Helix Engineering Software

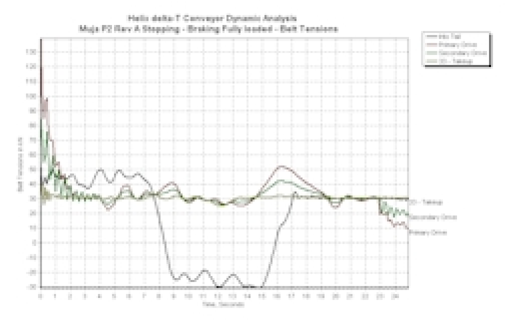
Helix Technologies specialises in Engineering Software Development. We have a number of standard programs for Conveyor Design, Conveyor Dynamic Analysis, DEM Chute Design, Pipe Network Analysis, Pump Selections, Vee Belt & Chain Drives and Share Portfolio Management and Project Investment Analysis

Helix delta-T6 Conveyor Design

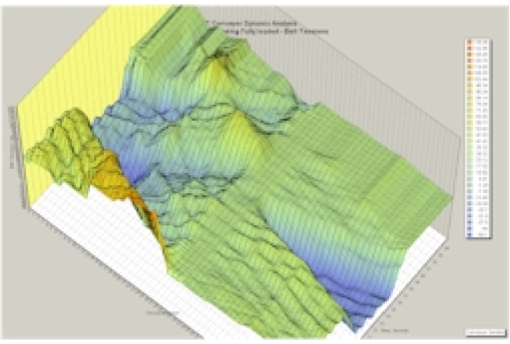
Helix delta-T6 is a powerful Windows® based belt conveyor design tool and it includes conveyor equipment databases for Belts, Idlers, Pulleys, Motors, Gearboxes, Fluid Couplings, Holdbacks, Brakes and Couplings. Helix Technologies' research and development of this software began in 1992 and delta-T now has more than a thousand users in 25 countries who depend on the program to provide consistent, accurate and cost effective belt conveyor and material handling designs.

Dynamic Analysis

2D Belt Tensions



3D Belt Tensions

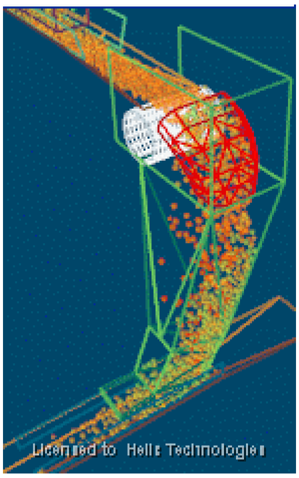


Download brochure (pdf file) (/DownloadFiles/Helixdelta-T5Brochure02.pdf)

More delta-T6 ...

Helix DEM Chute Design

Helix DEM Chute Design is an engineering design tool which combines CAD Drawing and 3D Modeling with a powerful calculation engine to predict the motion of particles in a transfer chute. The program allows the user to quickly build a model of a bulk material transfer chute station and then to perform calculations incorporating the **Discrete Element Method** of predicting particle motion through the chute. The motion of the particles is displayed in a 3 dimensional model on the computer screen and the design engineer can quickly add, modify or move the chute surfaces to allow the material to flow through the transfer efficiently. The program eliminates the need for the design engineer to guess what the material flow trajectories will be in the transfer.



Press play button to view video below..

Download brochure (2.7Mb PDF file) (/DownloadFiles/Helix Chute Design Brochure.pdf)

Chute Design overview

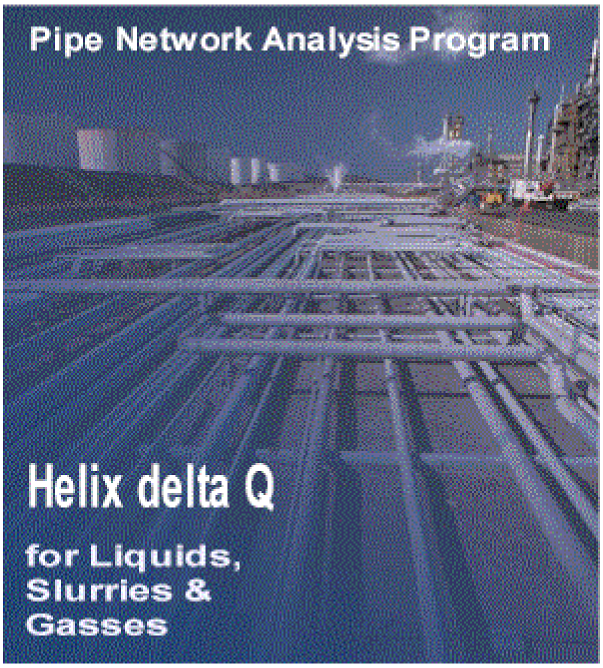
More chute videos ...

Helix delta-Q Pipe Networks

Helix delta-Q is a powerful tool for engineers and equipment suppliers to quickly and easily design and optimise pipe networks for compressible and incompressible fluids. You can produce economically and technically sound pipe system designs in a very short time.

You can calculate friction losses and pressure drop in pipes and fittings for Liquids, Slurries and Gases. Model complex process flow pipe networks and solve for unknown flow rates and node pressures at the press of a button. Retrieve data from user accessible databases for Liquids, Slurries, Gasses, Pumps, Pipes and Fittings or add your own data.

DeltaQ Online Pipe Network Software



Download brochure (pdf) (/DownloadFiles/Delta-QBrochure.pdf)

More Pipe Networks ...

Conveyor Design, Conveyor Dynamic Analysis, Belt Conveyors, DEM Chute Design, Discrete Element Method Transfer Chute Design, Particle Flow, Pipe Network Analysis, Piping System Design, Pump Selection Software, Pulleys, Vee Drives. transportador, correia, roletes, Fluid Flow, Liquids, slurries, Pump Selection Software, piping design software, pipe network analysis software, fluid flow software, pipe flow software, water flow software, fluid flow analysis software, gas flow software, settling slurry, bingham plastic, isothermal gas flow, modified Darcy gas flow, flow calculation software, pipe flow analysis software, gas flow analysis software, air flow, slurry flow, Liquid, slurry and gas Pipe Flow and Head Loss, Solve Complex Pipe Networks, Design Pipe and Pump systems, Pump Selections and Database, Applications for Process Design, Slurry Systems, Medical Gas Distribution systems, Fire Protection system design, Air conditioning, Dust Extraction, Compressed Air Systems,

HELIX delta-T for Windows®

HELIX delta-T is a powerful computer software package developed to assist materials handling design engineers and equipment suppliers with conveyor design and optimisation. Helix Technologies' research and development of this software began in 1992 and delta-T now has more than a thousand users in 25 countries who depend on the program to provide consistent, accurate and cost effective belt conveyor and material handling designs. Features of the new delta-T version 6 program include:

- Automatic Selection of Belt and Tension, Power Calculations.
- Equipment Selection from Databases for Belts, Idlers, Pulleys & Shafts, Gearboxes, Motors, Fluid Couplings, Brakes etc.
- New Equipment databases for Shaft and Drive couplings and conveyor holdbacks have been added in version 6.
- Draw a sketch of the conveyor Profile and also view a scale drawing and a 3D model of the conveyor - use Drag and Drop to add Pulleys, Drives, loading Hoppers
- Calculate concave and convex Vertical Curves including belt lift off radii, edge tensions and centre tensions
- Horizontal Curve calculations - design curved conveyors including banking angle and belt drift calculations for all operating conditions
- Calculate using CEMA, ISO 5048 or the new Viscoelastic method for low resistance rubber belts
- Add any number of Conveyor Pulleys, Drives, Loading points, Trippers, Brakes etc
- Over 70 reports can be viewed, printed or exported to Word, PDF files or Excel etc.
- You can merge multiple selected reports into a single PDF file
- Delta-T6 has been completely re-written in Microsoft Visual Studio® and uses the latest software development tools from Microsoft. It is written in a development language called C# and uses the MS Common Language Runtime compiled for .Net with xml data. This technology is the latest available from Microsoft and this makes it compatible with the latest operating systems including Windows® XP, Vista® and Windows® 7, 8 and also 32bit and 64bit systems.
- New Features in Helix delta-T6 (/DownloadFiles/Helix_delta-T6_Conveyor_Program_New_Features.pdf)

Quick introduction to Helix delta-T6 video from youtube

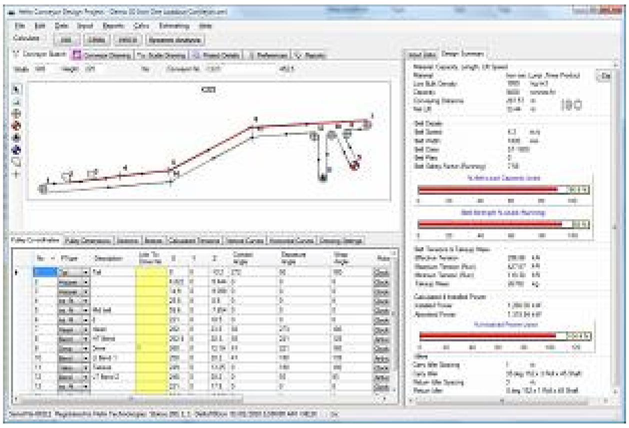
Dynamic analysis module

Helix delta-T has a full flexible body conveyor dynamic analysis version.

The Dynamic Analysis version calculates the transient belt Tensions and Velocities during starting and stopping of a conveyor. It can model the conveyor belt transient behaviour during Starting Fully Loaded, Starting Empty, Stopping Fully Loaded and Stopping Empty. The program allows the user to input any number of Drives or Brakes and allows for input of Drive Torque / Speed curves, Delay times, Braking Torques, Flywheels and inertia effects. After the Dynamic Calculations have been performed, the user can view and Print two dimensional and surface plot three dimensional graphs for Belt Tensions, Belt Velocities, Strain rates and Takeup movement versus time step for all points along the conveyor.

The following is a Helix delta-T6 sample Dynamic Analysis report - file size is 6Mb (/DownloadFiles/Helix_Sample_CV202_Conveyor_Design_Report_Dynamic_Analysis.zip)

Helix delta-T has been used as the design tool and proven in many hundreds of real conveyor installations in more than 25 countries around the world for more than 23 years. The latest version Helix delta-T 6 brings you even more power and flexibility in your conveyor designs.



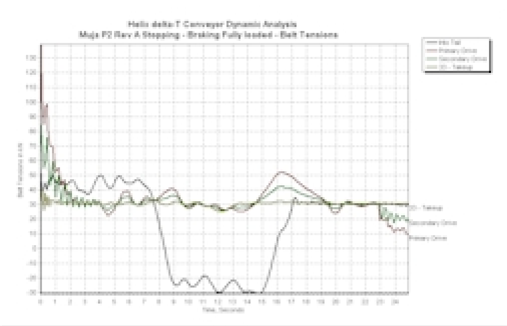
The program will automatically calculate the belt tensions in the system, select a suitable belt from the database, calculate the pulley and shaft sizes required, select a suitable electric motor, fluid coupling and gearbox from the databases, calculate the idler shaft deflections and bearing life and then present the full conveyor design in reports which can be viewed, printed or exported to Word for Windows®, Excel®, PDF® files and other applications.

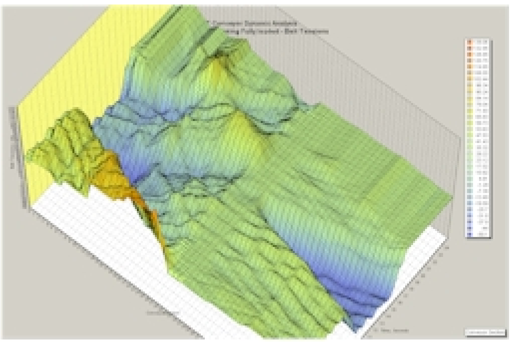
Belt tensions can be viewed graphically, and the Calc section provides useful procedures for calculating discharge trajectories, hoper pull-out forces, vertical curve radii, horizontal curve banking angles and belt drift, trough transitions distances and other frequently performed routines. Context sensitive on screen Help will guide you through the operating procedures and provide the formulae used in the calculations.

You can also create and view a 3D model of the conveyor. The program also allows you to dynamically calculate vertical and Horizontal curve geometry for the conveyor. In addition, delta-T provides an in-depth analysis of conveyor belt tensions under different operating conditions such as running fully loaded, running empty, starting fully loaded, starting empty, braking fully loaded, braking empty and coasting. A new sketch facility allows users to sketch the conveyor profile and enter data in tabular format.

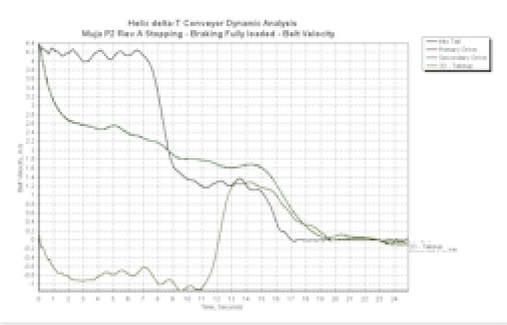
Dynamic analysis 2D and 3D graphs

2D Belt Tensions **3D Belt Tensions**

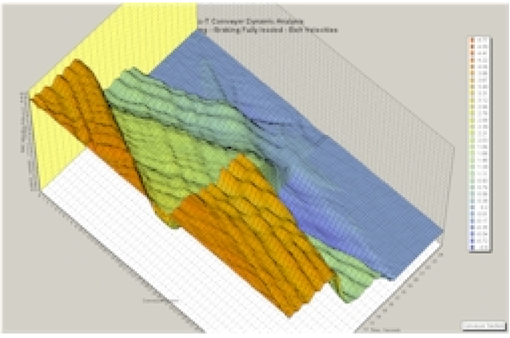




2D Belt Velocities



3D Belt Velocities



View a Delta-T6 Conveyor Design Brochure- pdf (/DownloadFiles/Helixdelta-T5Brochure02.pdf)

View a Dynamic Analysis Case Study - pdf (/DownloadFiles/ConveyorDynamicAnalysisCaseStudy.pdf)

View a PDF file brochure on the Dynamic Analysis module - pdf (/DownloadFiles/T5DynBrochWeb.pdf)

Equipment Databases ...

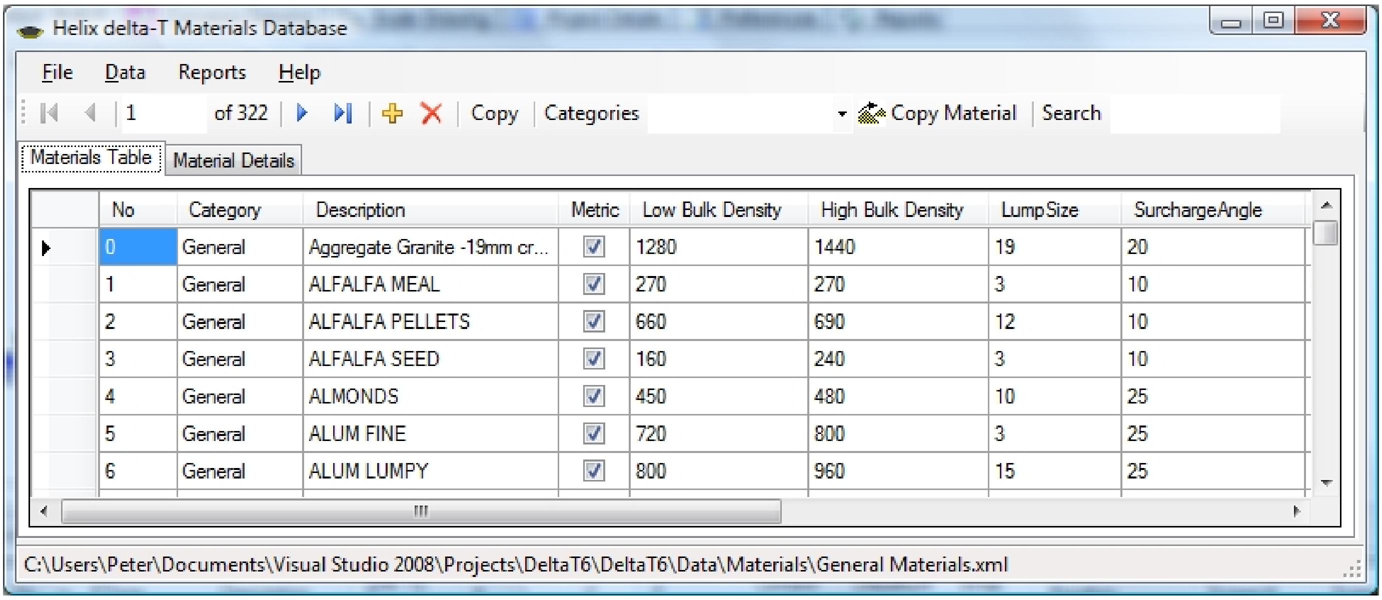
HELIX delta-T Equipment Databases

HELIX delta-T6 has extensive equipment databases supplied with the program. These files contain valuable information obtained directly from leading equipment suppliers. Having this data available ensures that the conveyor designs produced and equipment selected will be suitable for the conveyor installation. The equipment selection process for Belts, Motors, Gearboxes, Fluid Couplings, Shaft Couplings, Holdbacks, Idlers and Brakes are based on the manufacturer's selection procedures and this ensures reliable equipment selection.

Databases for Belts, Gearboxes, Fluid Couplings, Starters, Idlers, Motors, Shaft Couplings, Holdbacks, Brakes and Materials

Helix delta-T is provided with hundreds of different materials and thousands of items of equipment ranging from Belts and Gearboxes to Motors and Disc Brakes. delta-T is not only a belt tension calculator - it has built in intelligence which allows it to select the right equipment from the comprehensive database.

Example of Material Database form

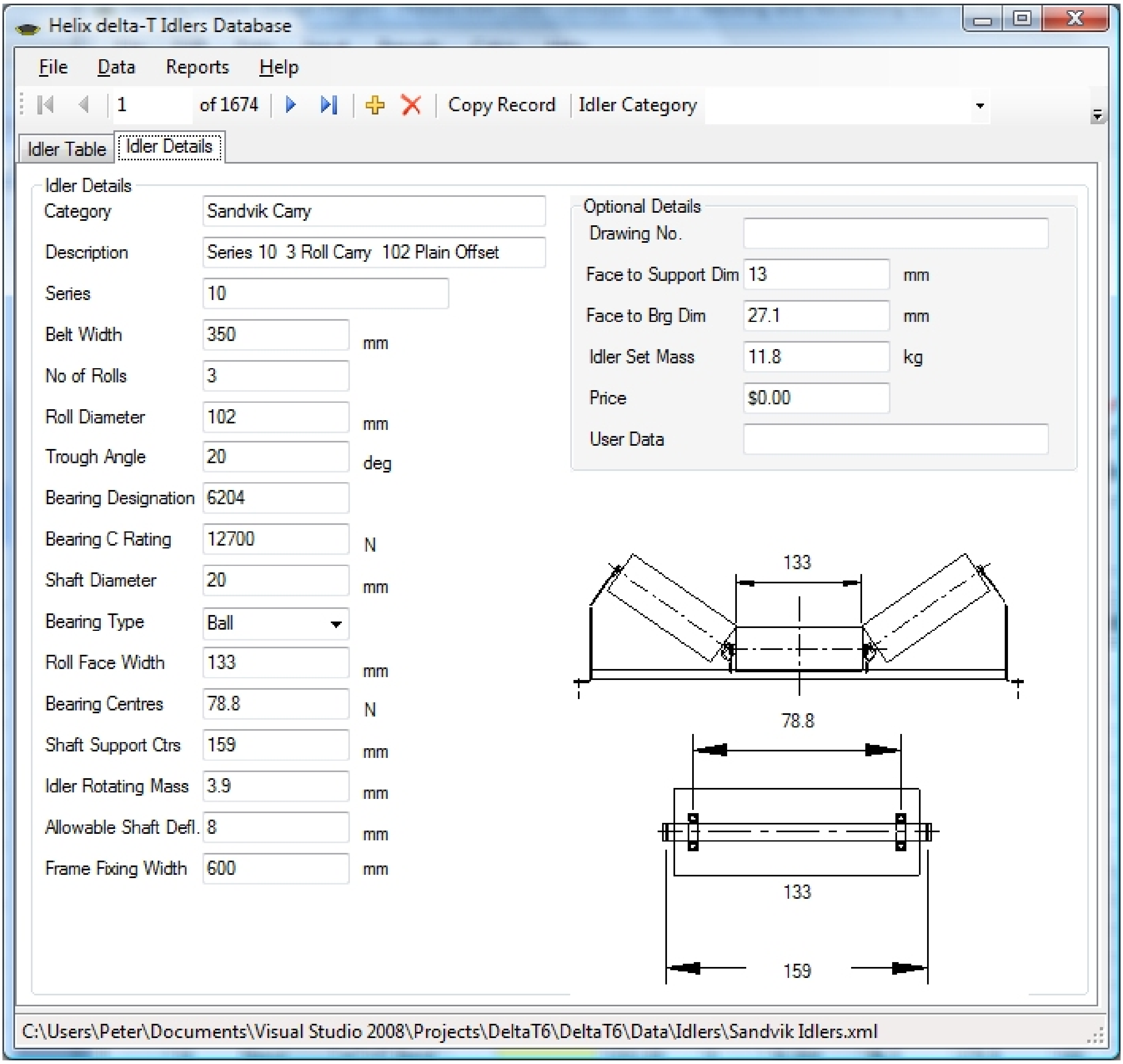


No	Category	Description	Metric	Low Bulk Density	High Bulk Density	Lump Size	Surcharge Angle
0	General	Aggregate Granite -19mm cr...	☑	1280	1440	19	20
1	General	ALFALFA MEAL	☑	270	270	3	10
2	General	ALFALFA PELLETS	☑	660	690	12	10
3	General	ALFALFA SEED	☑	160	240	3	10
4	General	ALMONDS	☑	450	480	10	25
5	General	ALUM FINE	☑	720	800	3	25
6	General	ALUM LUMPY	☑	800	960	15	25

Add your own data to the Database

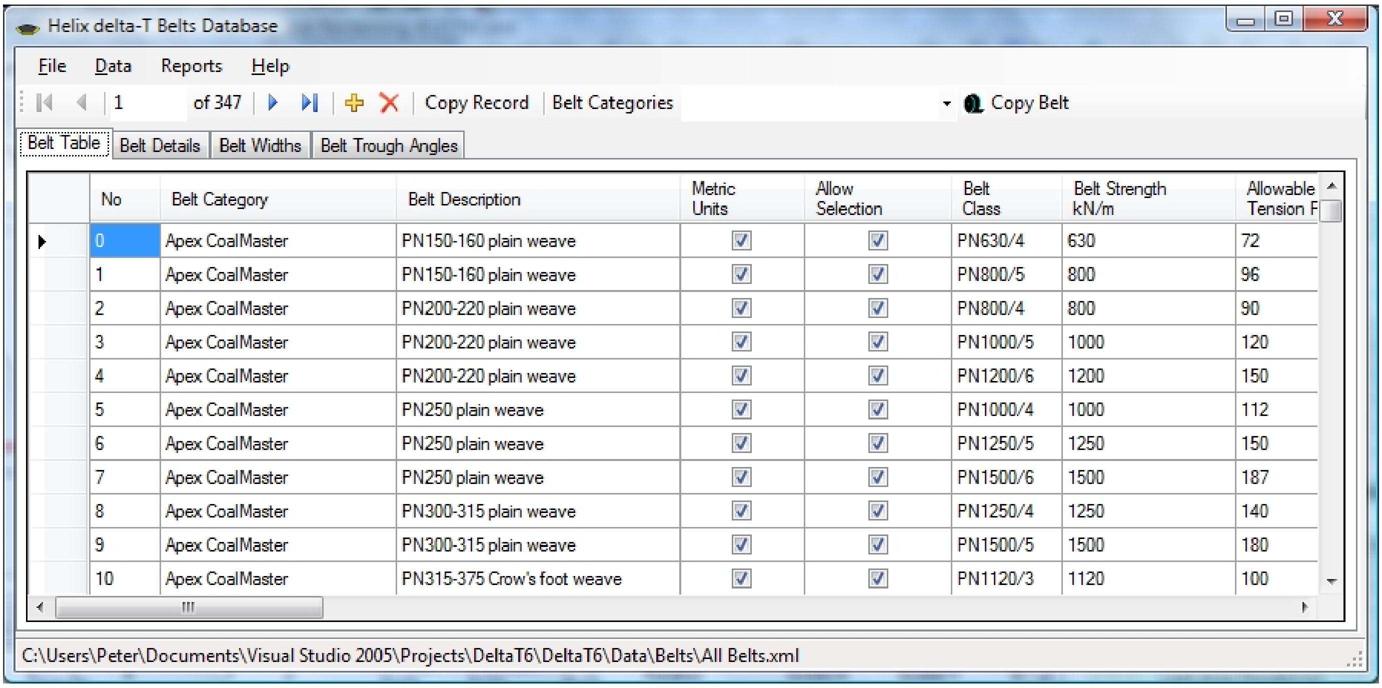
It is easy to add your own data or to import it from Excel® or text files. delta-T contains many different manufacturers catalogues and can save the user many hours of searching by providing equipment information at the click of a button.

