements are:

- Elastic
- Temperature
- Total

The movements are particularly important, for pavement design, in the design of

- Movement Joints
- Dowels

Edge Movement (mm)							
Left End Right End							
Elastic	1.43	1.29					
Total	18.38	18.02					
৲emp 10°C √	3.00	3.00					

Figure 14: Slab Design – Edge Movements

3.3.3.4. Slab Design – Tendons Spacing Option

PTsog displays the Tendon Design options and makes an educated guess at the selection, as shown in **Figures 15**

The options are based on

- Strand Properties defined by user
- The number of strand used in the design

The PTsog selected option

12.7mm Strand3-stand Tendon

- at 1.705m spacing

User can make his own selection

As shown in Figure 16

- 12.7mm Strand4-stand Tendon
- at 2.273m spacing



Figure 15: PTsog Option

OPTIONS>	SELECT
1/12.7 Ø/0.568	m C
2/12.7 Ø/1.136	m O
3/12.7 Ø/1.705	m C
4/12.7 Ø/2.273	m 📀
5/12.7 Ø/2.841	m C
6/12.7 Ø/3.409	m C

Figure 16: User Option

The Selected option defines the spacing to be used to calculate the

- Number of Tendons
- Tendon Spacing

For the full Slab With, while maintaining the design P/A (prestress)

3.3.3.5. Slab Design - Slab Width and Tendon Spacing

PTsog calculates the spacing based on the specified option (Figures 15 and 16) The Design window can be accessed by selecting the Tendon Spacing Tab as shown in Figure 17



Figure17: The Tendon

Pressing the Tendon Spacing Tab brings up the Default Spacing Window as shown in Figure 18



Figure18: Spacing Window with Defaults

The default window assumes the width of slab (secondary direction) has the same edge conditions as the main direction. Based on this, the specified spacing, PTsog calculates

- The number of tendons
- Actual Spacing at Ends
- Spacing internally
- Total number of tendons
- Average spacing



The user can modify the edge conditions and re-evaluate, as shown in Figure 19

Figure19: Spacing Window with User amendments

As seen in Figure 19, the

- Left Edge has no edge thickening
- The Right Edge has been made wider and deeper

User can Print/ View this analysis by pressing the View/Print command button

3.4. Loading and Saving Design Files

PTsog allows user to save each and every completed Tendon Run to a disk file. The user can:

- Save to a New File
- Load and Append to Existing File

The file status is always shown on top of the Window, as shown in Figures 20 and 21.

File: C:\Wareas\Development\VBWind\Vb6\Sog\NoLogo\Warea\Levadia.sog									
Design	∪tilities	Dowel Design	Punching Shear Check	Tendon Spaci					

Figure 20: File Status - Loaded (current) File displayed

Figure 20 shows a File has been Loaded or Saved

File: None Loaded								
Design	Utilities	Dowel Design	Punching Shear Check	Tendon Spacin				

Figure 21: File Status – No File Loaded or Saved

Figure 21 shows No file has been Loaded or Nothing Saved

3.4.1. Saving the Current Run

When a design has been completed user can save save/append this run by pressing the **Save Run** Command Button.

To save a run, the Tendon must have an ID, refer **Figure 5**. If no ID has been entered, the Run cannot be saved.

PTsog lets user know, by displaying an error message as shown in **Figure 22**.



Figure 22: User Warning – Tendon ID required

If a file has not been loaded or this is the first run to be saved, PTsog displays the Save dialogue Window as shown in **Figure 23**.

User enters the file name, or selects an existing file to be overwritten.

The default file extension is .sog

Pressing the Save buttons the New File is saved containing the current run.