Example of Idler Database detail view tab sheet



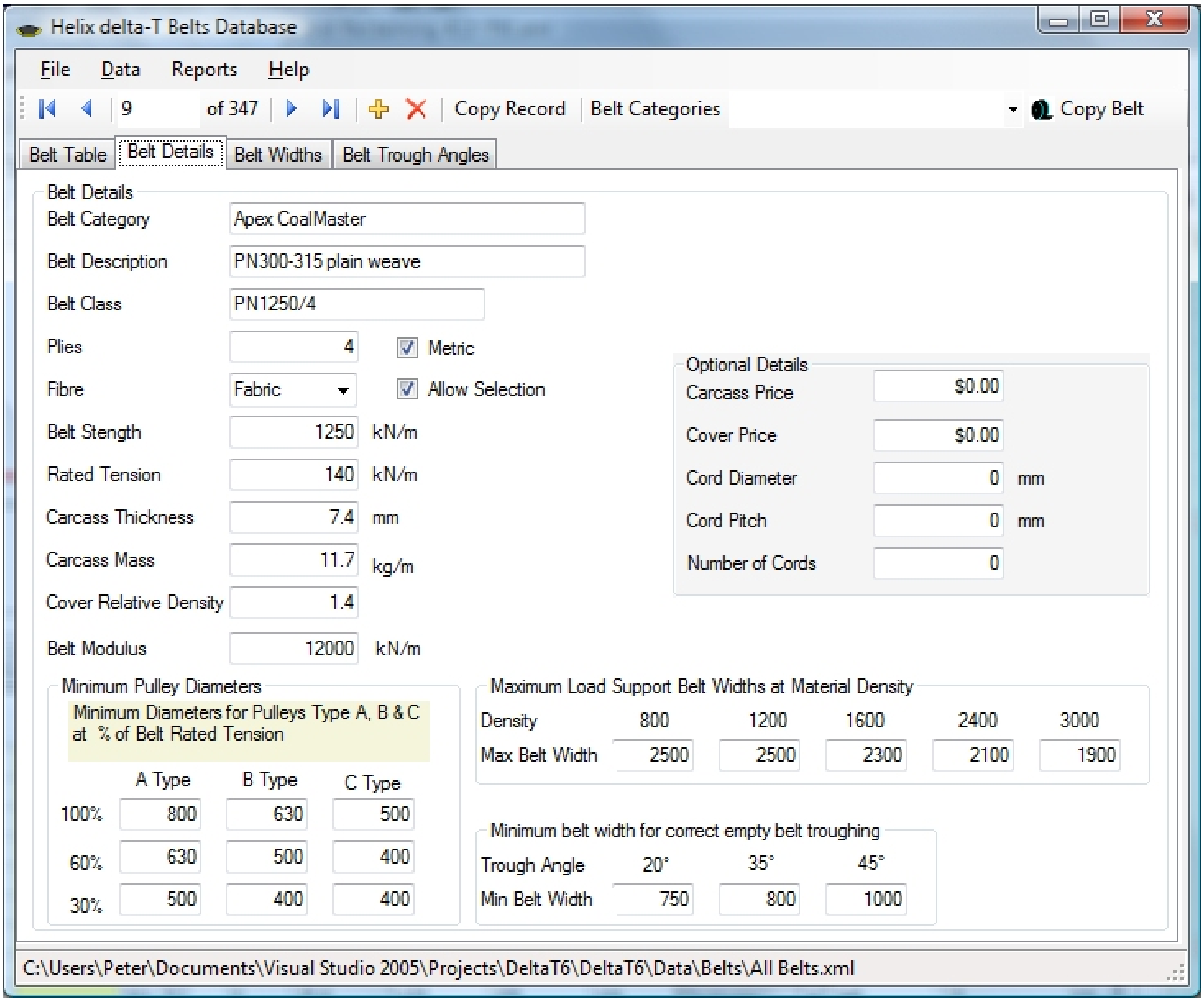
Samples of other database files such as Belts, Brakes, Couplings, Motors, Gearboxes and Starters follow

Belt Database Table

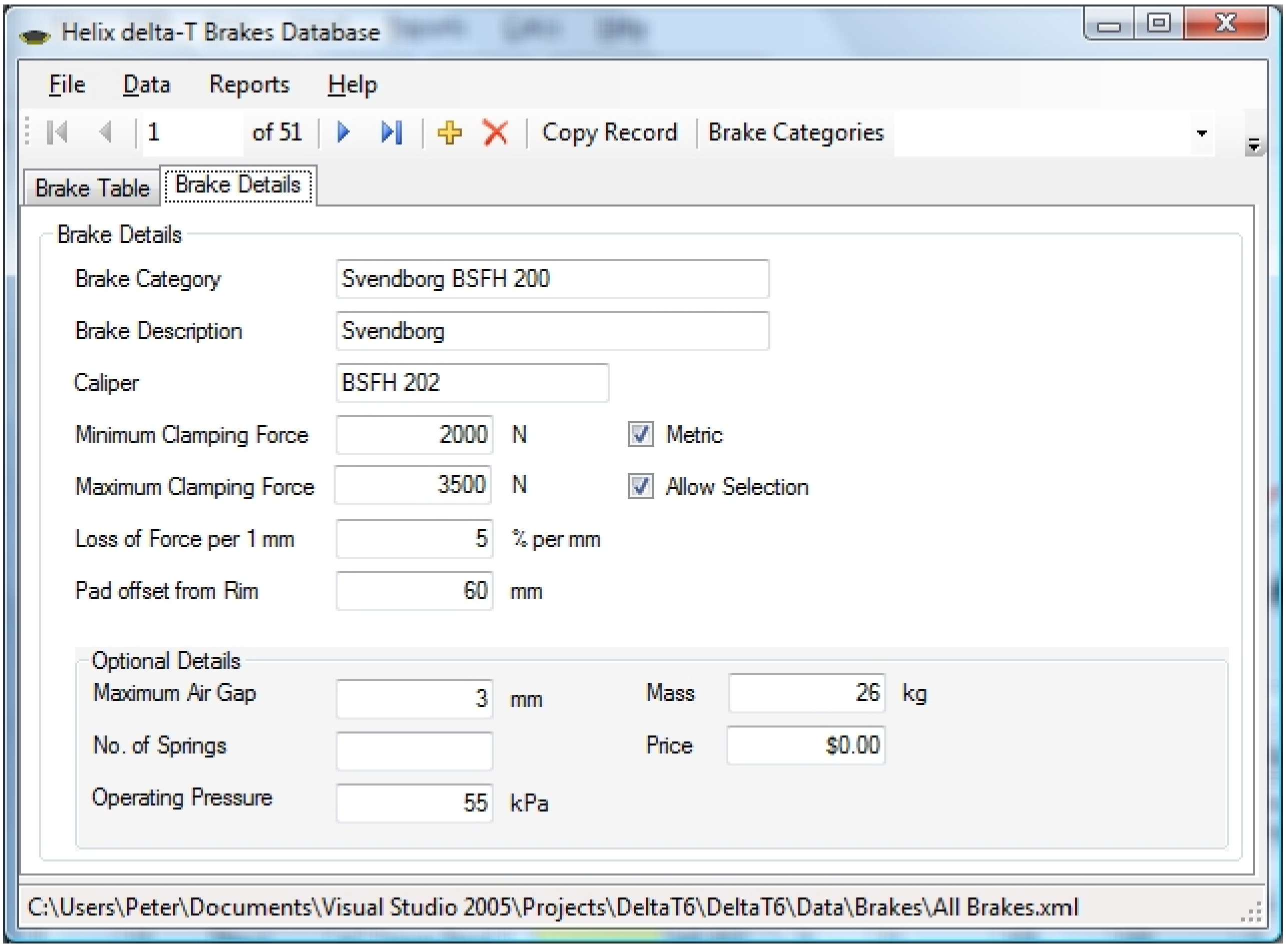


No	Belt Category	Belt Description	Metric Units	Allow Selection	Belt Class	Belt Strength kN/m	Allowable Tension F
0	Apex CoalMaster	PN150-160 plain weave	☑	☑	PN630/4	630	72
1	Apex CoalMaster	PN150-160 plain weave	☑	☑	PN800/5	800	96
2	Apex CoalMaster	PN200-220 plain weave	☑	☑	PN800/4	800	90
3	Apex CoalMaster	PN200-220 plain weave	☑	☑	PN1000/5	1000	120
4	Apex CoalMaster	PN200-220 plain weave	☑	☑	PN1200/6	1200	150
5	Apex CoalMaster	PN250 plain weave	☑	☑	PN1000/4	1000	112
6	Apex CoalMaster	PN250 plain weave	☑	☑	PN1250/5	1250	150
7	Apex CoalMaster	PN250 plain weave	☑	☑	PN1500/6	1500	187
8	Apex CoalMaster	PN300-315 plain weave	☑	☑	PN1250/4	1250	140
9	Apex CoalMaster	PN300-315 plain weave	☑	☑	PN1500/5	1500	180
10	Apex CoalMaster	PN315-375 Crow's foot weave	☑	☑	PN1120/3	1120	100

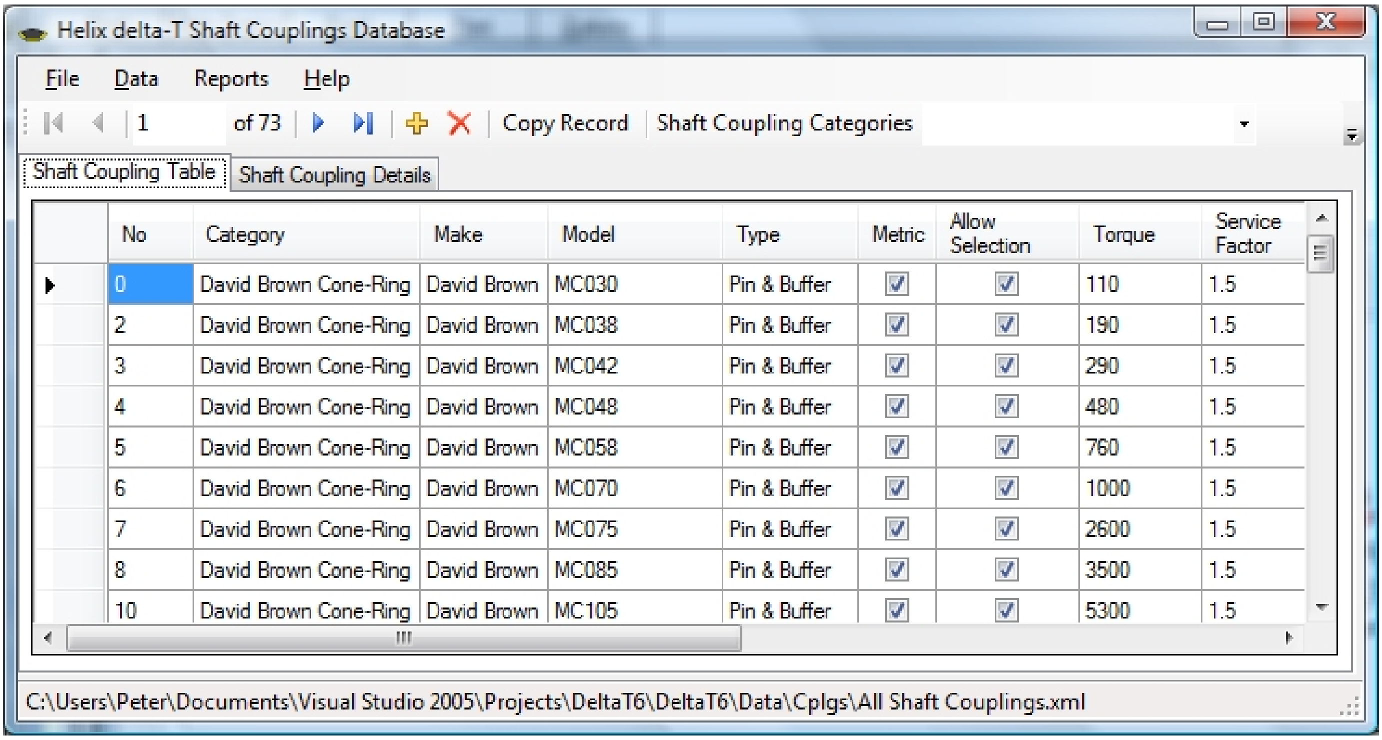
Belt Database Detail



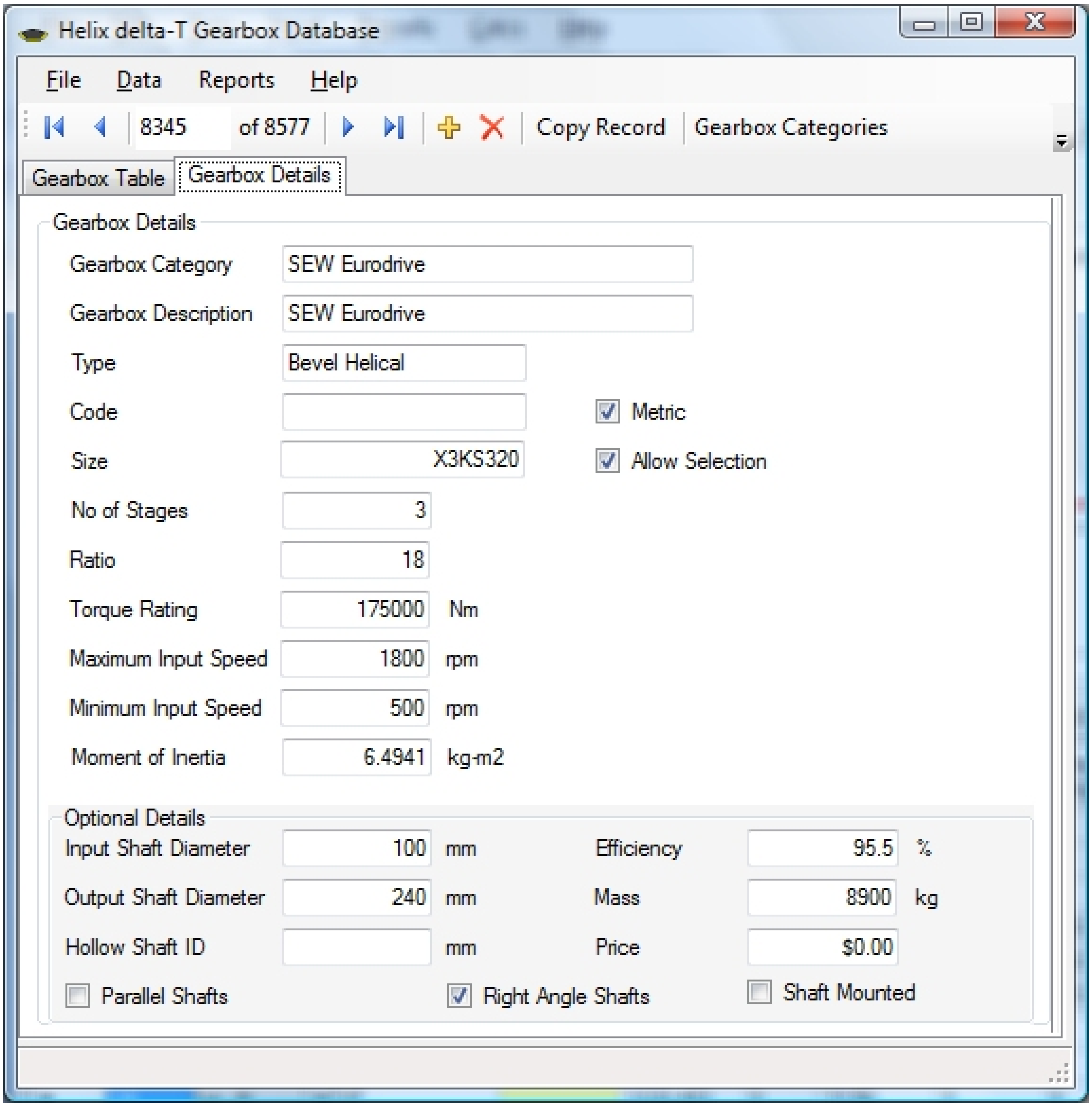
Brakes Database



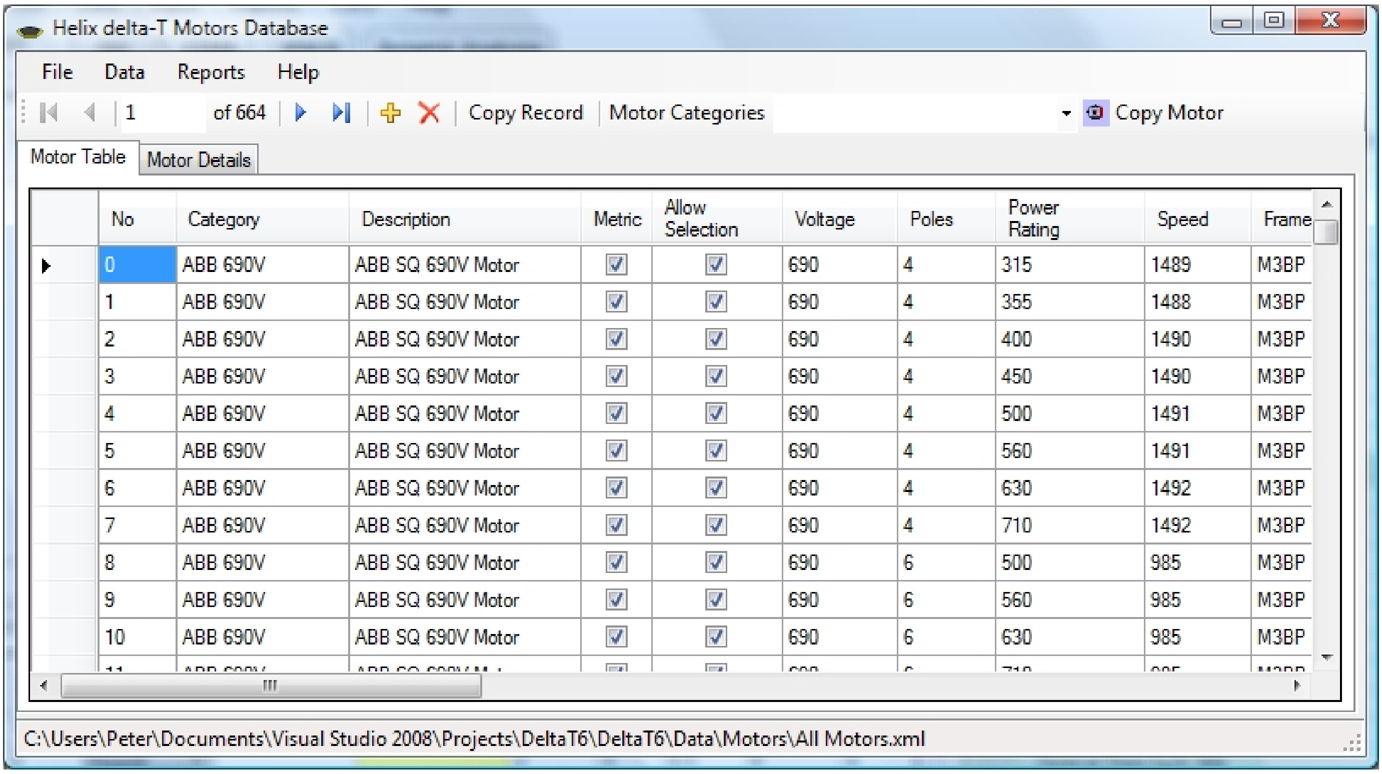
Couplings Database



Gearbox Database

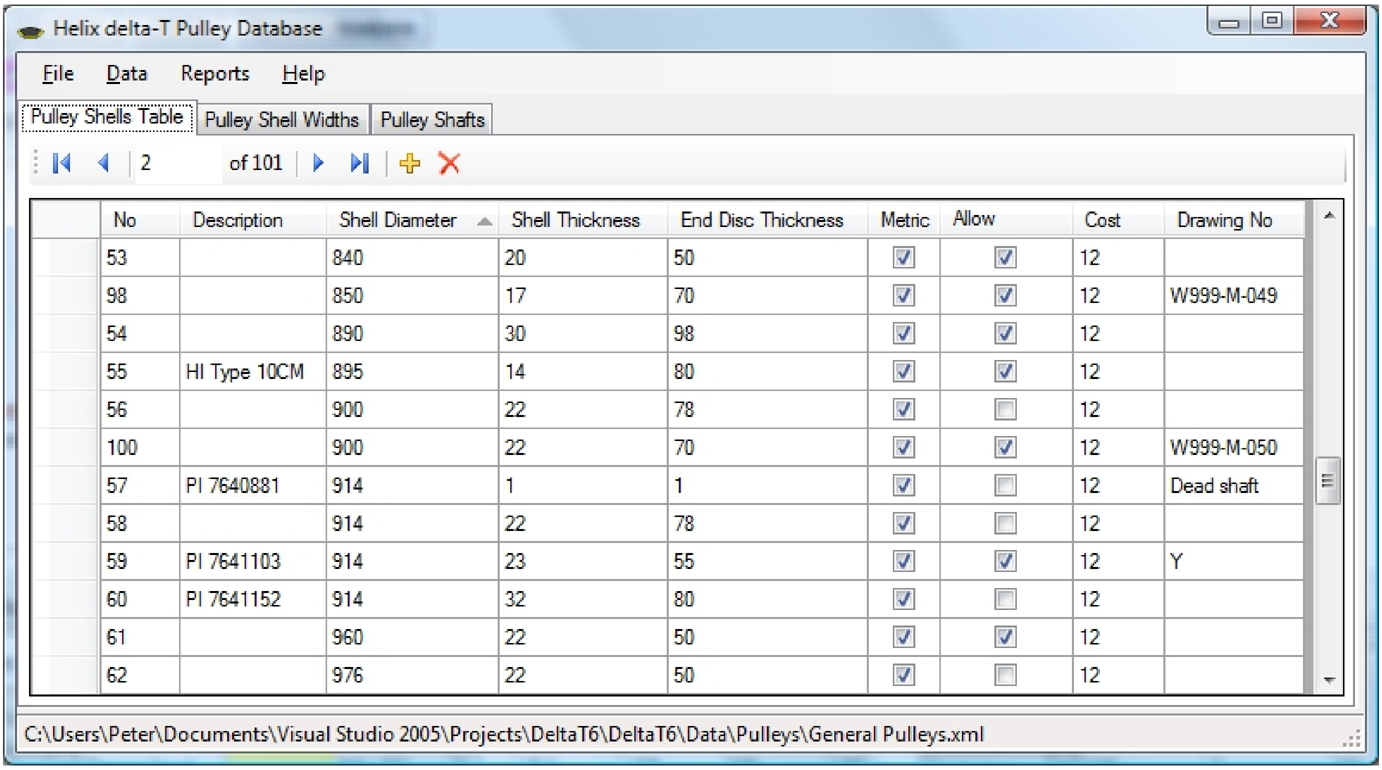


Motors Database

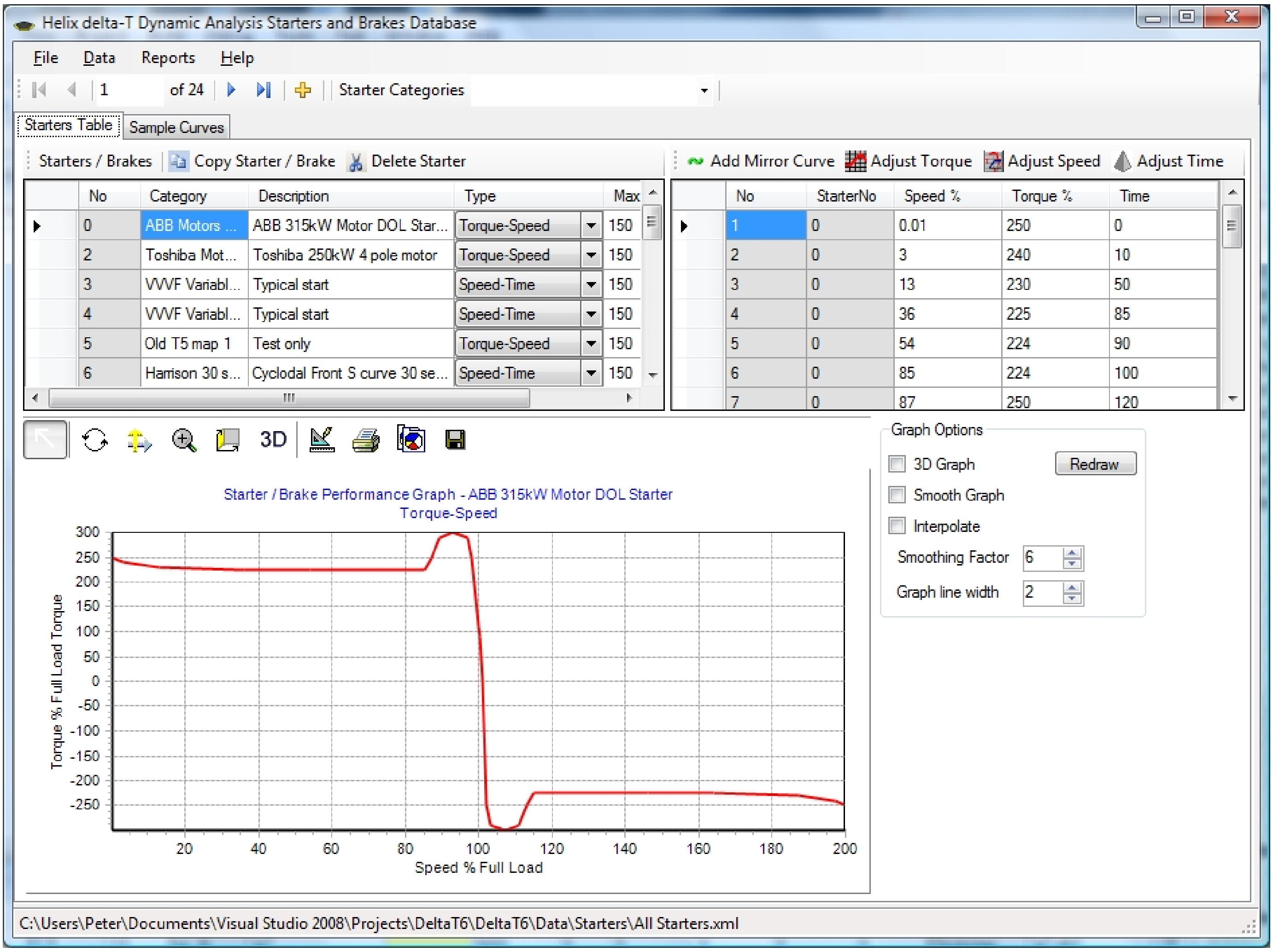


No	Category	Description	Metric	Allow Selection	Voltage	Poles	Power Rating	Speed	Frame
0	ABB 690V	ABB SQ 690V Motor	☑	☑	690	4	315	1489	M3BP
1	ABB 690V	ABB SQ 690V Motor	☑	☑	690	4	355	1488	M3BP
2	ABB 690V	ABB SQ 690V Motor	☑	☑	690	4	400	1490	M3BP
3	ABB 690V	ABB SQ 690V Motor	☑	☑	690	4	450	1490	M3BP
4	ABB 690V	ABB SQ 690V Motor	☑	☑	690	4	500	1491	M3BP
5	ABB 690V	ABB SQ 690V Motor	☑	☑	690	4	560	1491	M3BP
6	ABB 690V	ABB SQ 690V Motor	☑	☑	690	4	630	1492	M3BP
7	ABB 690V	ABB SQ 690V Motor	☑	☑	690	4	710	1492	M3BP
8	ABB 690V	ABB SQ 690V Motor	☑	☑	690	6	500	985	M3BP
9	ABB 690V	ABB SQ 690V Motor	☑	☑	690	6	560	985	M3BP
10	ABB 690V	ABB SQ 690V Motor	☑	☑	690	6	630	985	M3BP

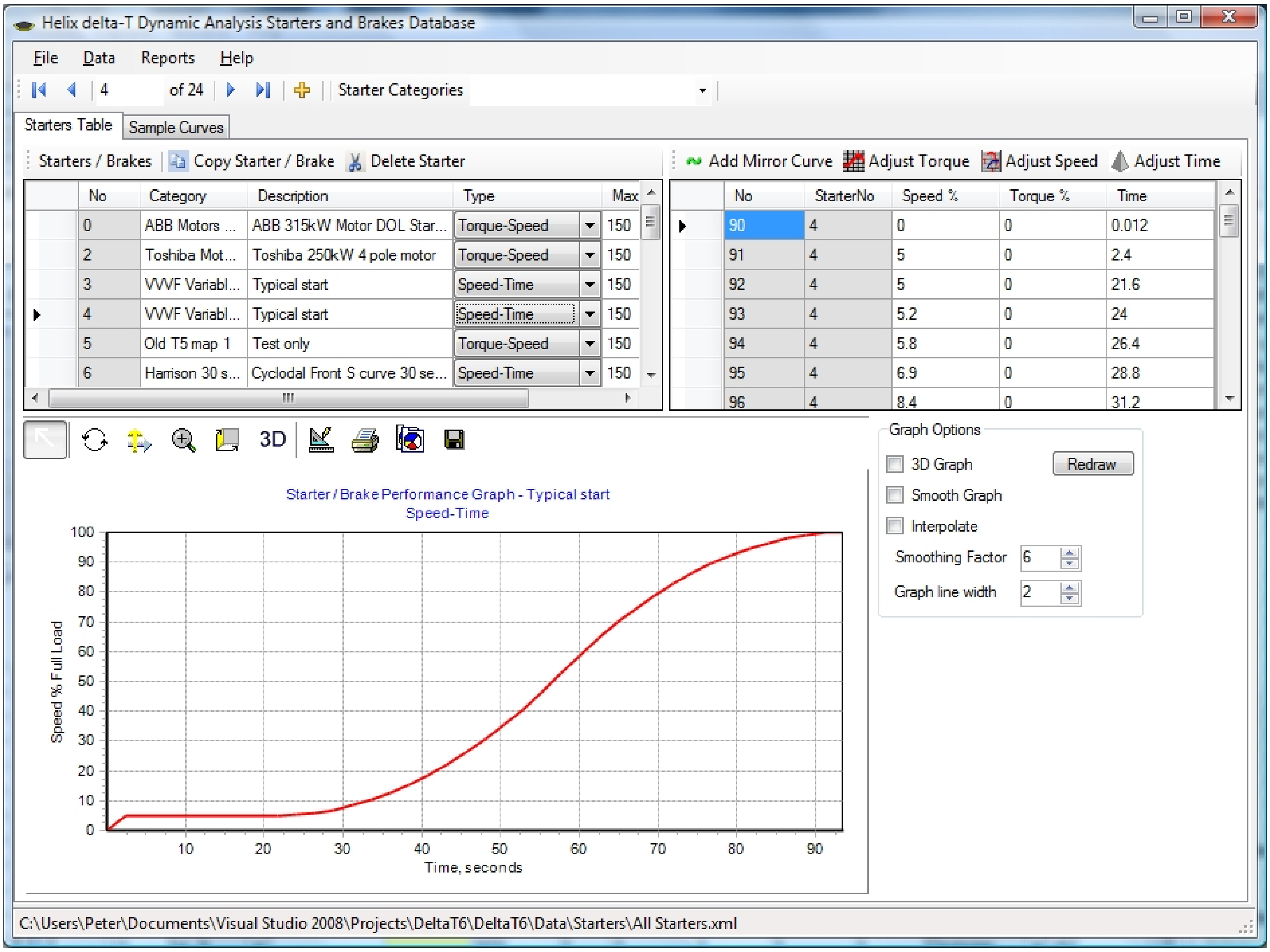
Pulley Database



Starters Database



Database for VVVF Variable Speed Starters



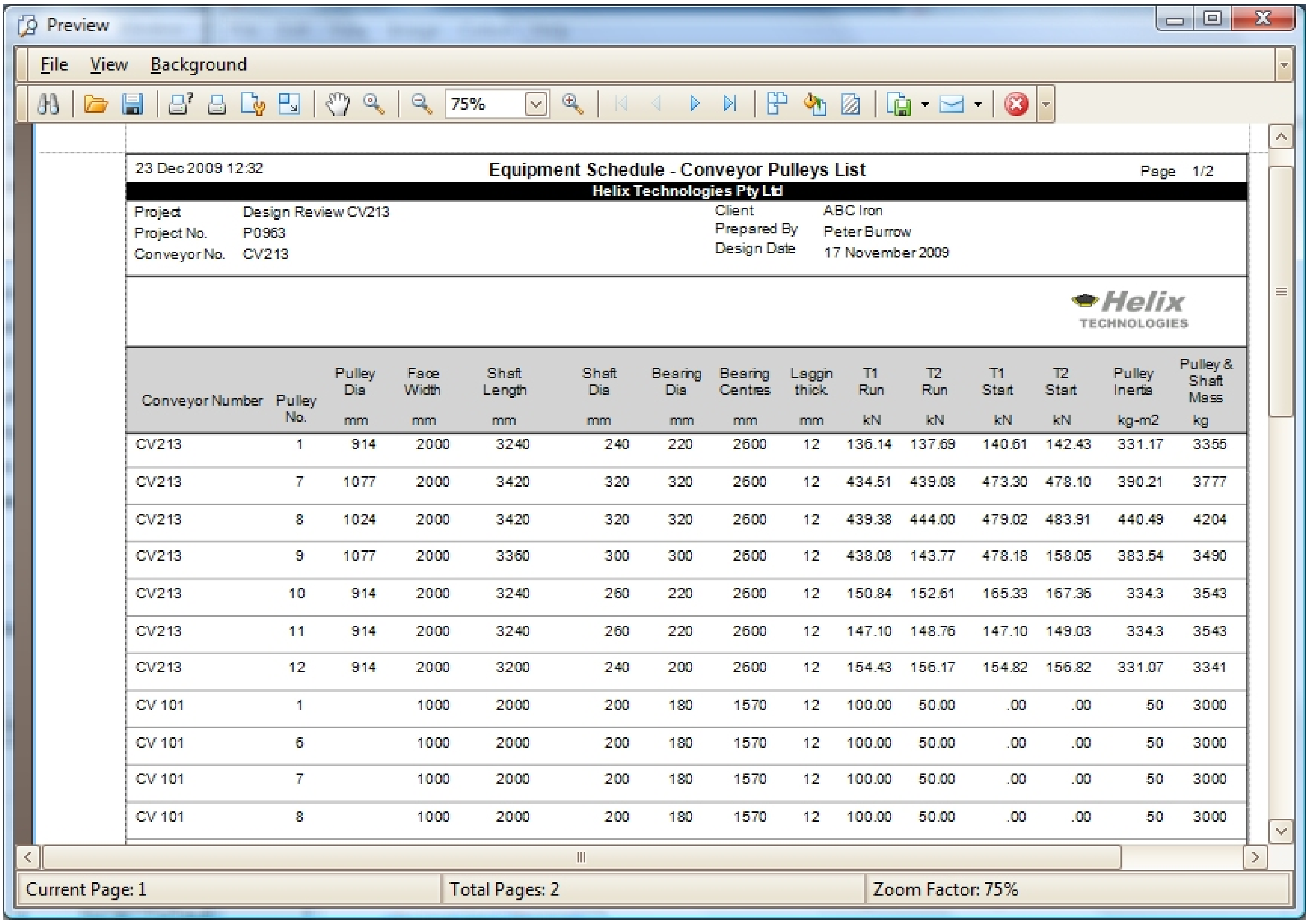
No more searching for equipment catalogues - it is built into the software.

Equipment Schedules

The delta-T6 program allows you complete your designs and then to rationalise the equipment by standardising where possible. You can then extract a list of equipment from multiple Design Files. These equipment schedules can then be sent to suppliers with requests for prices and also used as the basis of equipment and Spares Lists.

Equipment Schedule types include

- Conveyor Design Sumary
- Belt Schedule
- Idler Schedule
- Pulley Schedule
- Motors Schedule
- Fluid Couplings Schedule
- Gearbox Schedule
- Shaft Couplings Schedule
- Belt Tension Comparison between different load cases of same conveyor
- Design Summary Comparison between different load cases of same conveyor



23 Dec 2009 12:32

Equipment Schedule - Conveyor Pulleys List

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Helix Technologies Pty Ltd

Project Design Review CV213
Project No. P0963
Conveyor No. CV213

Client ABC Iron
Prepared By Peter Burrow
Design Date 17 November 2009

Conveyor Number	Pulley No.	Pulley Dia mm	Face Width mm	Shaft Length mm	Shaft Dia mm	Bearing Dia mm	Bearing Centres mm	Laggin thick. mm	T1 Run kN	T2 Run kN	T1 Start kN	T2 Start kN	Pulley Inertia kg-m2	Pulley & Shaft Mass kg
CV213	1	914	2000	3240	240	220	2600	12	136.14	137.69	140.61	142.43	331.17	3355
CV213	7	1077	2000	3420	320	320	2600	12	434.51	439.08	473.30	478.10	390.21	3777
CV213	8	1024	2000	3420	320	320	2600	12	439.38	444.00	479.02	483.91	440.49	4204
CV213	9	1077	2000	3360	300	300	2600	12	438.08	143.77	478.18	158.05	383.54	3490
CV213	10	914	2000	3240	260	220	2600	12	150.84	152.61	165.33	167.36	334.3	3543
CV213	11	914	2000	3240	260	220	2600	12	147.10	148.76	147.10	149.03	334.3	3543
CV213	12	914	2000	3200	240	200	2600	12	154.43	156.17	154.82	156.82	331.07	3341
CV 101	1		1000	2000	200	180	1570	12	100.00	50.00	.00	.00	50	3000
CV 101	6		1000	2000	200	180	1570	12	100.00	50.00	.00	.00	50	3000
CV 101	7		1000	2000	200	180	1570	12	100.00	50.00	.00	.00	50	3000
CV 101	8		1000	2000	200	180	1570	12	100.00	50.00	.00	.00	50	3000

Calculation Methods ...

HELIX delta-T Calculation Methods

Helix delta-T6 has three main methods for calculating conveyors:

ISO 5048
Calculation based ISO 5048 methods - similar to DIN 22101

CEMA
Calculation Conveyor Equipmeent Manufacturers' method

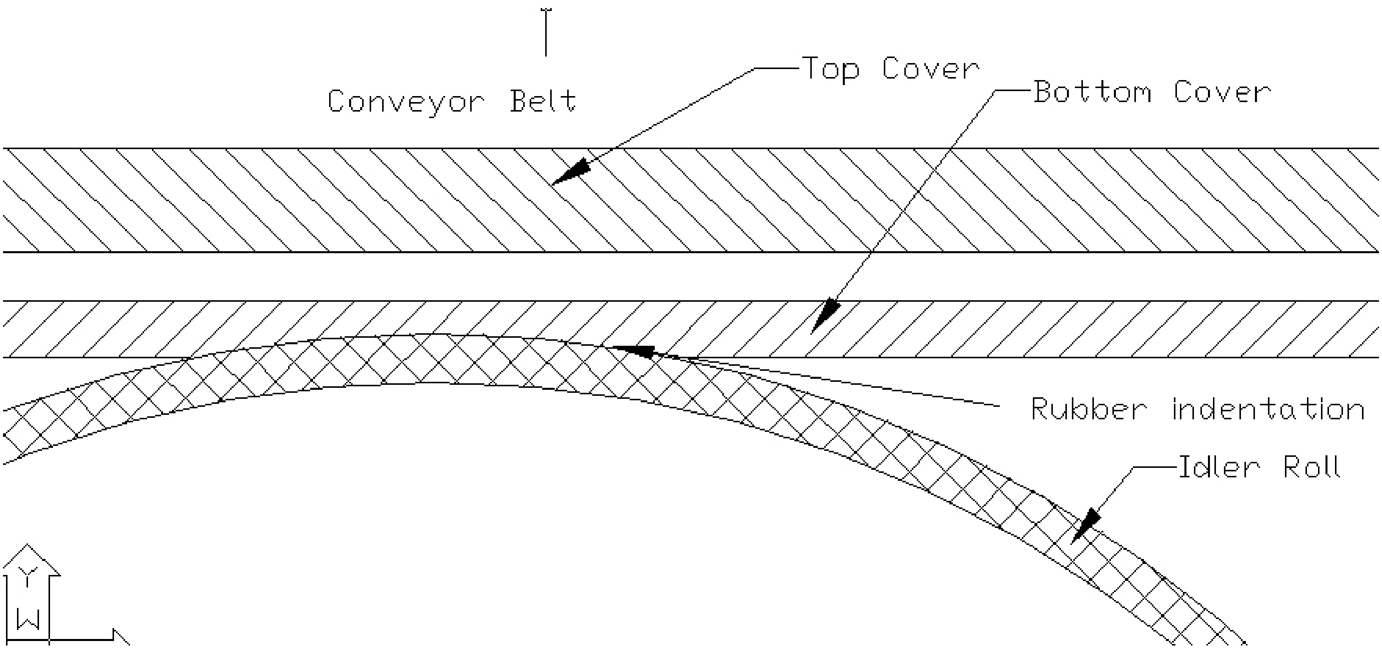
VISCO
Calculation based on conveyor belt rheology - uses the conveyor belt Rubber properties to calculate the friction factor

The ISO 5048 is the International Standard method and is closely related to the German DIN 22101 Standard. The Helix delta-T program follows the requirements of this standard with the addition of an automatic friction factor estimation based on belt sag. This f factor estimation has been successfully used to design and build many thousands of conveyors.

The CEMA (Conveyor Equipment Manufacturers Association) methed uses the methods and formulae detailed in the CEMA manual.

The VISCO method in the delta-T program uses the conveyor belt Rubber properties to calculate the belt - roller indentation and combines this with the material and belt flexure losses and idler drag and scuffing resistance to accurately calculate the friction factor of the conveyor. This method is a very accurate method of calculating conveyors as it takes into account the actual rubber properties of the belt to calculate the friction factor. This method allows the user to design conveyors which utilise the latest technology including the Low Resistance Rubber belts made by leading manufircturers around the world.