Figure 23: Save Dialogue Window

3.4.2. Analysed Tendon List

When a run is saved it automatically gets added to the **Analysed Tendon List** When a file is loaded, all Runs contained are displayed in the **Analysed Tendon List**, as shown in **Figure 24**

Design	Ĺ	hilities	Dowel Design	Punching Shear	Check Ter	ndon Spacing	RC Design	Heat Ar	nalysis 🍸	Analysis	R
Project		Mat	Material Properties Losses		Loading Analysis		Results Analise		ed Tendon Li	st	
Number of Runs:		Designed Tendon List		Required By Analysis			Required By Geometry			1	
Selected F	Run	Run No #	Tendon Discription	Tendon Length (m)	Required Strands per/m	Specified Strands per/m	Tendon System & Spacing	Slab Width (m)	No of Tendons #	Average Spacing (m)	
016		002	Tendon 2	45.00	1.531	1.531	3/12.7 Ø/1.960 m	60.00	32.000	1.875	^
010	2	003	Tendon 3	25.00	1.374	1.374	2/12.7 Ø/1.456 m	20.00	15.000	1.333	
		004	Tendon 4	49.00	1.566	1.566	3/12.7 Ø/1.916 m	35.00	19.000	1.842	
		005	Tendon 6	35.00	1.444	1.510	3/12.7 Ø/1.987 m	36.00	19.000	1.895	
Delete Run	No:	006	Tendon 7	62.00	1.683	1.700	3/12.7 Ø/1.765 m	60.00	35.000	1.714	
016		007	Tendon 8	52.00	1.593	1.593	3/12.7 Ø/1.883 m	40.00	22.000	1.818	
27777777777	[[]]	008	Tendon 10	42.00	1.504	1.504	3/12.7 Ø/1.995 m	52.00	27.000	1.926	
		009	Tendon 11	42.00	1.504	1.504	3/12.7 Ø/1.995 m	32.00	17.000	1.882	
		010	Tendon 15	27.00	1.381	1.381	2/12.7 Ø/1.448 m	41.00	29.000	1.414	
Dessendi		011	Tendon 18	20.00	1.357	1.357	2/12.7 Ø/1.474 m	60.00	42.000	1.429	
Descendin	ng	012	Tendon 20	25.00	1.374	1.374	2/12.7 Ø/1.456 m	44.00	31.000	1.419	
		013	Tendon 22 Last Pour	33.00	1.427	1.427	2/12.7 Ø/1.402 m	46.00	34.000	1.353	
		014	Tendon 24 Last Pour	45.00	1.531	1.531	3/12.7 Ø/1.960 m	46.00	24.000	1.917	
Sort		015	Tendon 26 Last Pour	60.00	1.665	1.665	3/12.7 Ø/1.802 m	46.00	27.000	1.704	
Ascendi	ig	016	Tendon 27 Last Pour	59.00	1.656	1.656	3/12.7 Ø/1.812 m	46.659	27.000	1.728	~

Figure 24: Analysed Tendon List

The Analysed Tendon List displays the

- Design Summary Table, which include
 - Tendon Run Number
 - Tendon Description (ID)
 - Design Requirement
 - o Strands/meter
 - Specified Strand/meter
 - Selected System and Spacing
 - Geometry Requirement
 - o Slab Width
 - Number of Tendons used
 - Average Spacing
- Number of Tendon Runs
- The Selected Run (Highlighted)
- Three Command Buttons, which are
 - Delete (Selected Run)
 - Pressing this button, deletes/purges the selected run permanently fro list and file.
 - Sort Descending
 - $\circ~$ Pressing this button, displays list in descending order, based on Tendon ID
 - Sort Ascending
 - \circ Pressing this button, displays list in ascending order, based on Tendon ID

Selecting a Run from the List is done by simply clicking on that Run (anywhere along the row). This highlights the whole row and fills all the tabs with the Input and Results for this run.

File: C:\Wareas\Development\VBWind\Vb6\Sog\NoLogo\Warea\Levadia.sog										
Design L	Dowel Design P	unching Shear	ing Shear Check Tendon Spacing RC Design			Heat Analysis Analysis		<u>ں</u>		
Project Material Properties		Losses	- Y	Loading	Analysis	Analysis Results Analised Tendon List			t	
Number of Runs:	7///	Designed Tendon	List	Re	quired By	Analysis	Requi	ired By G	eometry	
016	Run	Tendon	Tendon	Required	Specified	Tendon	Slab	No of	Average	
Selected Run	No	Discription	Length	Strands	Strands	System &	Width	Tendons #	Spacing (m)	
Selected Kull	002	Tendon 2	45.00	1.531	1.531	3/12.7 Ø/1.960 m	60.00	32.000	1.875	~
011	003	Tendon 3	25.00	1.374	1.374	2/12.7 Ø/1.456 m	20.00	15.000	1.333	
	004	Tendon 4	49.00	1.566	1.566	3/12.7 Ø/1.916 m	35.00	19.000	1.842	
	005	Tendon 6	35.00	1.444	1.510	3/12.7 Ø/1.987 m	36.00	19.000	1.895	
Delete Run No:	006	Tendon 7	62.00	1.683	1.700	3/12.7 Ø/1.765 m	60.00	35.000	1.714	
011	007	Tendon 8	52.00	1.593	1.593	3/12.7 Ø/1.883 m	40.00	22.000	1.818	
	008	Tendon 10	42.00	1.504	1.504	3/12.7 Ø/1.995 m	52.00	27.000	1.926	
	009	Tendon 11	42.00	1.504	1.504	3/12.7 Ø/1.995 m	32.00	17.000	1.882	
Sort	010	Tendon 15	27.00	1.381	1.381	2/12.7 Ø/1.448 m	41.00	29.000	1.414	
Descending	011	Tendon 20	20.00	1.307	1.307	2/12.7 Ø/1.474 m	44.00	42.000	1.429	
	012	Tendon 22 Last Pour	33.00	1.374	1.374	2/12.7 @/1.400 m	44.00	34,000	1.418	
	014	Tendon 24 Last Pour	45.00	1.531	1.531	2/12.7 Ø/1.402 m	46.00	24,000	1.000	
Sort	015	Tendon 26 Last Pour	60.00	1.665	1.665	3/12.7 Ø/1.802 m	46.00	27.000	1.704	
Ascending	016	Tendon 27 Last Pour	59.00	1.656	1.656	3/12.7 Ø/1.812 m	46.659	27.000	1.728	-
		Drootroop 8 Cul	arada Str	And (MDa)	la Slah Lan	ath (ma)		dae Move	ment (mn	
4.000		Presuess a su	1 096	ess (IVIPa)	rs slab Len	<u>gun (m)</u> 1.092		Left E	Ind Right Er	nd
1.00					1.112		9 054 E	lastic 0.4	40 0.41	
0.8								Total 5.8	39 5.92	
0.0				Gross (After	Anchoring)	135.7	Ten	np 10°C 1.0	00 1.00	
0.8				Ext	ension (mm) I	10011		IGNORE	CHECKS	
0.4							Let	t (Origin)	Rig	ht
0.2 0.014			0.096			0.014		Slab	Ends 🗌	
(0,0) 0.000		_		Kink	0.059 =13.874 m		8.000	Footin	gEnd 🗖	
P/A @ Live-End	L.Edge	/Slab Kink	Mid-Le	ength	R.Slab	/Edge Dead-E	ind 📃	DPTIONS-	-> SELEC	CT.
Distance 0.000m Effective 1.016	1.500	0m <u>13.874m</u> 30 1.112	10.00	00m 96	18.50	00m 20.000r 32 1.054	n 1/*	12.7 Ø/0.7	37 m 🦷 (0
Residual 1.016	1.04	1.053	1.0	00	1.0	78 1.054	2/*	12.7 Ø/1.4	74 m 🛛 🤇	•
Anchor Depth	Slab	Design Length (m) 20	1.00	inimum Desi	dual	Anchor De	pth 3/	12.7 Ø/2.2	11 m (
(mm) 105 Edge Length (mm) Slab Design Width (m) 60.00 ↓ 1500 → Slab Thickness (mm) 150							48 m (
							85 m (-		
							12 7 6/4 4	22 m /	_	
	a service of				the set on the set			2.1 0/4.4		-
	do Eric	tion Coefficient 0.4	Subgrade	Modulus	(kPa/mm)	25.0 Edge Denth	(Then)	View Print	This Run	
Edge Depth (mm) Subgra	uernc	tion coefficient			(··· ··· ··· · · · · · · · · · · · · ·	Eago Dopa	. ()			
Edge Depth (mm) Subgrad	de l'IIC ds Requ 1.357	ired Strands to be Ado 1.357	pted CO	MPLETE DE 0.00 Str	SIGN with inds	Save Run		<u>E</u> :	ĸit	

Figure 25: Selected Run No: 011

Figure 25, shows the user has selected Run No. 011

Note the Delete button contains this Number. Pressing it will permanently delete this run