Viscoelastic Calculation Method

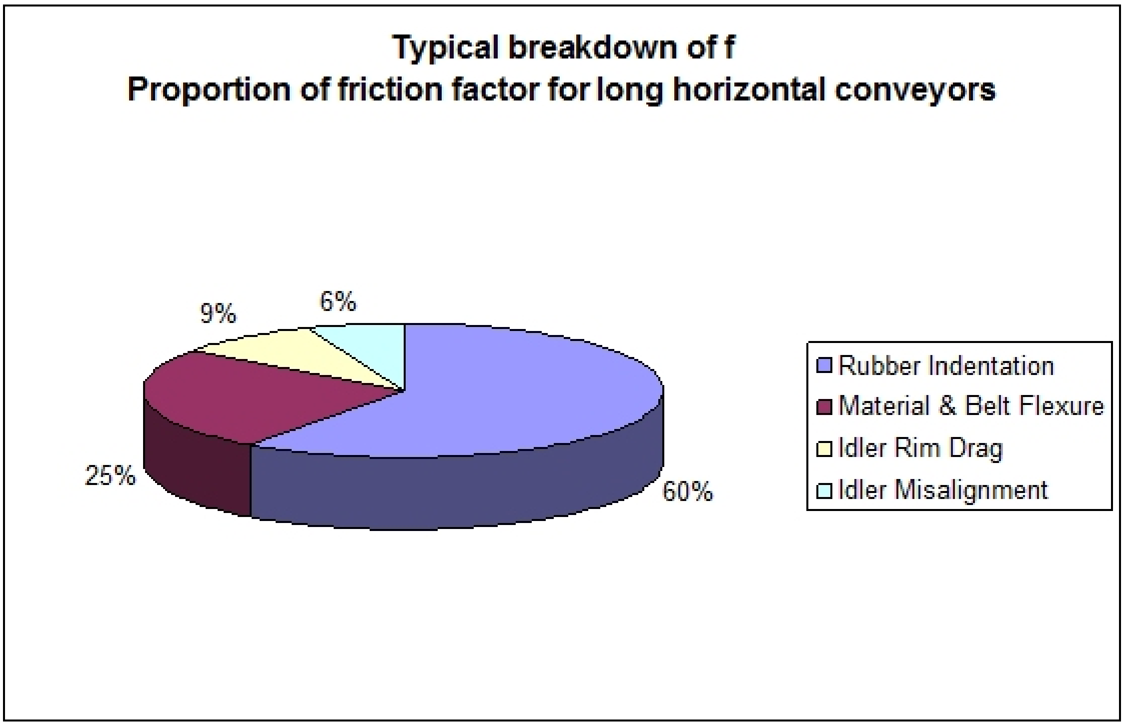


Indentation resistance is caused by the idler roll pressing into the relatively soft belt cover rubber. It is intuitively apparent that the more the penetration of the idler roll into the belt cover, the more resistance there is likely to be. Many people have researched this subject and names such as Jonkers, Spaans, Hager, Lodewijks and Wheeler come to mind. From this research it is evident that the main factors which affect the indentation resistance are the actual rubber properties of the belt cover, the diameter of the idler rolls and the load on the idler roll, which for a fixed tonnage and belt speed is dependent on the idler spacing.

Jonkers developed the following formula for the Indentation resistance

$$F'_{er} = 1.14 Tan(delta) \left(\frac{Z}{E' D^2 B_r} \right)^{\frac{1}{3}} (q_r B_r)^{\frac{4}{3}}$$

Typical makeup of the friction of a long overland conveyor



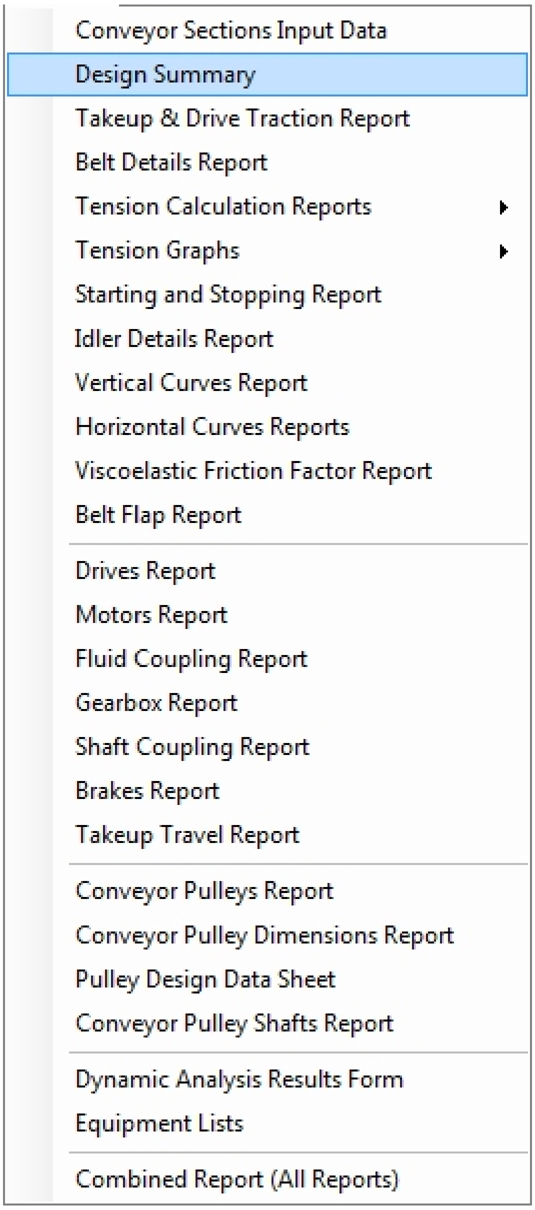
With delta-T it is very easy to compare the different methods - simply build your conveyor model and then press the ISO, CEMA and VISCO buttons to compare the results.

Design Reports ...

HELIX delta-T Design Reports

Helix delta-T6 has more than 70 design reports which can be viewed, printed and exported to other applications such as MS Word® Excel® or PDF® file formats plus others. You can also choose reports from a list and compile a single composite report and save it as PDF® file.

You can view a sample report by clicking the following link: Sample Design report - pdf file (/DownloadFiles/Helix_delta-T6_Sample_Report01.pdf)



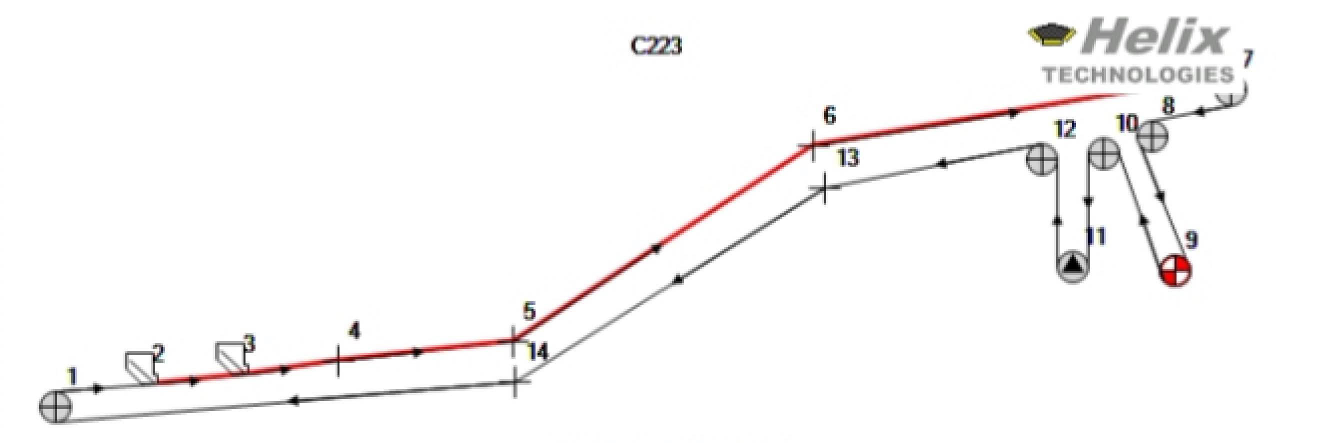
View of some sample reports follow:

Design Summary

24 Mar 2010 12:34 **Conveyor Design Summary** Page 1/1

Helix Technologies Pty Ltd

Project	Demo Conveyor High Lift	Client	ABC Iron
Project No.	P9823	Prepared By	Peter Burrow
Conveyor No.	C223	Design Date	14 January 2010



Conveyed Material					
Material Description	***Iron ore, Lump & Fines Product***		Surcharge Angle	***15***	deg
Low Bulk Density	***1860***	kg/m3	Angle of Repose	***34***	deg
High Bulk Density	***2400***	kg/m3	Material Lump size	***31.5***	mm
Conveyor Data					
Conveying Distance	287.57	m	Design Capacity	***9400***	tonnes/hr
Nett Lift / Lower (-)	33.44	m	Belt Speed	***4.3***	m/s
Belt Details					
Belt Width Selected	***1800***	mm	Calculated Belt % Full	90.5	%
Belt Class & Run Safety Factor	***ST-1800***	7.58	Top Cover Thickness	***22***	mm
Belt Rated Tension	***253***	kN/m	Bottom Cover Thickness	***7***	mm
Belt Total Length	630.7	m	Belt Mass	81.70	kg/m
Belt Tensions and Power Calculations ISO					
Effective Tens. Fully Loaded	296.86	kN	Belt Power - Empty Belt	106.51	kW
Maximum Tension Tmax	427.57	kN	Belt Power - Inclines Loaded	1251.3	kW
Minimum Tension Tmin	119.30	kN	Belt Power - Declines Loaded	227.31	kW
Sag Tension 1.1 %	76.78	kN	Belt Power - Fully Loaded	1276.51	kW
Takeup Type	***Vertical Gravity***		Drive Efficiency	***95.0***	%
Takeup Mass	***26700***	kg	Absorbed Power Fully Loaded	1315.94	kW
Takeup Pulley Belt Tension	***130.92***	kN	Installed Motor Power	1260	kW
Carry and Return Idlers					
Carry Idler Trough Angle	***35***	°	Return Idler Trough Angle	***0***	°
Carry Idler Spacing	***1***	m	Return Idler Spacing	***3***	m
Carry Idler No Rolls x Dia	***3 x 152***	mm	Return Idler No Rolls x Dia	***1 x 152***	mm
Dynamics and Miscellaneous Data					
Startup Factor - Fully Loaded	***122***	%	CEMA Temperature Factor Kt	***1.00***	
Startup Factor - Empty	***122***	%	Total Braking Torque LSS	26.50	kNm
Starting Time - Fully Loaded	***25.80***	sec	Stop Time - Loaded, Braking	***4.26***	sec
Starting Time - Empty	***2.33***	sec	Stop Time - Loaded, Coasting	***5.01***	sec

Belt Details

24 Mar 2010 14:11	**Belt Details Report**	Page 1/1

Helix Technologies Pty Ltd

Project	Demo Conveyor High Lift	Client	ABC Iron
Project No.	P9823	Prepared By	Peter Burrow
Conveyor No.	C223	Design Date	14 January 2010

Low BD = 1860kg/m3 High BD = 2400kg/m3

Conveyed Material

Material Description	*Iron ore, Lump & Fines Product*	
Low Bulk Density	*1860*	kg/m3
High Bulk Density	*2400*	kg/m3
Surcharge Angle	*15*	deg
Angle of Repose	*34*	deg
Material Lump size	*31.5*	mm

Belt Make & Class

Belt Category	*Bando Steel*	
Belt Description	*BANDO STEEL CORD*	
Belt Class / Plies	*ST-1800*	*0*
Belt Reinforcement Fibre	*Steel*	
Belt Width Selected	*1800*	mm
Belt Modulus	*129600*	kN/m
Cord Diameter	*4.4*	mm
Cord Pitch	*10.0*	mm
Number of Cords	*0*	

Belt Tensions

Belt Rated Tension / m width	*253*	kN/m
Calculated Tension / m width	237.5	kN/m
Belt Rated Tension for width	*455.4*	kN
Calculated Max Run Tension	427.57	kN
Minimum Tension Tmin	119.30	kN
Allowable Tension Rise, Starting	*150*	%
Allowable Belt Tension, Starting	683.1	kN
Actual Belt Tension, Starting	467.85	kN

Belt and Material Mass

Belt Top Cover Mass	44.7	kg/m
Belt Bottom Cover Mass	14.2	kg/m
Belt Carcass Mass	21.1	kg/m
Belt Mass Wb (per linear m)	81.7	kg/m
Material Mass Wm	607.2	kg/m
Total Mass (Wb + Wm)	688.9	kg/m
Total Belt Mass (Wb x L)	51528	kg

Belt Speed & Capacity

Belt Speed	*4.3*	m/s
Belt Design Capacity Input	*9400*	tonnes/hr
Section Loading Max Capacity	*9400*	tonnes/hr
Carry Idler Trough Angle	*35*	°

Belt Dimensions

Top Cover Thickness	*22*	mm
Bottom Cover Thickness	*7*	mm
Belt Carcass Thickness	*4.4*	mm
Belt Total Thickness	33.4	mm
Belt Total Belt Length (L)	630.7	m
Time for 1 Revolution	146.7	sec

Belt Load Area and Capacity at 1860kg/m3

Minimum Rec. Edge Distance	122	mm
Actual Edge Distance Low BD	150	mm
Load Burden Depth	305	mm
Load Burden Width	1208	mm
Belt Load Area at Minimum Recommended Edge Distance	0.3608	m2
Belt Load Area Utilised at Low Bulk Density	0.3265	m2
Belt Actual % Full at Low BD	90.5	%

Belt Load Area and Capacity at 2400kg/m3

Minimum Rec. Edge Distance	122	mm
Actual Edge Distance High BD	230	mm
Belt Load Area Utilised at High Bulk Density	0.253	m2
Belt Actual % Full at High BD	70.1	%

Flooded Belt Capacity at 2400kg/m3

Flooded Belt Load Area at Zero Edge Distance	0.4846	m2
Flooded Belt Capacity	18003	tonnes/hr
Flooded Belt Material Mass	1163	kg/m

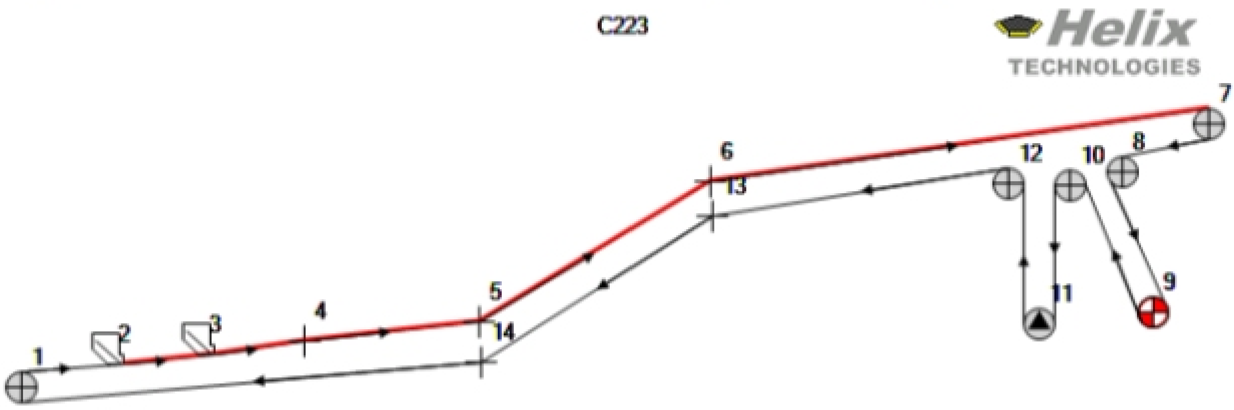
Designers Comments

Drive Details

24 Mar 2010 15:13 **Drive Details Report** Page 1/1

Helix Technologies Pty Ltd

Project	Demo Conveyor High Lift	Client	ABC Iron
Project No.	P9823	Prepared By	Peter Burrow
Conveyor No.	C223	Design Date	14 January 2010



Drive No.	1 Drive	
Drive Description	Head	
Load Share on Drive Pulley	100	%
Starting Torque Factor, Fully Loaded	122	%
Starting Torque Factor, Empty	122	%
Number of Motors on Drive Pulley	2	
Motor Description	Toshiba Wound Rotor TIM	
Motor Power Rating	630	kW
Motor Voltage	6600	Volts
Gearbox Description	Falk M505AB2	
Drive Efficiency	95	%
High Speed Coupling		
HS Coupling Make	Falk	
HS Coupling Model	1120T35	
Low Speed Coupling		
LS Coupling Make	Falk	
LS Coupling Model	1080 / 505 MCFAS	
Brake		
Brake Location	High Speed Side	
Low Speed Brake Torque Input	26.5	kNm
Equiv HS Brake Torque	2271	Nm
Holdback		
Static Analysis Runback Force Fv	199153	kN
Static Analysis Horizontal Force Fh	97707	kN
Calculated Holdback Torque	76953	Nm
Holdback Required (Yes / No)	Yes	Fv>Fh/2
Holdback Torque 3 x Motor FLT	450117	Nm

Pulley No.	9	
Pulley Condition	Moist	
Pulley Lagging Type	Ceramic	
Belt Wrap Angle	180	°
Coefficient of Friction, Running	0.35	
Drive Factor Cw, Running	0.5	
Coefficient of Friction, Starting	0.45	
Drive Factor Cw, Starting	0.32	
Pulley and Shaft Dimensions		
Pulley Shell Diameter	1000	mm
Pulley Lagging Thickness	12	mm
Pulley Outside Diameter	1024	mm
Pulley Shaft Diameter at Hub	320	mm
Pulley Shaft Diameter at Brg	240	mm
Pulley and Belt Speed		
Motor Full Load Speed	985	rpm
Required Gearbox Ratio	12.282	:1
Selected Gearbox Ratio	12.21	:1
Required Pulley Speed	80.2	rpm
Calculated Pulley Speed for Reducer	80.67	rpm
Required Belt Speed	4.3	m/s
Calculated Belt Speed	4.33	m/s
Drive Inertia		
Motor Inertia	74.1	kg-m2
High Speed Coupling Inertia	0.514	kg-m2
High Speed Brake Disc Inertia	8.8	kg-m2
Flywheel Inertia	0	kg-m2
Gearbox Inertia (HSS)	0	kg-m2
Total Drive Inertia	170.374	kg-m2
Total Drive Equivalent Mass	98038	kg

Idler Details

24 Mar 2010 14:25

Conveyor Idler Details Report

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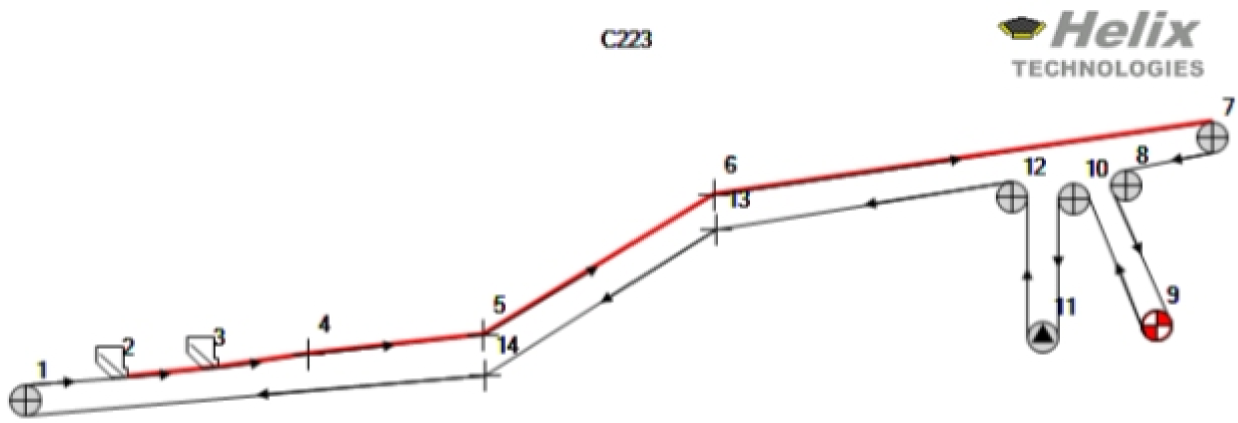
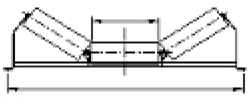
Helix Technologies Pty Ltd

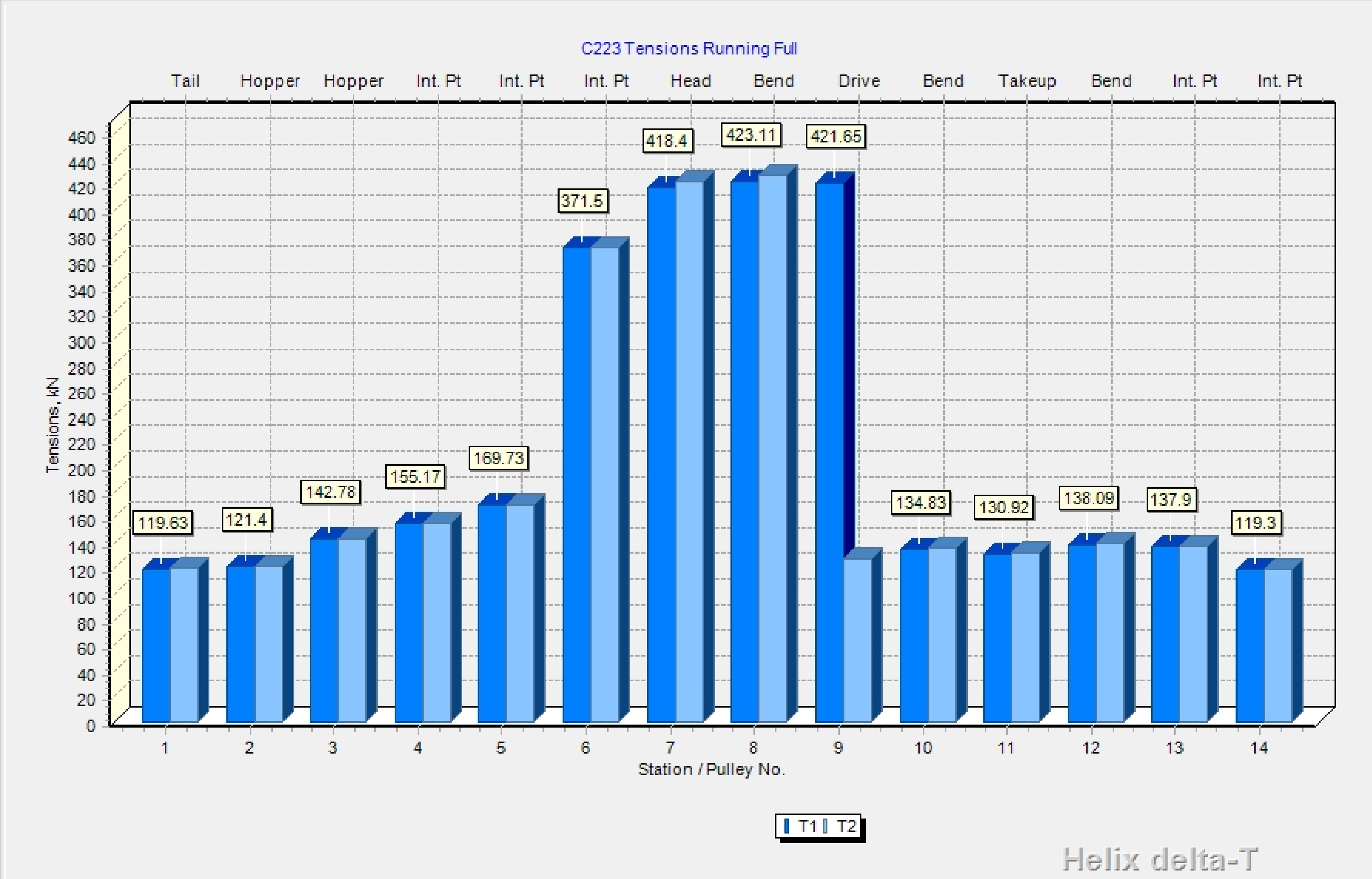
Project	Demo Conveyor High Lift	Client	ABC Iron
Project No.	P9823	Prepared By	Peter Burrow
Conveyor No.	C223	Design Date	14 January 2010





	Carry Side Idlers		Return Side Idlers	
Idler Category	*Prok Carry*		*Prok Flat Return*	
Idler Description	*Series 55 3 Roll Carry 152 Plain Inline*		*Series 45 1 Roll Flat Carry 152 Dia*	
Idler Design Belt Width	*1800*	mm	*1800*	mm
Idler Series	*55*		*45*	
Drawing Number				
Nominal Idler Spacing	*1*	m	*3*	m
Total Number of Idlers	240		111	
Idler Price	*0*		*0*	
Troughing Angle	*35.0*	deg	*0.0*	deg
Idler Shaft Diameter	*45.0*	mm	*45.0*	mm
Idler Bearing Diameter	*45.0*	mm	*35.0*	mm
Number of Idler Rolls	*3*		*1*	
Idler Roll Diameter	*152*	mm	*152*	mm
Idler Rotation Speed	540	rpm	540	rpm
Roll Face Width	*633*	mm	*2050*	mm
Roll Bearing Centres	*535.9*	mm	*1976.2*	mm
Shaft Support Centres	*659.5*	mm	*2078*	mm
Idler Support Fixing Width	*2200*	mm	*2200*	mm
Idlerset Rotating Mass	*34.2*	kg	*31.6*	kg
Idlerset Total Mass	*117.4*	kg	*67.6*	kg
Idler Vertical Misalignment Allowance	*4.0*	mm	*36.0*	mm
Dynamic Load Factor	1.26		1.40	
Belt Deviation Load	*667*	N	*500*	N
Total Load on Centre Roll	6,316	N	4,680	N
Type of Bearing	*Ball*		*Ball*	
Bearing Designation	*6309*		*6307*	
Bearing Dynamic Load Rating C	*52,700*	N	*33,200*	N
Bearing L10h Life	143,377	hrs	88,120	hrs
Allowable Shaft Deflection at Bearing	*8.00*	min	*10.00*	min
Actual Shaft Deflection at Bearing	4.25	min	9.57	min

Belt Tension Graphs



Belt Tension Summary Report

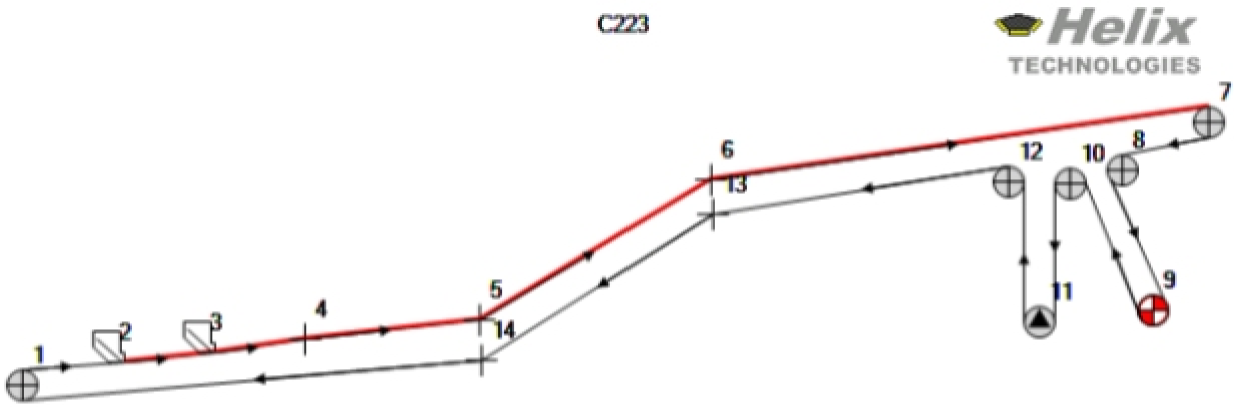
24 Mar 2010 16:35

Tension Calculations - Summary Run / Start

Page 1/1

Helix Technologies Pty Ltd

Project	Demo Conveyor High Lift	Client	ABC Iron
Project No.	P9823	Prepared By	Peter Burrow
Conveyor No.	C223	Design Date	14 January 2010



Drive Torque Start-up Factor Loaded 122 %

Drive Torque Start-up Factor Empty 122 %

Takeup Mass 26700 kg

Station No	Running				Starting		Braking		Coasting	
	Fully Loaded Tension kN	Empty Tension kN	Inclines Loaded Tension kN	Declines Loaded Tension kN	Fully Loaded Tension kN	Empty Tension kN	Fully Loaded Tension kN	Empty Tension kN	Fully Loaded Tension kN	Empty Tension kN
1 Tail	119.63	119.63	119.63	119.63	123.97	167.80	93.34	107.97	97.24	115.85
2 Hopper	121.40	121.40	121.40	121.40	126.07	173.17	93.16	108.87	97.35	117.35
3 Hopper	142.78	121.88	142.78	139.75	148.49	176.02	108.25	108.78	113.37	117.64
4 Int. Pt	155.17	122.39	155.19	149.09	162.27	179.69	112.23	108.52	118.60	117.90
5 Int. Pt	169.73	123.86	169.90	152.10	180.83	187.65	102.58	108.42	112.55	118.87
6 Int. Pt	371.50	147.48	372.70	175.72	402.09	243.04	186.38	124.35	213.86	140.00
7 Head	418.40	153.10	420.71	181.34	457.41	263.03	182.28	126.49	217.33	144.49
8 Bend	423.11	155.13	422.74	183.37	463.07	275.56	181.26	125.97	217.16	145.69
9 Drive	421.65	150.95	418.56	179.19	462.11	277.01	176.72	120.43	213.08	141.07
10 Bend	134.83	134.85	134.85	134.85	149.38	132.84	138.95	135.24	140.55	135.81
11 Takeup	130.92	130.92	130.92	130.92	130.92	130.92	130.92	130.92	130.92	130.92
12 Bend	138.09	138.09	138.09	138.09	138.38	141.38	136.29	137.29	136.56	137.83
13 Int. Pt	137.90	137.90	137.90	137.90	138.80	147.87	132.46	135.48	133.26	137.12
14 Int. Pt	119.30	119.30	119.30	119.30	122.73	157.30	98.56	110.10	101.64	116.32
Minimum Ten	**119.30**	**119.30**	**119.30**	**119.30**	**122.73**	**130.92**	**93.16**	**107.97**	**97.24**	**115.85**
Maximum Ten	**423.11**	**155.13**	**422.74**	**183.37**	**463.07**	**277.01**	**186.38**	**137.29**	**217.33**	**145.69**
Effective Ten	**296.86**	**24.77**	**291.00**	**52.86**						
Ave. Belt Ten	**222.02**	**134.26**	**222.32**	**149.11**	**236.79**	**192.64**	**135.29**	**120.12**	**148.23**	**129.71**
Belt Elong. m	**0.262**	**0.025**	**0.263**	**0.065**	**0.302**	**0.183**	**0.028**	**-0.013**	**0.063**	**0.012**
T/up Travel m	**0.131**	**0.012**	**0.132**	**0.032**	**0.151**	**0.092**	**0.014**	**-0.006**	**0.032**	**0.006**

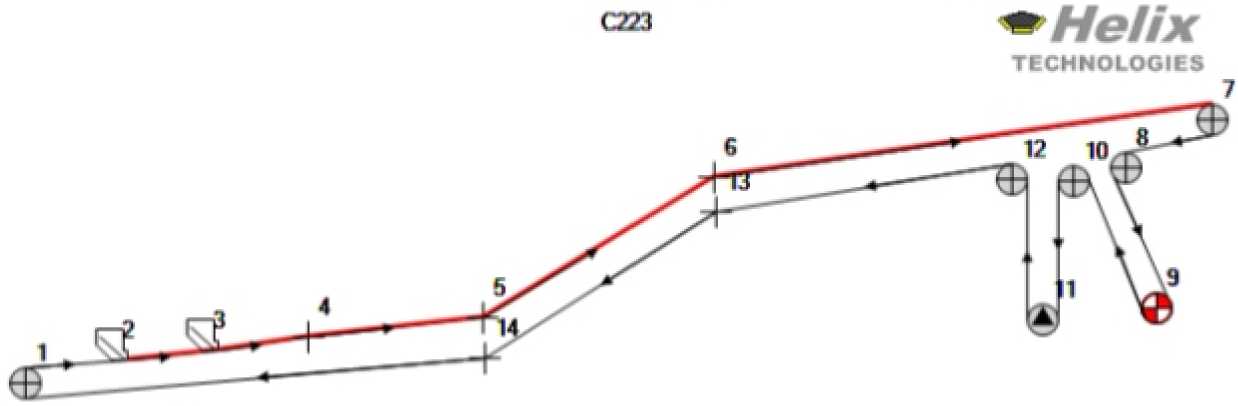
Designers Comments

Belt Sag Summary Report

24 Mar 2010 16:37 **Tension Calculations - Summary Belt Sag** Page 1/2

Helix Technologies Pty Ltd

Project	Demo Conveyor High Lift	Client	ABC Iron
Project No.	P9823	Prepared By	Peter Burrow
Conveyor No.	C223	Design Date	14 January 2010



Allowable Belt Sag % Running 1.1 %

Allowable Belt Sag % Start / Stop 5 %

Takeup Mass 26700 kg

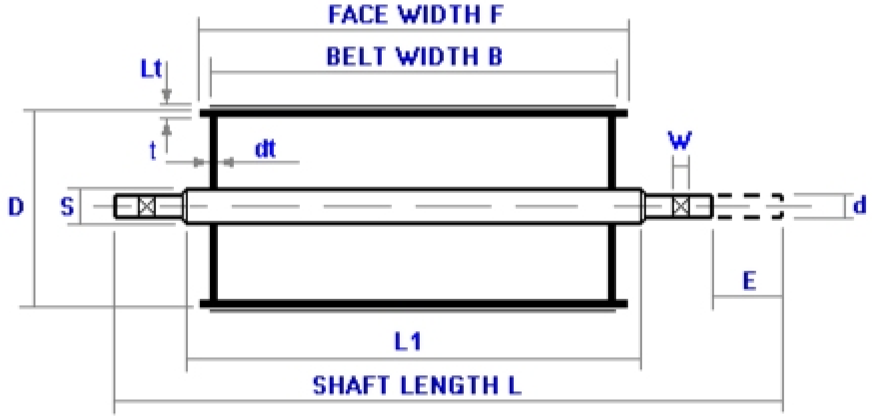
Station No	Running				Starting		Braking		Coasting	
	Fully Loaded Tension kN	Empty Tension kN	Inclines Loaded Tension kN	Declines Loaded Tension kN	Fully Loaded Tension kN	Empty Tension kN	Fully Loaded Tension kN	Empty Tension kN	Fully Loaded Tension kN	Empty Tension kN
1 Tail	119.63	119.63	119.63	119.63	123.97	167.80	93.34	107.97	97.24	115.85
Idler Spacing m	1.00									
Belt Sag %	0.08	0.08	0.08	0.08	0.08	0.06	0.11	0.09	0.1	0.09
2 Hopper	121.40	121.40	121.40	121.40	126.07	173.17	93.16	108.87	97.35	117.35
Idler Spacing m	0.45									
Belt Sag %	0.31	0.04	0.31	0.04	0.3	0.03	0.41	0.04	0.39	0.04
3 Hopper	142.78	121.88	142.78	139.75	148.49	176.02	108.25	108.78	113.37	117.64
Idler Spacing m	0.45									
Belt Sag %	0.27	0.04	0.27	0.03	0.26	0.03	0.35	0.04	0.34	0.04
4 Int. Pt	155.17	122.39	155.19	149.09	162.27	179.69	112.23	108.52	118.60	117.90
Idler Spacing m	1.50									
Belt Sag %	0.82	0.12	0.82	0.1	0.78	0.08	1.13	0.14	1.07	0.13
5 Int. Pt	169.73	123.86	169.90	152.10	180.83	187.65	102.58	108.42	112.55	118.87
Idler Spacing m	1.50									
Belt Sag %	0.75	0.12	0.75	0.1	0.7	0.08	1.23	0.14	1.13	0.13
6 Int. Pt	371.50	147.48	372.70	175.72	402.09	243.04	186.38	124.35	213.86	140.00
Idler Spacing m	1.20									
Belt Sag %	0.27	0.08	0.27	0.07	0.25	0.05	0.54	0.1	0.47	0.09

Pulley Details Report

24 Mar 2010 14:53 **Conveyor Pulley Dimensions** Page 1/1

Helix Technologies Pty Ltd

Project	Demo Conveyor High Lift	Client	ABC Iron
Project No.	P9823	Prepared By	Peter Burrow
Conveyor No.	C223	Design Date	14 January 2010



Station / Section

Station	Description	Shell Dia mm	Lagging mm	OD mm	Face Width mm	Shaft Length mm	Brg Ctrs mm	Shaft Dia mm	Brg Dia mm	Belt Width mm	Pulley & Shaft Mass kg	Mom of Inertia kgm2
1	Tail	850	12	874	2000	3200	2560	280	160	1800	2815	197.0
7	Head	1000	12	1024	2000	3520	2700	380	240	1800	5464	506.1
8	Bend	1000	12	1024	2000	3520	2700	380	240	1800	5464	506.1
9	Drive	1000	12	1024	2000	3460	2700	320	240	1800	4414	448.9
10	Bend	850	12	874	2000	3200	2560	280	160	1800	2815	197.9
11	Takeup	850	12	874	2000	3200	2560	280	160	1800	2815	197.9
12	Bend	850	12	874	2000	3160	2560	280	160	1800	2796	197.7

Designers Comments

You can view a sample report by clicking the following link: Sample Design report - pdf file (/DownloadFiles/Helix_delta-T6_Sample_Report01.pdf)

Dynamic Analysis ...

HELIX delta-T6 Dynamic Analysis

A version of the program which has full flexible belt Dynamic Analysis capabilities has been available in Helix delta-T since 2003. This version calculates the transient belt Tensions and Velocities during starting and stopping of a conveyor. It can model the conveyor belt transient behaviour during Starting Fully Loaded, Starting Empty, Stopping Fully Loaded and Stopping Empty.

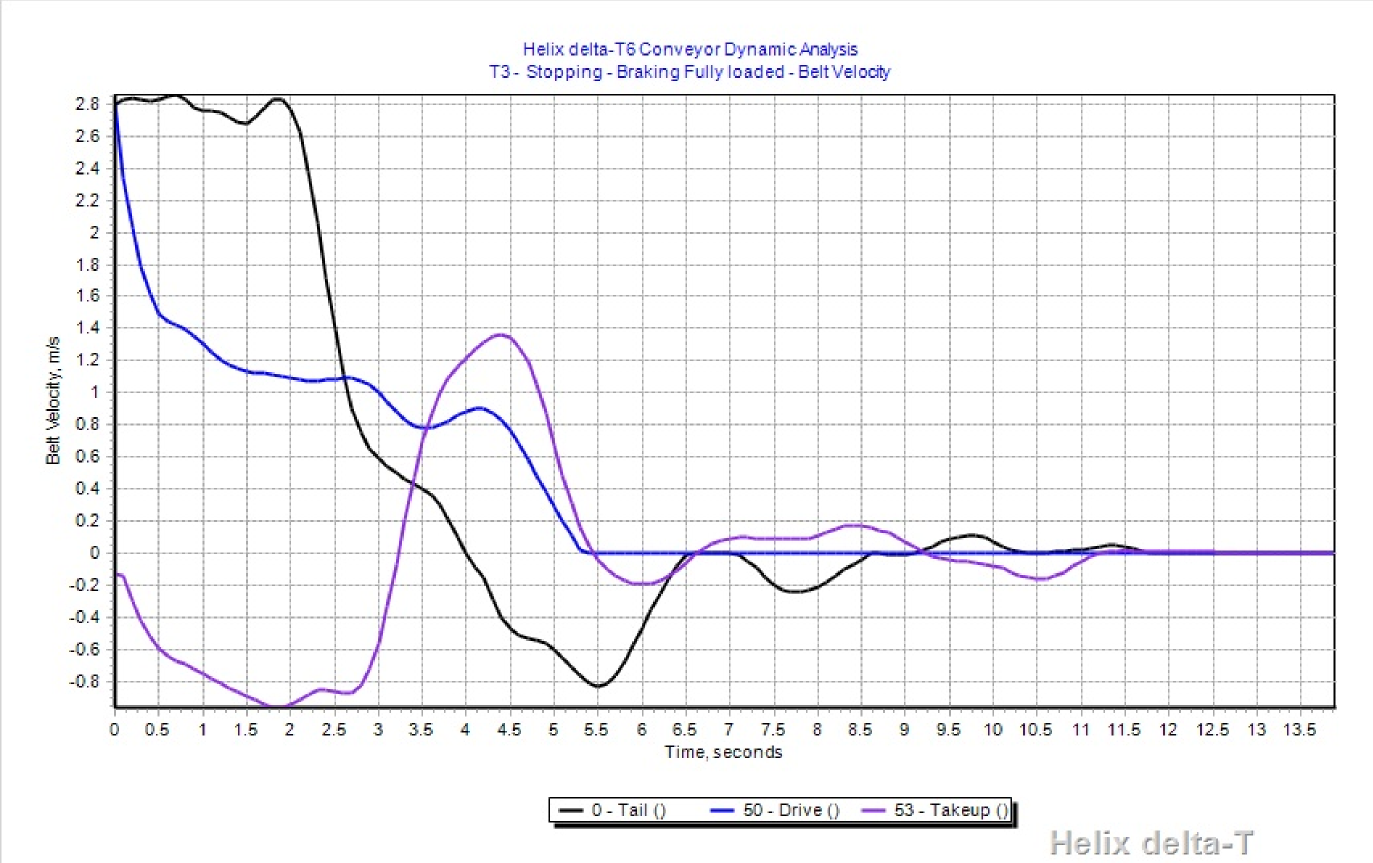
This new version of the program which has full Dynamic Analysis capabilities is essential for designing high powered conveyors and long overland conveyors. The Dynamic analysis version includes the Standard and Professional versions of the software. If the installed power on a conveyor is more about 800kW then Dynamic Analysis of the conveyor starting and especially stopping is recommended.

The program allows the user to input any number of Drives or Brakes and allows for input of Drive Torque / Speed curves, Delay times, Braking Torques, Flywheels and inertia effects. After the Dynamic Calculations have been performed, the user can view and Print two dimensional and surface plot three dimensional graphs for Belt Tensions, Belt Velocities, Strain rates and Takeup movement versus time step for all points along the conveyor.

Video of Conveyor Belt Contracting and Running Backwards at Tail

Video of Conveyor Stopping Fully loaded - note reverse running after belt reaches zero velocity

Helix Belt Velocity of Conveyor Belt Contracting and Running Backwards at Tail



The graph above shows the results of the stopping full dynamic analysis calculation; this is a graph of the Belt Velocities and you can see the program shows the Tail pulley (black line) running on at belt speed for 2 seconds, then decelerating and after the initial stop it has a negative velocity from 4.0 seconds to 6.5 seconds - this is the belt running backwards.

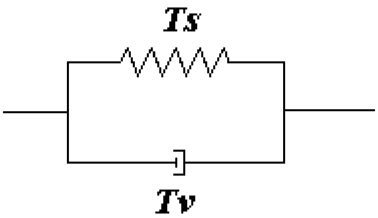
It has a final forward velocity for a short time shown in the graph and also in the video. This conveyor is almost flat so the run-back is not due to gravity but due to the very flexible Fabric reinforced belt contracting and so running backwards at the Tail Pulley.

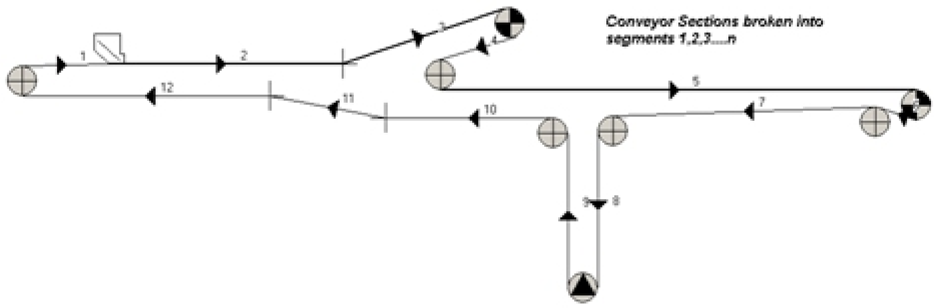
Helix Dynamic Analysis Calculation Method

The Dynamic calculation process uses sophisticated Variable Step Runge Kutta method integrators for solving the complex differential equations. All the numerical analysis is compiled into the program and it does not require any other software to perform the calculations or display graphs etc. It also allows flexible, easy to use boundary condition specification by the user.

Helix delta-T uses a Finite Element model of the conveyor to perform the dynamic analysis. The conveyor is broken up into segments, and for each segment, we use a Kelvin solid model, which is a spring in parallel with a viscoelastic element, as shown below:

Kelvin Solid Model





Conveyor Model Diagram

The conveyor model created and captured in the normal delta-T program is automatically broken up into segments in the Dynamic Calculation process. The program already knows the geometry of each section of conveyor, as well as the idler spacing, rotating masses, resistances, inertias, drive power and location, takeup mass and the equivalent mass of each element in the conveyor. The Dynamic calculation breaks the standard conveyor sections into smaller segments. The designer can specify the maximum segment length to be used.

$$m_i \dot{V} = T_{i+1}(t) - T_i(t) - m_i g \sin\theta - W_i(t) + F_m$$

Delta-T uses the Finite Element method of dynamic analysis Once the conveyor is segmented, the moving mass, length etc. of each segment is known. The Tension force acting on segment i at time t is given by the sum of the spring and viscoelastic Tension forces, Ts and Tv respectively. At each time step of say 0.1 seconds, the rate of change of velocity, combined with the strain on each conveyor segment is calculated. The peripheral force at the drive pulleys is the motivating force. The main conveyor resistances, represented by the Coulomb friction factor f, which is a function of instantaneous belt tension and belt sag at the segment under consideration, are taken into account. All idler roller rotating masses and pulley, drive and brake inertias are included in the acceleration and tension calculations. The Drive Torque or Velocity is input graphically, and the resulting Belt Tensions, strains and belt Velocities are output for each time step and for each point along the conveyor. These values are presented graphically for ease of interpretation.