4. DOWEL DESIGN

PTsog does a detail Dowel Design based on (TR34) Technical Report No 34 Third Edition UK Concrete Industrial Ground Floors A guide to design and construction



Figure 26: Dowel Design

PTsog, displays the Recommended/Default values (User can amend as required)

- Dowel size and associated properties
- Default Safety Factors

User needs to enter/confirm the:

- Loading as applicable (Figure 26 shows Typical Warehouse Storage Loading)
- Slab/Edge Depth (Figure 26 shows a depth of 210)
- Dowel Spacing (Figure 26 shows a spacing of 300)
- Edge to First Dowel distance (Normally half the dowel spacing)
- Dowel Depth (normally mid slab depth)
- Dowel Overall Length
- Concrete and Subgrade Modulus
- Expected maximum gap opening (obtained from PTsog edge movements)

Once all Dowel Input is completed, pressing the PTsog to do the Analysis Check.



command button allows

The first part of the Dowel Analysis process is the Load Sharing Analysis as shown in Figure 27



Figure 26: Load Sharing Analysis

PTsog evaluates, for the Loading specified, the:

- Number of Dowels Loaded (For example shown 18 Dowels)
- First Dowel Loaded (For example shown 12th Dowel)
- Last Dowel Loaded (For example shown 29th Dowel)
- The Dowel with Maximum Load (For example shown 21st Dowel)
- The Dowel Maximum Load (For example shown 15.382 kN)

PTsog then performs a Finite-Length Beam on Elastic Support analysis, and displays, as shown in **Figure 27**, the

- Actual Bearing Stress
- Allowable Stress to AS3600
- Allowable Stress to Y.H.Huang
- Dowel Deflection in mm

Theoretical Bearing Stress (MPa)								
(Finite-Length Beam on Elastic Support)								
Actual Bearing Stress	28.859							
Allowable To AS3600 (12.3)	48.000							
Allowable To Y.H. Huang	38.635							
Dowel Deflection (mm)	-0.070387							

Figure 27: Bearing Stresses

The Final phase of the Dowel design is the Dowel Capacities based on TR34, as shown on Figure 28

Dowel Capacities to TR34 (UK) -Section 9.10									
Shear	Bearing	Bending	Combined Shear &	Concrete Edge	STATUS				
Capacity (kN)	Capacity (kN)	Capacity (kN)	Bending (<= to 1.4)	Shear Capaciy (KN)					
74.667	69.689	87.111	0.383	29.817	ALLON				

Figure 28: Dowel Capacities

PTsog, displays the Capacity for

- Shear
- Bearing
- Bending
- Combined
- Edge Shear

And finally the Design Check STATUS, (For Example ALL OK)

5. PUNCHING SHEAR

PTsog performs a Punching Shear Check to AS3600, as shown in Figure 29



Figure 29: Punching Shear Check

User needs to confirm/edit the

- Base Plate Dimensions (For example 150mm x 150mm)
- P/A in Both Directions
 PTsog uses as defaults the specified minimum residual (For example shown 1.2 MPa)
- Effective Depth Both Directions
 PTsog used 0.8D as default for both directions (For the example shown, 120mm)
- Shear Perimeter Reduction, in case of holes in the vicinity (Default is zero)

Based on the above PTsog calculates the Ultimate Shear Capacity In example shown (Figure 29) capacity is **227.739 kN** User need to ensure <u>Applied Point Load < Capacity</u>

6. RC SLAB DESIGN

ile: None Loaded Dowel Design Punching Shear Check Tendon Spacing Design Utilities **RC** Design Heat Analysis RC SLAB DESIGN Tendon ID: Test Tendon ü RC Slab Thickness Analysis POST WHEEL UDL Material Safety 0.9 0.8 0.8 Factors TOP Slab Surface TOP BOT BOT TOP BOT Allowable 2.922 3.896 3,896 2,192 2.192 2,922 Tension (MPa) Stress on 150.00mm PT Slab - Includes: Temperature & Subgrate -0.036 -4.569 -0.036 -2.703 -0.036 -0.036 Friction **RC Thickness** 14.4 162.4 19.2 166.6 16.6 16.6 (mm) **Minimum RC** 166.6 Slab Thickness (mm) **Crack Control Reinforcement** Slab Thickness (mm) Diameter (mm) Area (mm²) 175 12 113.097 • Allowable fsy (MPa) Reinforcement Ratio (As/BD) 1.40 /fsy 500 Minimum Required Reinforcement 490.000 mm²/m Area of Steel Required $\overline{\mathbf{1}}$ **Bar Spacing** 12 Diameter Bar @ 230.8 mm Evaluate View / Print