Dynamic Analysis Graphs

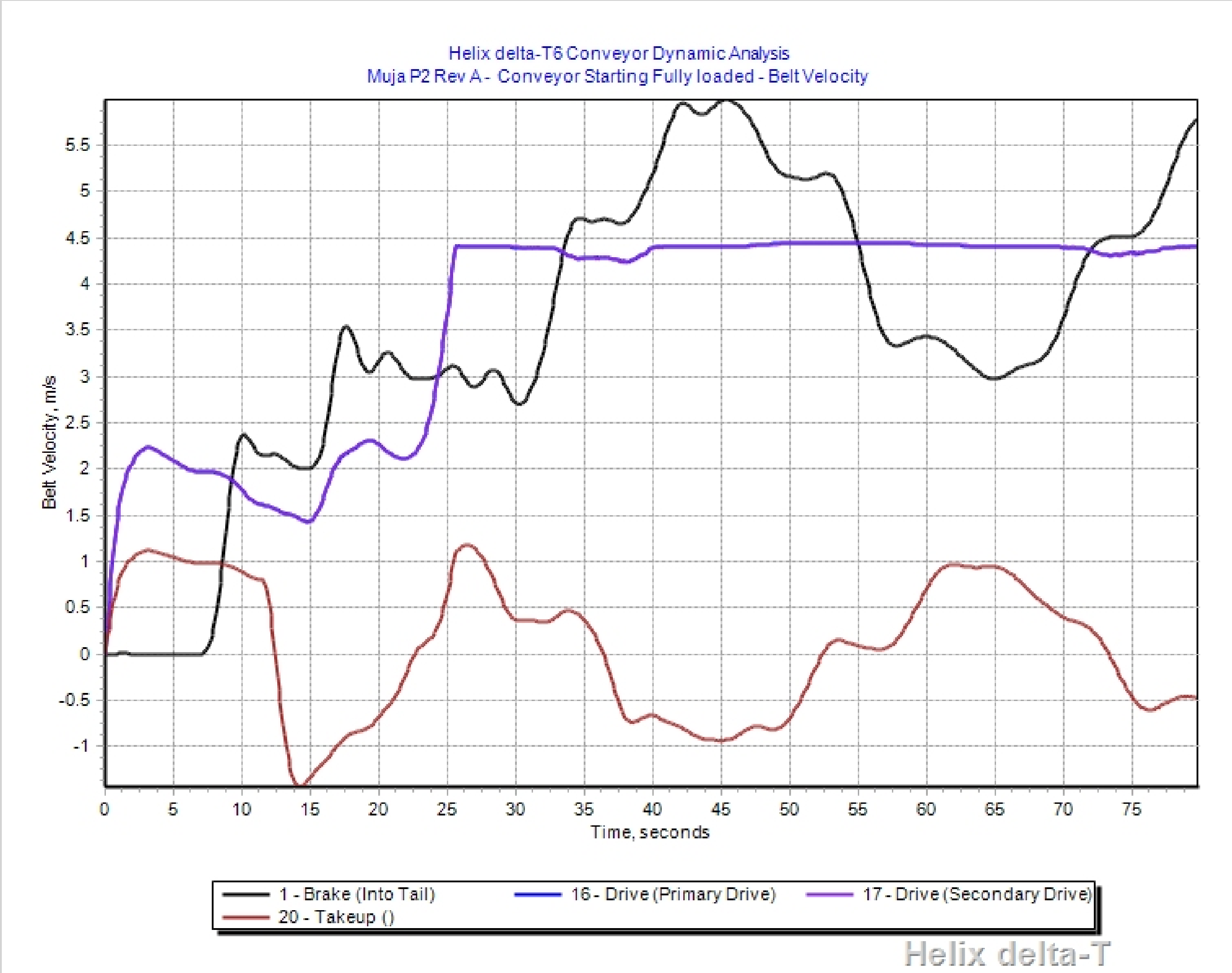
Dynamic Analysis Graphs			
Graph Description	**2D Graph**	**3D Graph**	**Remarks**
Belt Velocity at each pulley / point in conveyor	☑	☑	User can plot all points or any point
Belt Tensions at each pulley / point in conveyor	☑	☑	"
Take-up Travel at each pulley / point in conveyor	☑	☐	Only Take-up plotted
Pulley Torque at each pulley / point in conveyor	☑	☐	Drive and Brake Pulleys

Dynamic Analysis Features

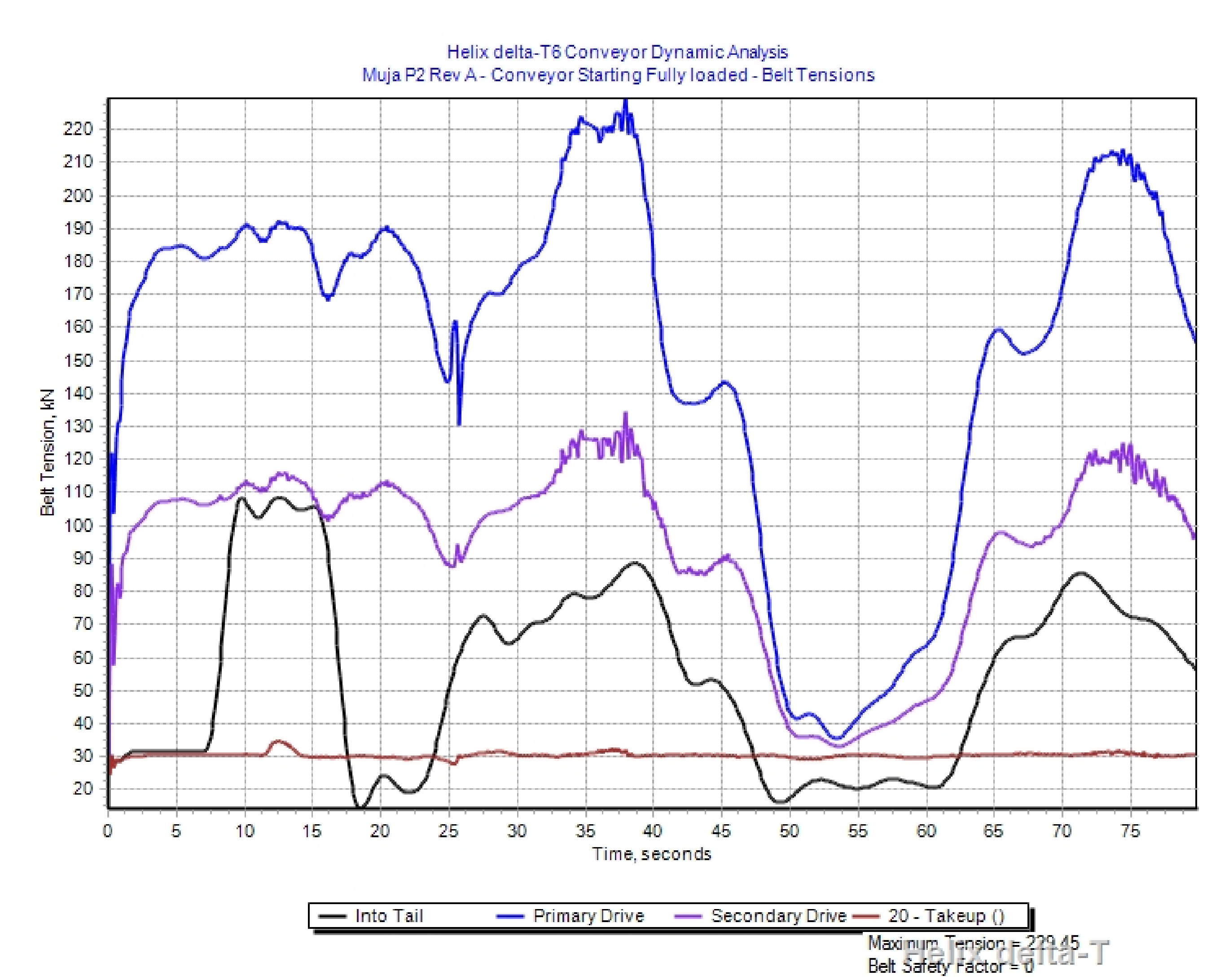
The Dynamic Calculations are easy use to use and Engineers who have static conveyor design experience can perform these complex dynamic simulations using this very powerful software.

- Easily model the belt transient tensions and velocities during Starting and Stopping of conveyors.
- Add Torque Control or Speed Control on drive acceleration.
- Add Delay times for multiple drives for Dynamic Tuning.
- Add Flywheels to pulleys to optimise starting and stopping.
- Add Brakes to pulleys as required.
- Calculate Dynamic Runback forces and size holdbacks for dynamic loads.
- View the movement of the Takeup pulley during Starting and Stopping.
- Predict the maximum Transient Belt Tensions at any point along the conveyor as well as the timing of these transients.
- Compare the Dynamic Calculations results with the rigid body static calculations in the delta-T5.
- Predict the magnitude of transient loads on conveyor structures.
- Calculate the torque loadings on gearboxes, holbacks and couplings during starting and stopping. Eliminate conditions which may cause costly equipment failures.
- Perform Dynamic Tuning by changing the start delay times on different drives.
- Helix delta-T allows the designer to control the starting of a conveyor by means of:
- **Starting - Stopping Control**
    - Torque Speed Control - Starting - e.g DOL, Wound Rotor, Fluid Coupling etc.
    - Speed Time Control - Starting e.g VVVF Variable Speed Drives, DC Motors
    - Constant Torque Brake - Stopping e.g Disc Brake
    - Speed Time Curve Control - Stopping e.g VVVF Controlled stop (ramp down)
- The Take-up can be locked on stopping to use belt stretch tension for sag control

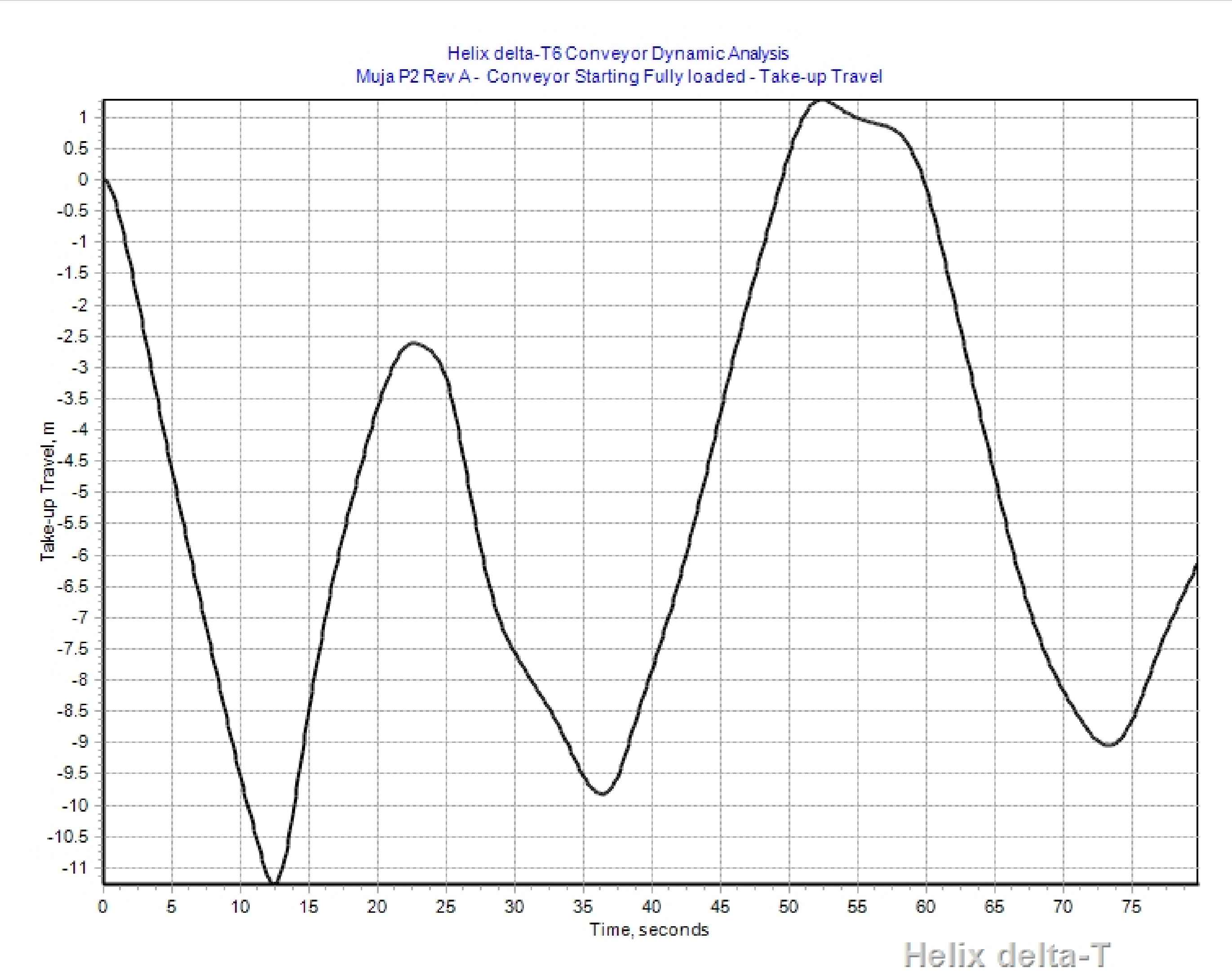
Sample of Belt Velocity Graph for conveyor starting



Sample Belt Tension Graphs for conveyor starting full

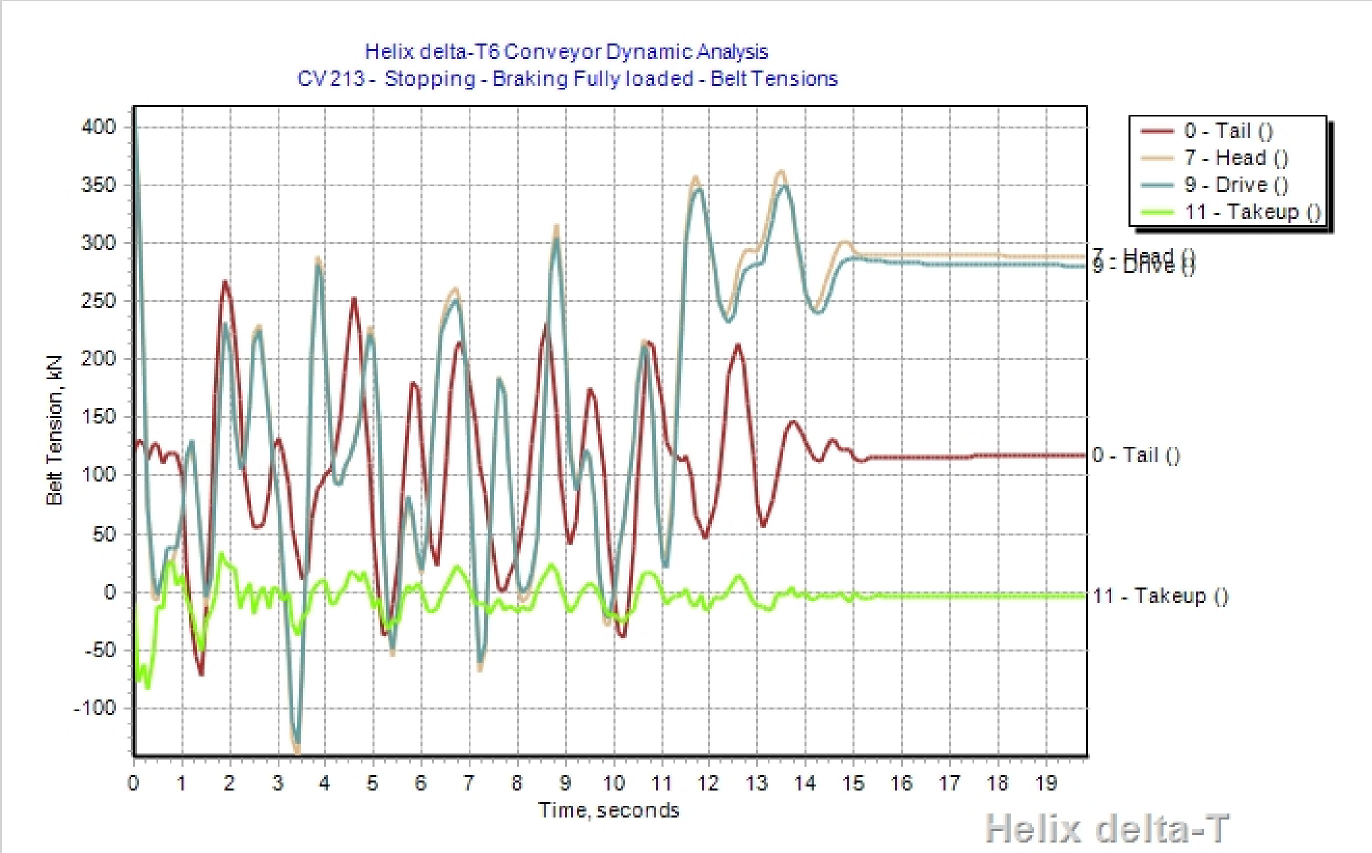


Takeup Travel Graph

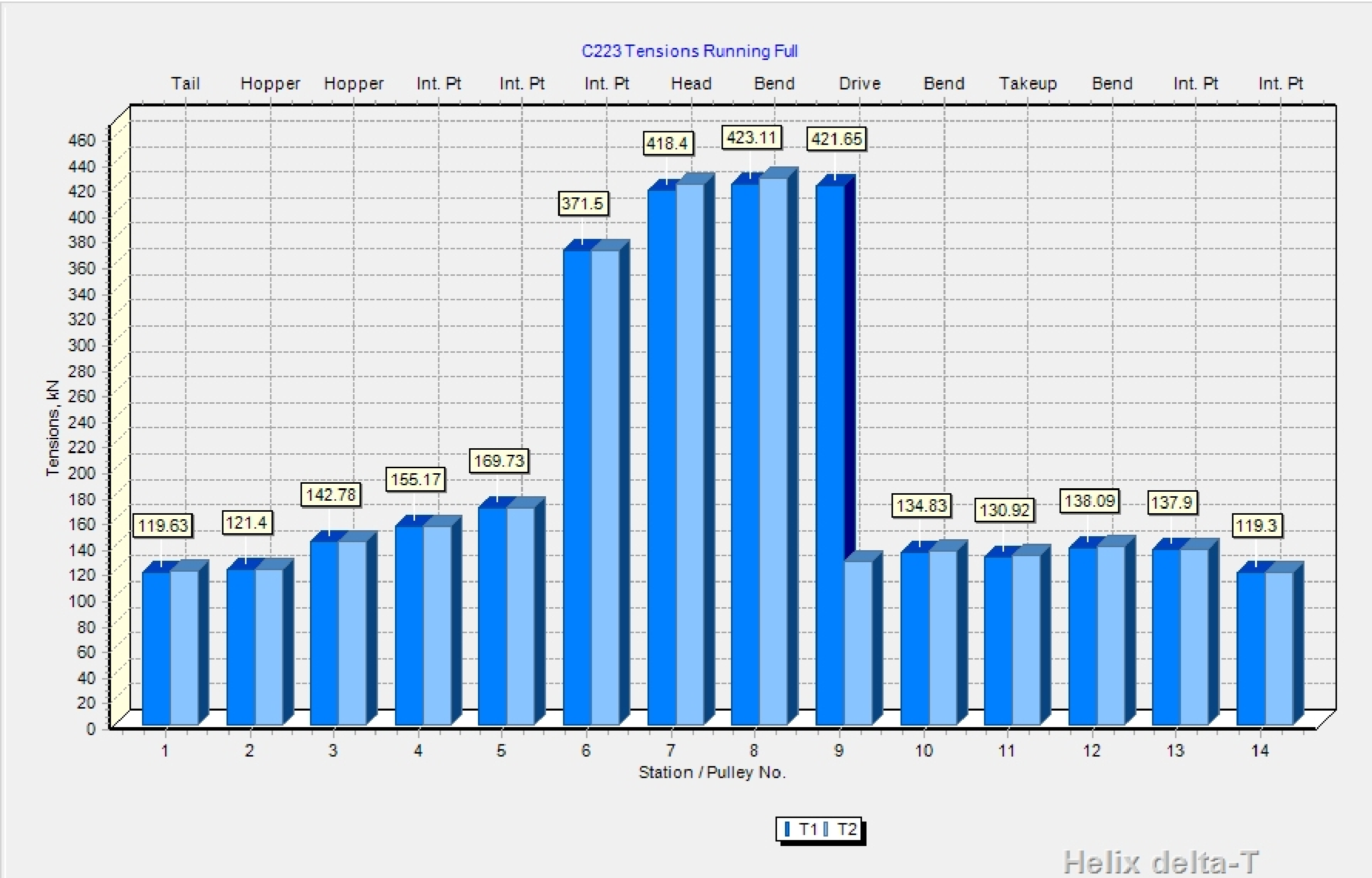


Example of Dynamic Analysis - conveyor stopping loaded

Belt Velocities

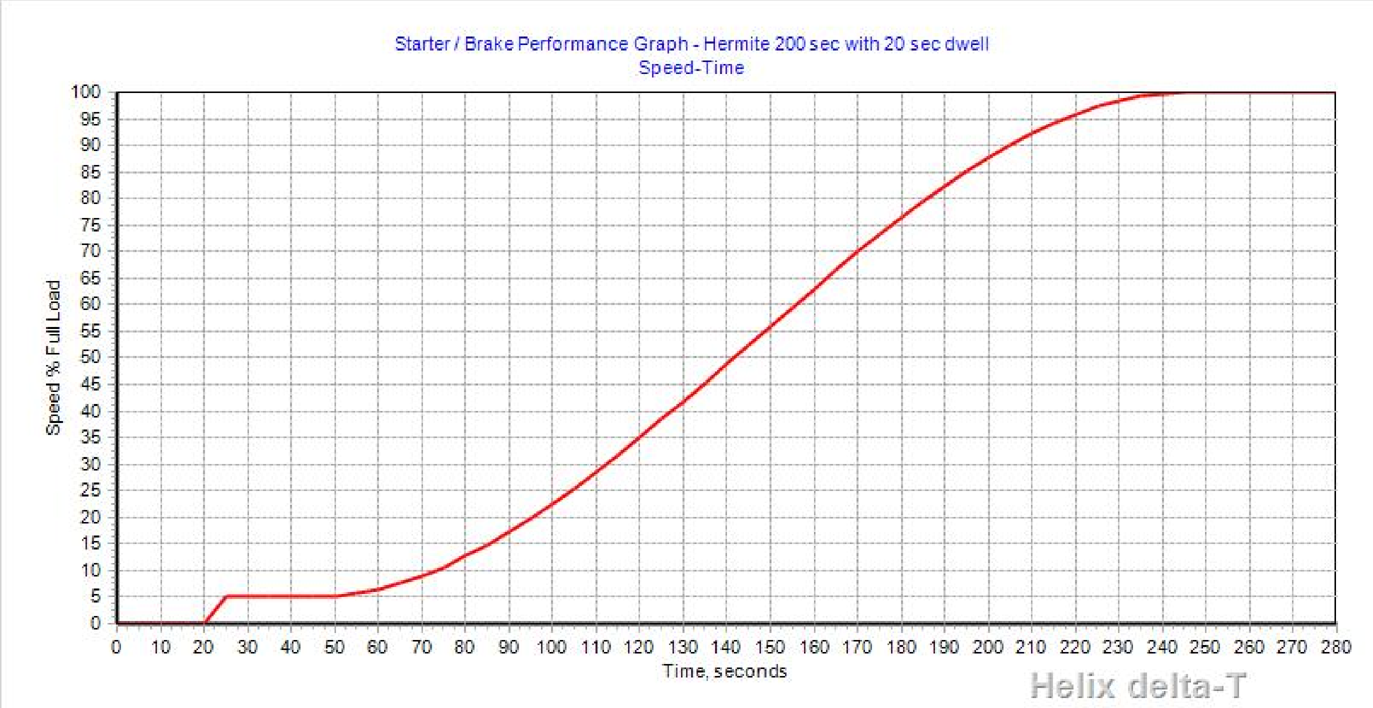


Belt Tensions



Note Tension rise as conveyor comes to rest and holdback locks up at 11.5 second mark.

Sample of VVVF Variable Speed Drive Starting Ramp using built in spline curve generator



You can download a Sample of a Conveyor Dynamic Analysis report for a 6.7kM long overland conveyor Sample Dynamic Analysis report - zip file. (/DownloadFiles/Helix_Sample_CV202_Conveyor_Design_Report_Dynamic_Analysis.zip) Save the file to disk and then unzip it and view the Word doc with reports and graphs generated from Helix delta-T

Conveyor Starters ...

HELIX delta-T6 Dynamic Analysis - starting conveyors

Helix delta-T version 6 has a powerful capability to allow the design Engineer to control and optimise the conveyor starting and stopping.

Conveyor Starting and Stopping Methods

Helix delta-T allows the designer to control the starting of a conveyor by means of:

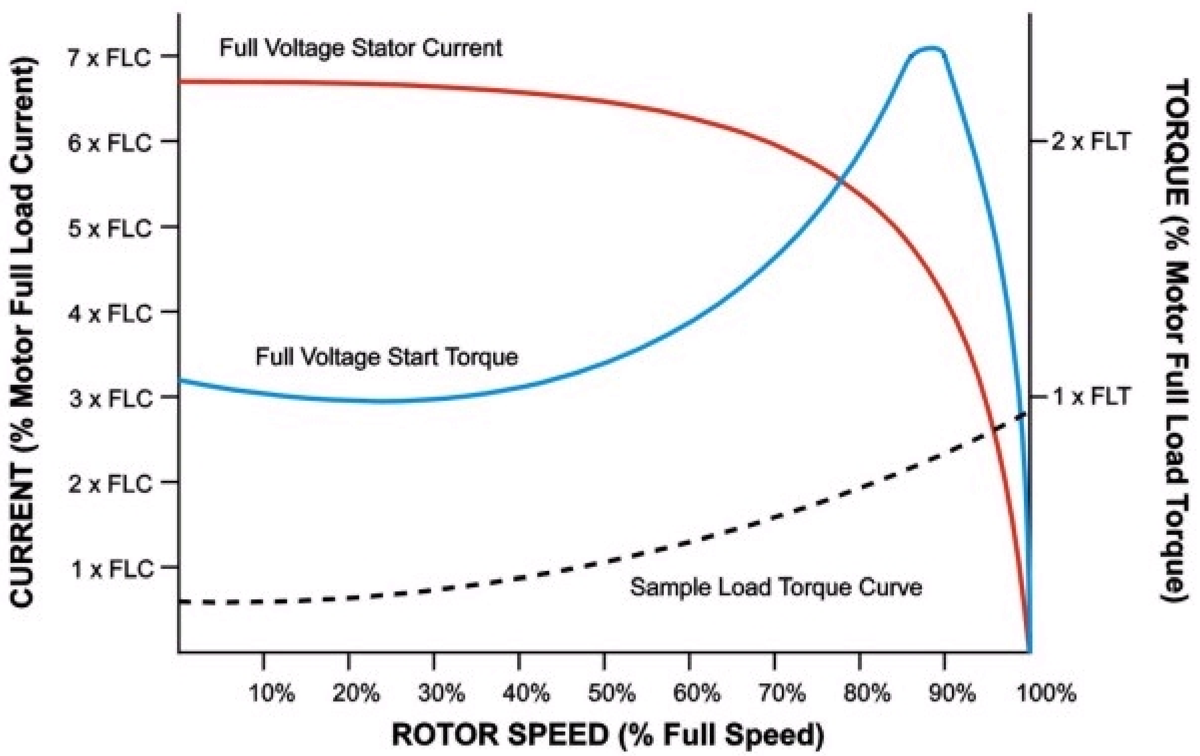
- Torque Speed Control - Starting.
- Speed Time Control - Starting.
- Constant Torque Brake - Stopping braking.
- No Brake - Stopping coasting.
- Speed Time Curve Control - Stopping ramp-down.
- Add Delay times between drives starting.
- Add Delay times between brakes activating.
- The Take-up can be locked on stopping to use belt stretch tension for sag control

All of the above controls can be programmed in by entering data in the Starters Database and then using these curves to control the conveyor during the dynamic analysis.

Torque Speed Control

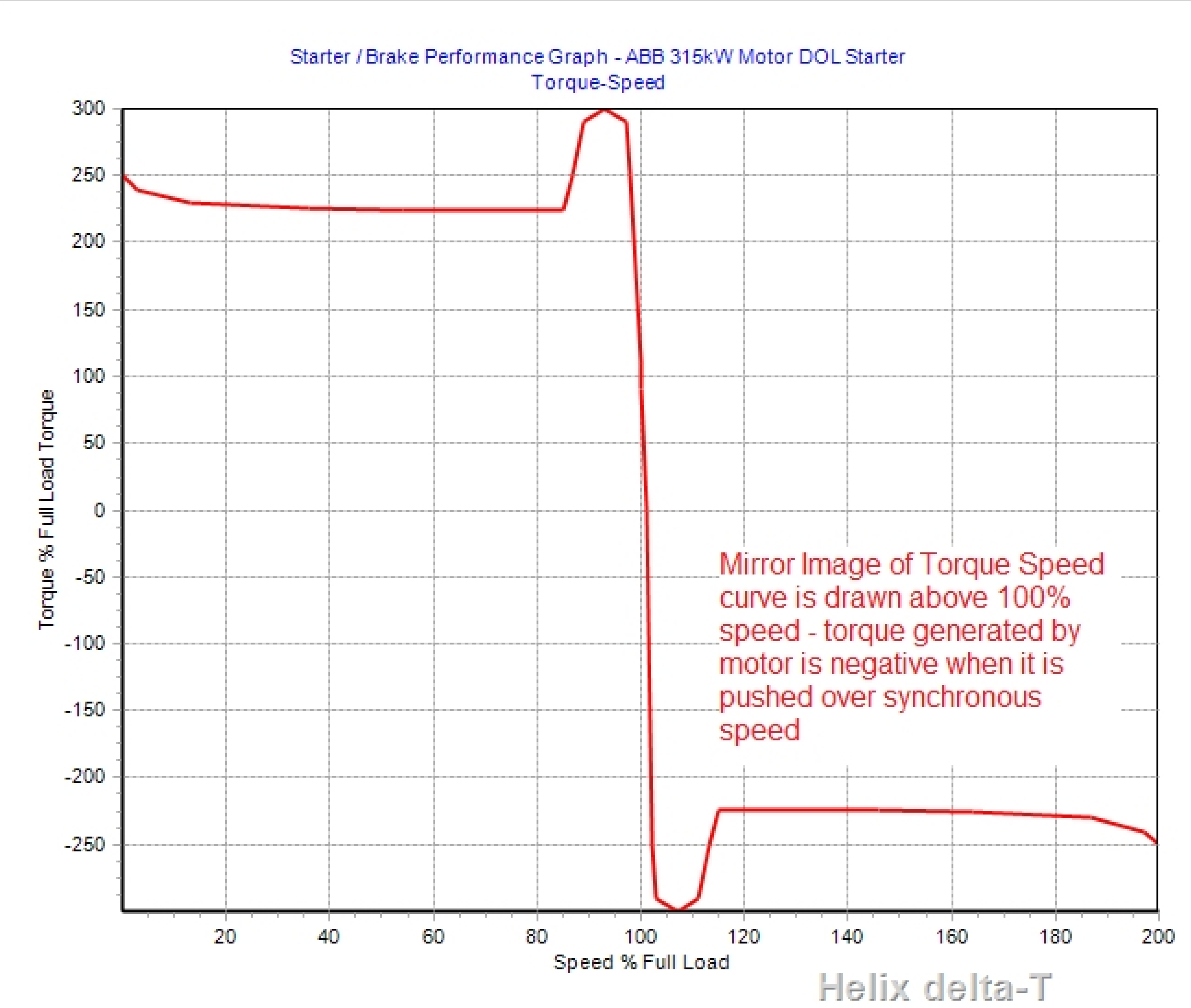
Torque control means that the Torque, expressed as a % of Full Load Torque is the controlled parameter at the Drive. This means that the Driving Peripheral force on the drive pulley is controlled and the magnitude of the force depends on the actual pulley speed at each time step expressed as a % of Full Load Speed.

Typical Starting Torque Curve for an Induction motor



The delta-T program allows you to model each Drive's Starting Torque vs Speed characteristics. The method used is a tabular description of the % of Full Load Torque vs the % of Full load speed. All you need to do is enter the Torque % at the relevant % Speed values and the program will draw the curves for you and then use regression methods to get the actual values of Torque to apply during the dynamic analysis calculation process.

Speed Control and Regenerative Drives



The Full Load Speed and Torque and is reached when 100% Speed is reached. Note that if the conveyor tries to run at speeds above the Full load speed of the motor, the available torque from the drive drops off rapidly, and the Conveyor load will then tend to bring to reduce the speed. Above the asynchronous speed the torque is reversed ie it becomes negative and the motor acts as brake.

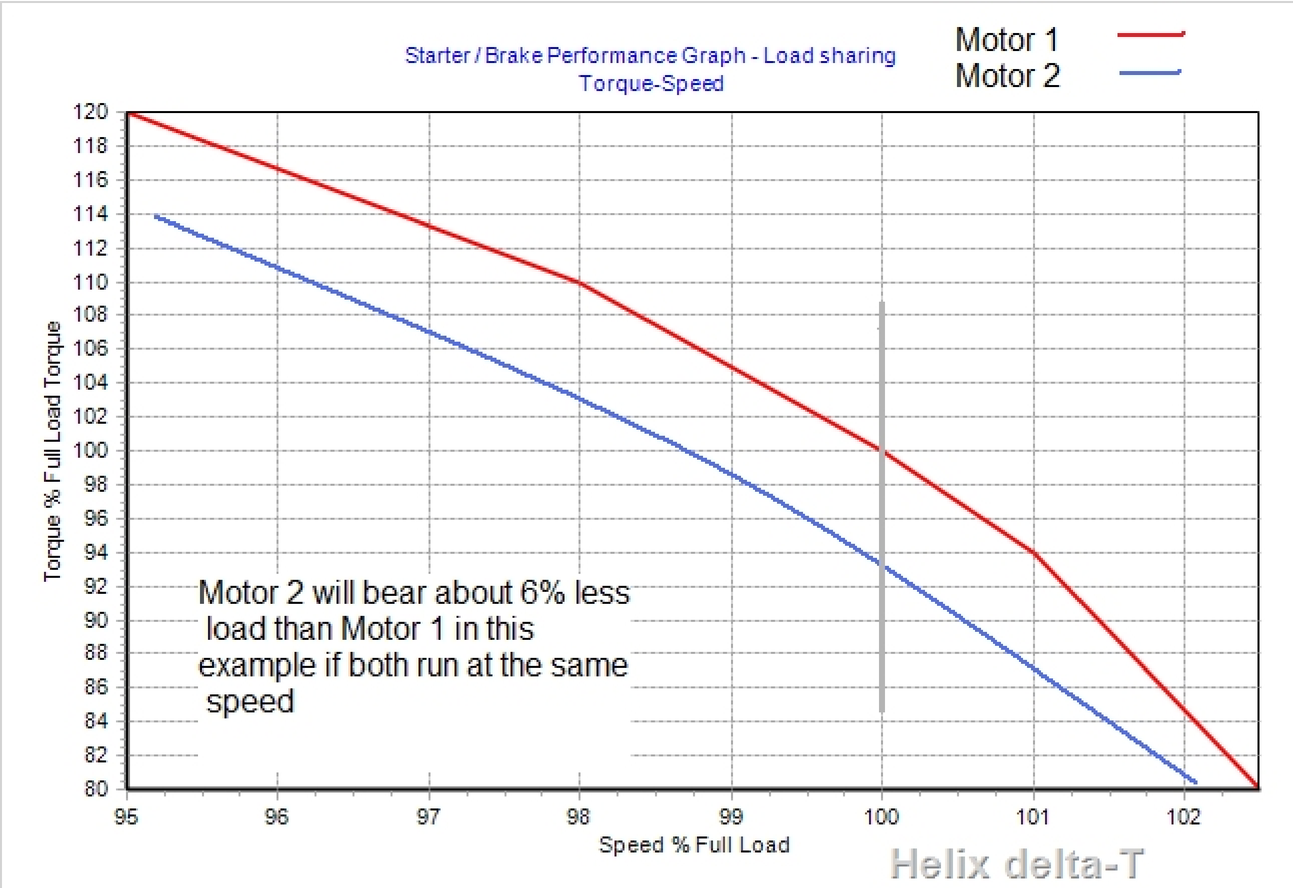
This overspeed braking effect is very important in Conveyor operation and Dynamic Analysis, as it helps to control the drive speed and keep it from overspeeding. For regenerative conveyors, the motor operates in the band above the 100% FL speed range and thus acts as a brake.

Load Torque vs Drive Torque

During the Dynamic Analysis calculations, the Torque supplied by the drive is applied to the drive pulley. When the Drive starts, the Starting Torque is applied and as the drive pulley accelerates, the Torque % along the curve is progressively applied until the pulley reaches 100% of Full Load speed. If the drive pulley is pushed over the full load speed by a Tension wave, the Torque reduces to below the Load Torque and the drive slows down. Eventually equilibrium is reached where the Drive Torque equals the Load Torque.

Load Sharing between Drives

If two or more induction motors are installed on a conveyor drive (or multiple drive pulleys) the motors will almost certainly have slightly different torque speed characteristics. If we examine two motors' torque speed curves close to the full load speed we may have something like the curve shown below:

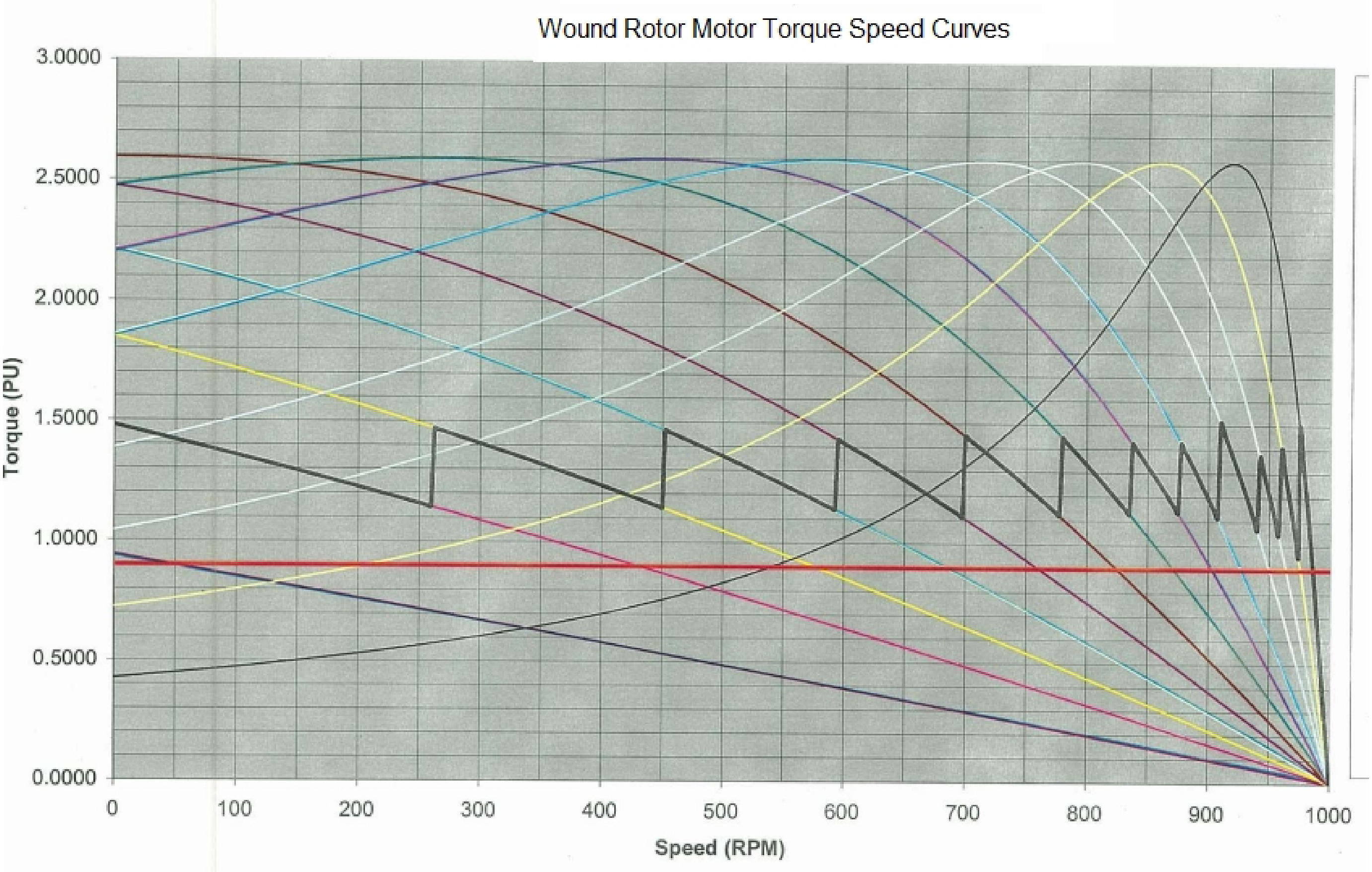


The above equilibrium explains why Squirrel Cage electric motors automatically load share. If one Drive takes less than its fair share of load, the other drives takes more share. This causes the second drive to slow down, and as it slows down, the first drive will automatically take more load.

Wound Rotor or Slip Ring Motor

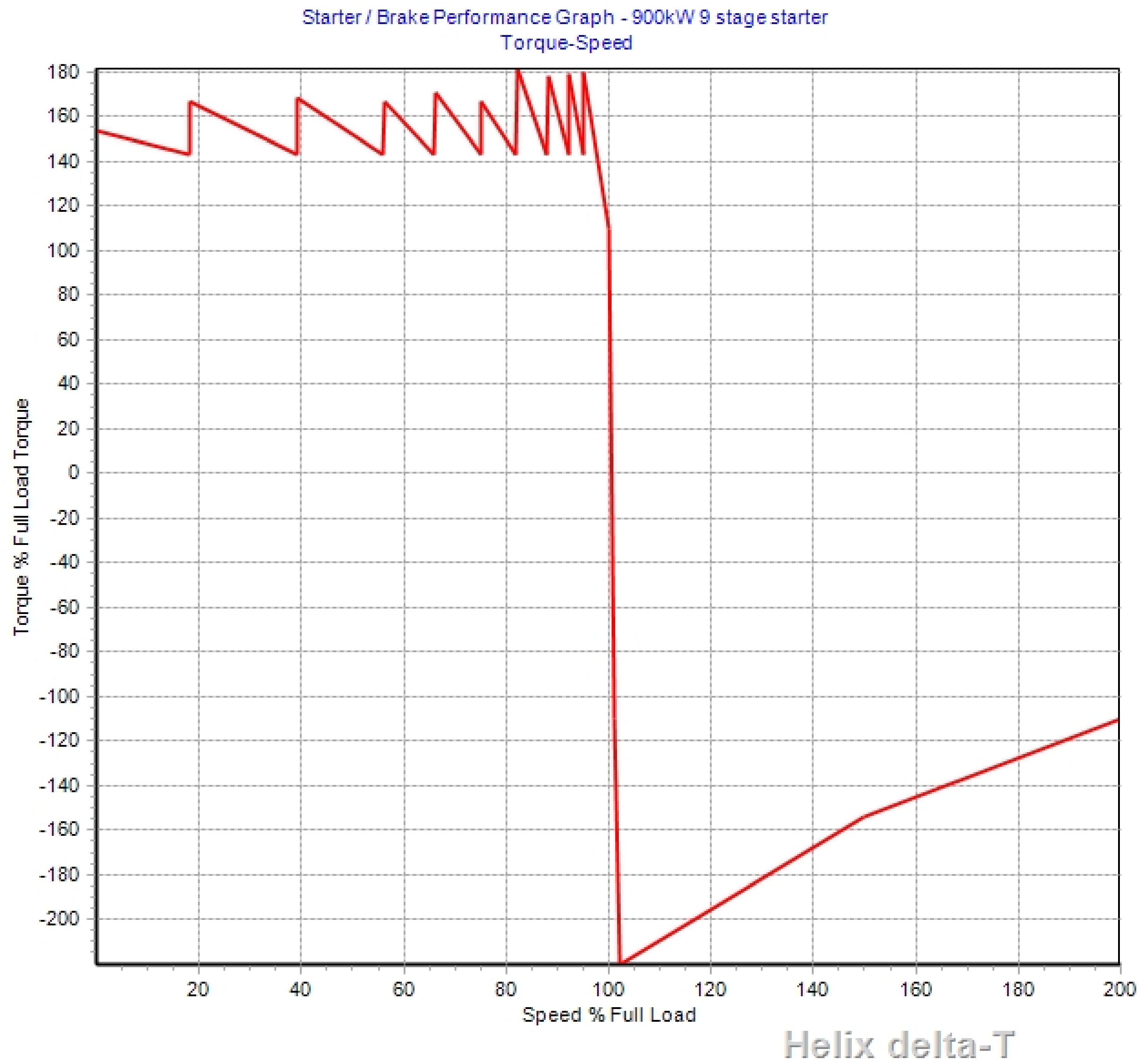
Slip ring motors or wound rotor motors are a variation on the standard cage induction motors. The slip ring motor has a set of windings on the rotor which are not short circuited, but are terminated to a set of slip rings for connection to external resistors and contactors. The slip ring motor enables the starting characteristics of the motor to be totally controlled and modified to suit the load. As the motor accelerates, the value of the rotor resistance can be reduced altering the start torque curve in a manner such that the maximum torque is gradually moved towards synchronous speed. This results in a step controlled starting torque from zero speed to full speed at a relatively low starting current. The sliprings and brush assemblies need regular maintenance which is a cost not applicable to the standard cage motor.

Typical Torque Speed Curve for a Slip Ring Wound Rotor Motor



The above graph shows the motor performance when the rotor resistance is varied. The resistors can be switched on fixed time steps or on reaching a % speed setting. The Starting torque at the motor output shaft is controlled along the 'Saw Tooth' shape shown by the thick black line. Torque is drawn as a PU (Per Unit) basis above graph and is shown and input as % of full load torque in Helix delta-T.