PTsog performs an equivalent Reinforced Only Design, as shown in Figure 30

Figure 30: RC Design

To perform the RC design a couple of items need to be addressed

- Slab Length The PT Slab Length needs to be reduced to the RC Length Say 7m
- The Temperature Loading, due to the short length, can be reduced or zeroed
- The Design Checks for Slab and Footing End, must be switched off to force check at mid-slab length

PTsog evaluates the minimum slab depth required to satisfy the allowable stress criterion. User needs to confirm/amend

- Slab Depth (Round up from evaluated minimum) In Example Shown increased from 166.6min to 175mm
- The Reinforcement Size
- Allowable Steel Yield Stress (fy)
- Reinforcement Ratio required (Default 1.4/fsy)

PTsog completes RC Design by evaluating the minimum required reinforcement



Figure 31: Ignore Edge Checks

7. UTILITIES

File: None Loaded						N 🛛
Design Utilities	Dowel Design	Punching Shear Check	Tendon Spacing	RC Design	Heat Analysis	Analysis
Utilities →	Edge Bar CBR% to Tyre Cont	Design ks Converter act Area Calc	ulator			
CBR% to Enter CBR (%) 3.0 CBR%> ks	Ks Conver Subgrade Mo 27.50 0.02750 M 0.02750 ge Bars	tor bodulus (ks) kPa/mm Pa/mm3 D N/mm3		Axle Load Tonnes KN	red Contact	Areas
Diameter (mm) Are 12 Allowable Edge Depth (mm) 210 Minimum Reinforcement Ratio	a (mm²) fsy (MPa) Tendon Spac (As/BD)	113.097 400 iing (m) 1.500 .70 / fsy		Tyre Area W (mm))=Default	Criterion Criterion Ratio (1.4	a (L/W)
Area of Steel Required (mm², Bar Spacing (m	n) 1.51 (m) <u>367.5</u> m) <u>307</u>	00 00 .7	Tyre Co W-m 316.4	mtact Area m L-mm 442.9		
			W-m 223.7	m L-mm 313.2		
			W-m 158.2	m <u>L-mm</u> 221.5		

PTsog makes available a Utility Page, as shown in Figure 32

Figure 32: Utilities

The Utilities available are:

• CBR% to ks Converter.

This is useful when a CBR value is given by Geotechnical engineer and the equivalent ks is required to be entered in the FE analysis

• Pneumatic Tyre Contact Pressures

This calculates the pressure and applied pressure, for entry into FE Analysis, based on

- $\circ \quad \text{Axle Load} \quad$
- Tyre Are Criterion, which can be
 - Ratio of W/L
 - Specified W
- Edge Bars Design

PTsog evaluates the minimum

- Bar spacing
- o Straight Edge Bar Length

Based on

- o Bar Diameter
- o Minimum Reinforcement Ratio
- o Tendon Spacing

The tendon spacing using the **Dispersion angle of prestres** , as defined in AS3600 (30° either side of tendon centre-line)

8. PRINT

PTsog allows user to View and Print the:

- PT Slab Design (Figure 33) •
- Dowel Design (Figure 34) •
- Punching Shear Check (Figure 35) •
- Tendon Spacing (Figure 36) •
- Equivalent RC Design (Figure 37) ٠

This is done by pressing the View / Print Command Button at each of the above individual windows. This brings up the associated page to be printed



Figure 36: Tendon Spacing

Figure 37: RC Slab Design

Crack Control R

able fsy (MPa)

Area of St

Minimum Required Re

Required 518.00 Bar Spacing 16 Diameter Bar @ 388 2 mr

182.9

forcement

Area (mm²) 201.052

nt Ratio (As/BD) 1.41 /fsv

PTsog produces an output of the displayed pages (based on the defined printer).