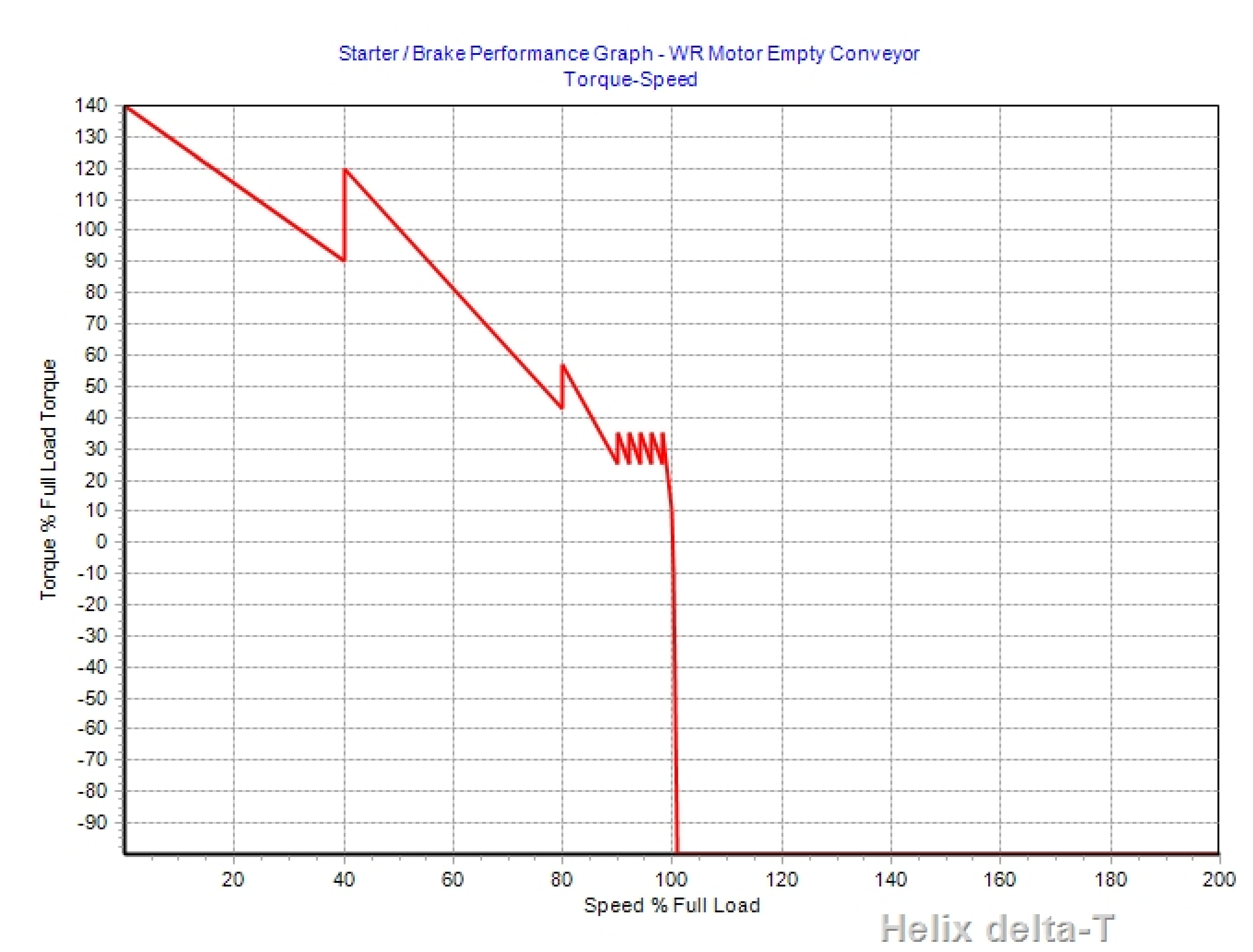
Wound Rotor Motor Speed Torque Curve Input into Delta-T



Note the speed curve is input for speeds above 100% to simulate the negative torque the motor will develop if pushed above 100% speed. Delta-T applies the calculated torque at each time step to the Drive pulley according to the relationship shown in the Torque speed Curve. This means that the program can model any Torque Speed relationship you wish.

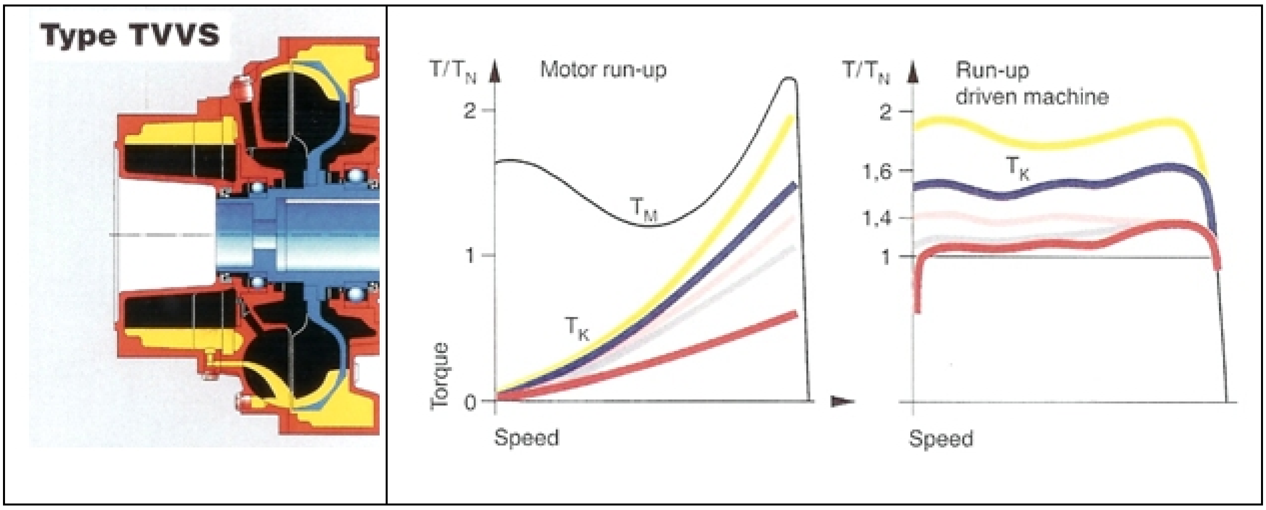
WR Switched Resistances for an Empty Conveyor

For an empty conveyor the torque speed may look something like the one below. Because the load is say only 25% to 30% of the motor FLT the conveyor will accelerate to a large degree on the first or second resistance step with the remaining acceleration occurring at closely spaced intervals until the normal run resistance is finally connected. We still need to show the negative torque curve beyond the 100% speed mark as this controls the conveyor belt speed, both in practice on actual conveyors and in the Helix Dynamic analysis calculations.



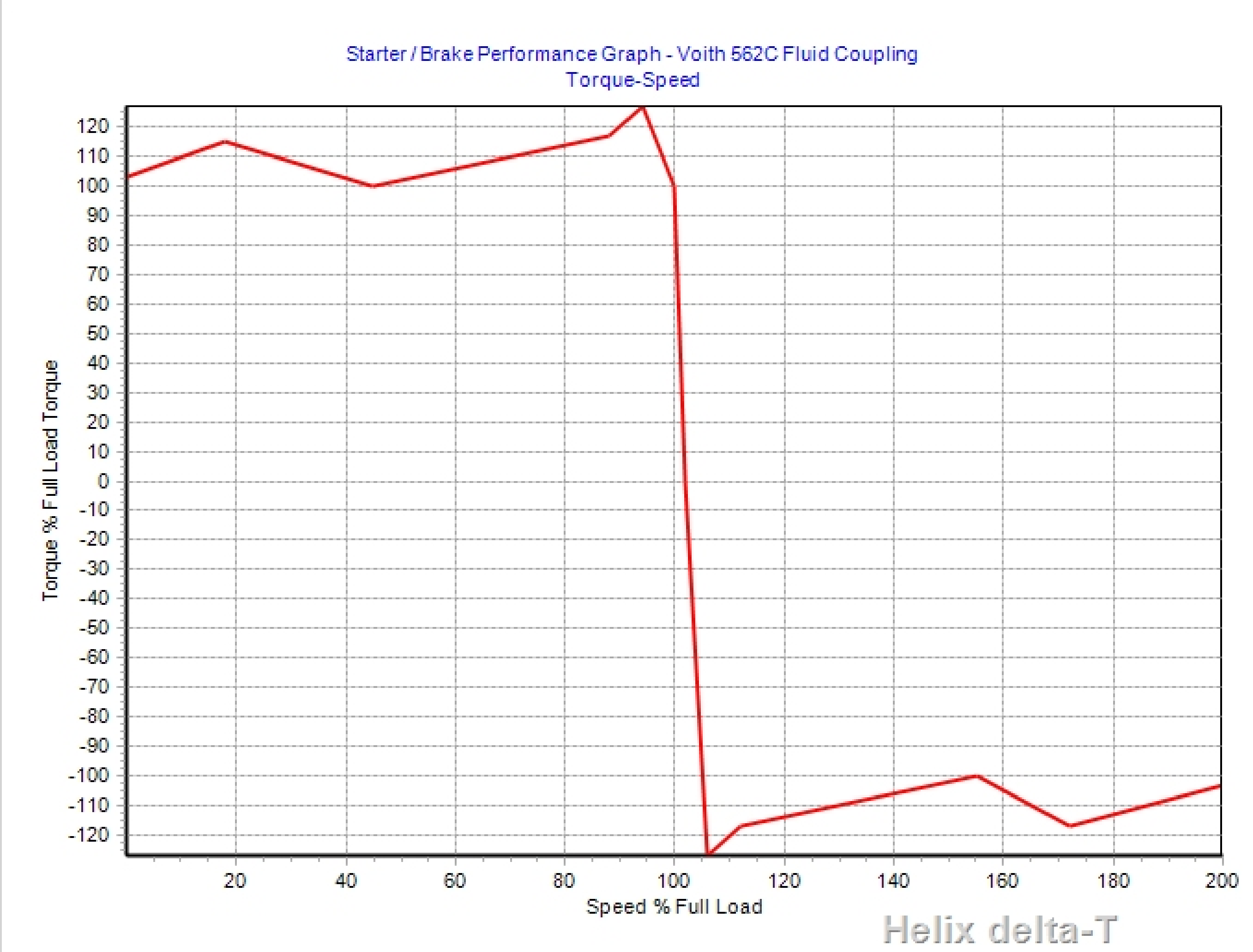
Fluid Coupling Torque Control

A Fluid Coupling is a device consisting of an impeller and a runner where the impeller is driven by the motor and torque is transmitted to the runner by fluid between the impeller and runner. This allows the motor to start freely and as fluid is drawn into the impeller / runner interface, the torque on the output shaft of the fluid coupling increase gradually until it is sufficient to move the conveyor and accelerate it. To use a Fluid Coupling Start in Helix delta-T, merely enter the output shaft Torque Speed curve for the fluid coupling as a dataset in the Torque Speed curve table. The program will then use whatever shape of curve you specify.



Cross sectional drawing of a soft start fluid coupling and some typical Torque speed curves - Drawing and Graphs Courtesy of Voith Transmissions.

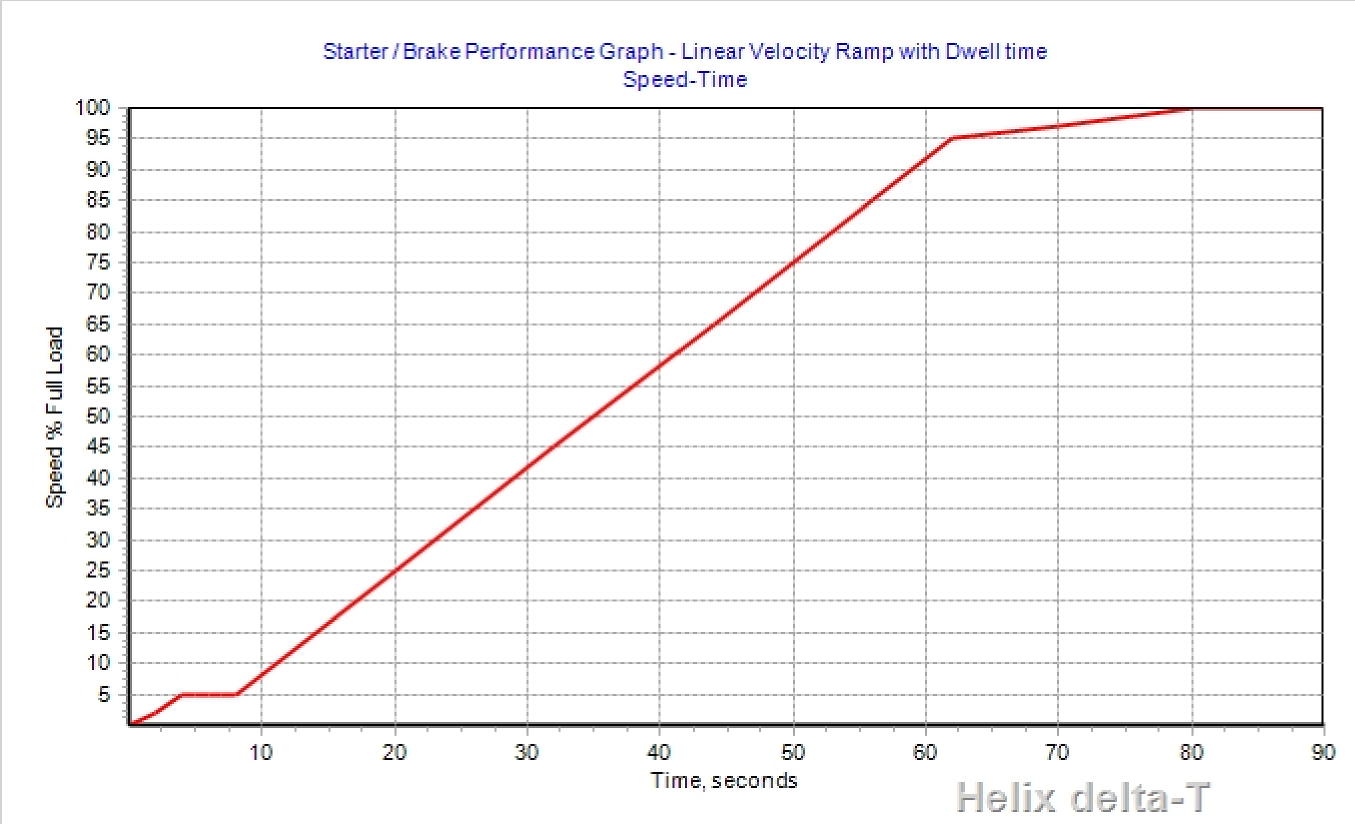
Fluid Coupling curve entered into Helix delta-T



Speed Time Control

The second method of starting control is known as Speed Control or a Velocity Ramp control. This method of control does not specify the amount of Torque applied to the Drive pulley. It specifies a pulley Speed at each time step during acceleration and sufficient Torque is applied in order to maintain the specified speed. This method of starting is usually provided by electronic solid state Variable Speed Drives which control the motor speed accurately to with fractions of a percent of Full Load Speed.

A typical linear Velocity Ramp



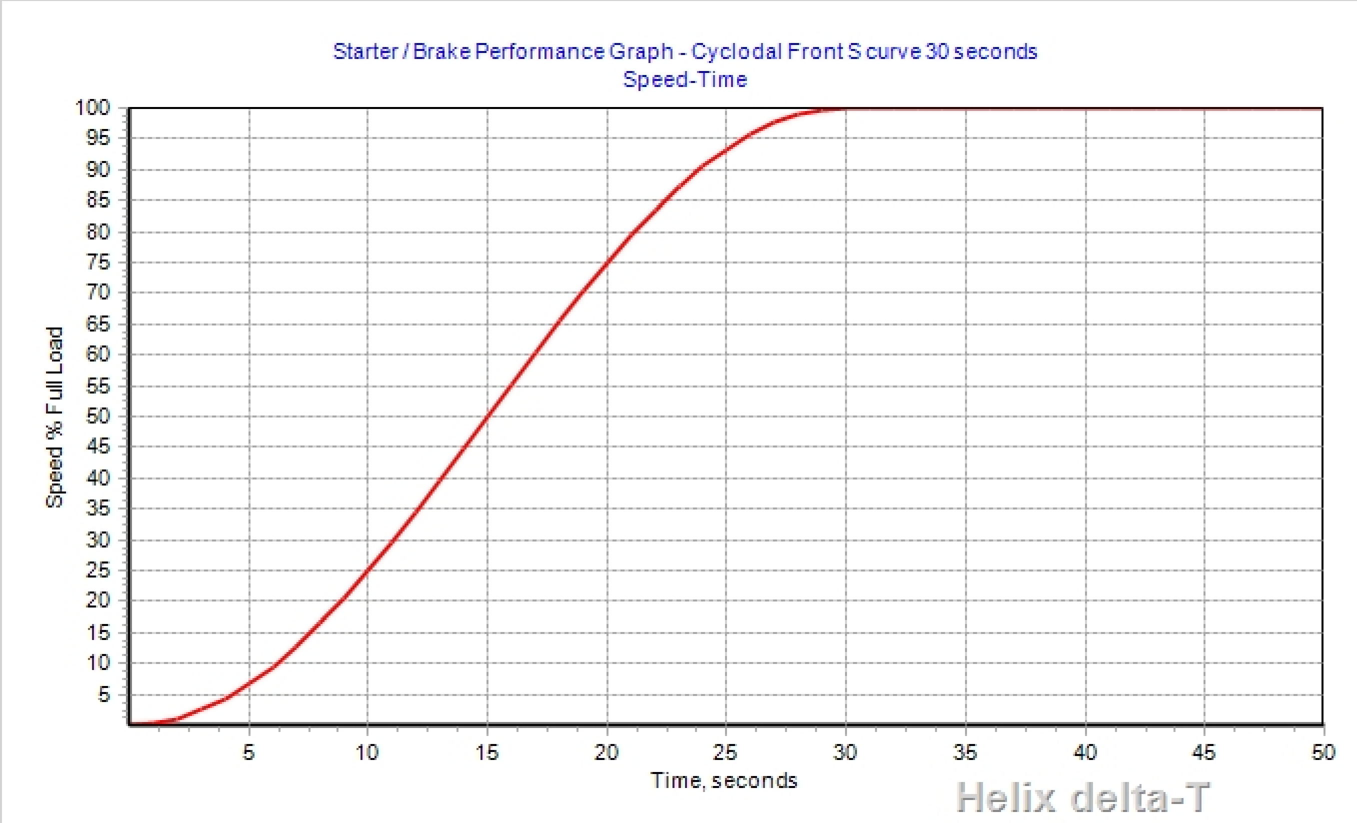
In the above starting speed ramp the speed increases linearly with time with a dwell time of 5 seconds when speed reaches 5% of speed. In this case the starter type is selected as Speed Time and the % Speed and Time in seconds are input into the starter database.

S curve Acceleration Ramps

Messers A. Harrison and L. Nordell have proposed various 'S' curve acceleration ramps. Both of these starting methods can be simulated in delta-T. Refer to the papers on these subjects in the References section for more details.

Cycloidal Front S curve - Harrison Model

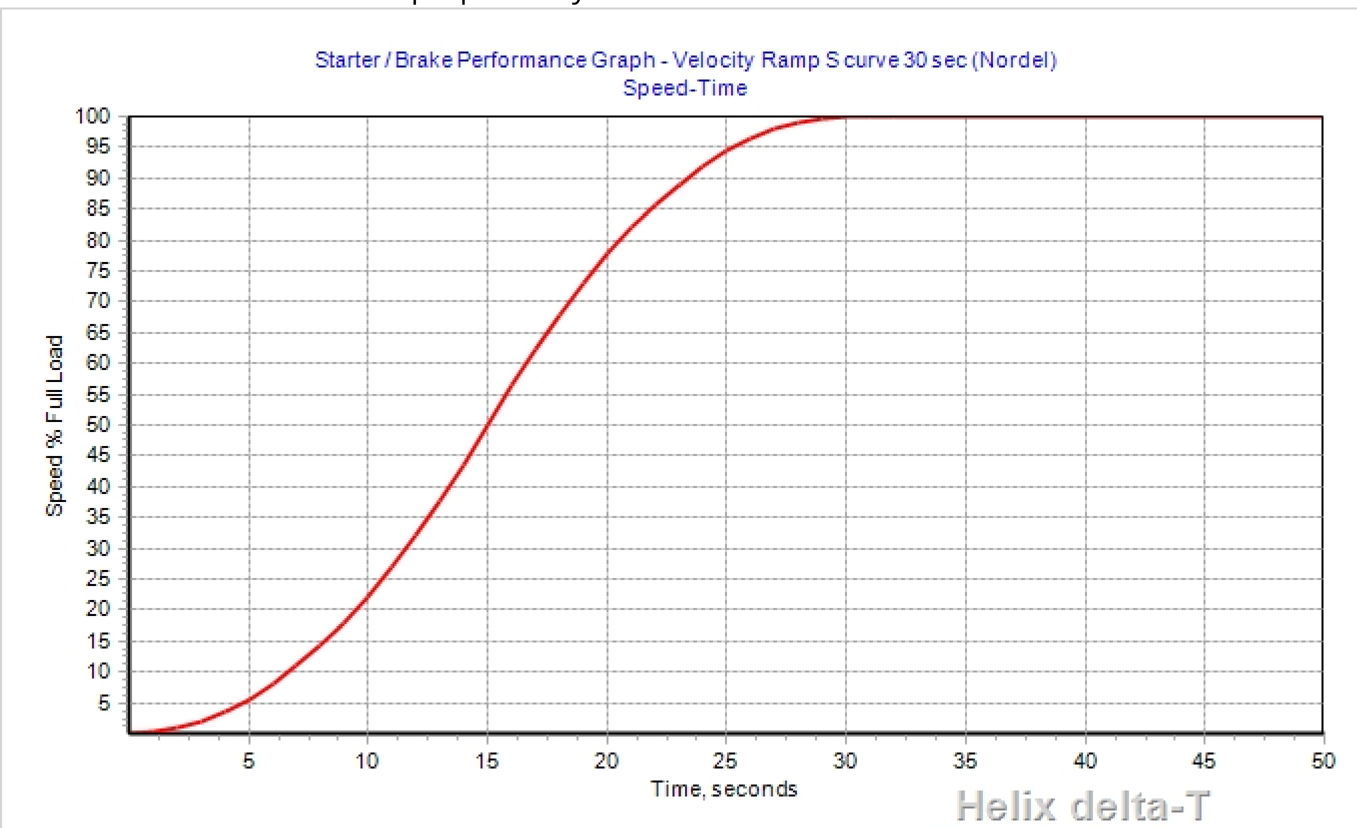
This form of S curve was first proposed by Dr Alex Harrison and it is called a cycloidal front characteristic.



The cycloidal front curve is derived from: $v(t) = \frac{V}{2}\left(1 - Cos\frac{\pi}{T}t\right), 0 \le t \le T$

S curve - Nordell Model

This form of S curve was first proposed by Nordell. It takes the form:



This S curve is obtained as follows:

$$v(t) = V\left(\frac{2t^2}{T^2}\right), 0 \le t \le \frac{T}{2}$$

$$v(t) = V\left(-1 + 4\frac{t}{T} - 2\frac{t^2}{T^2}\right), \frac{T}{2} \le t \le T$$

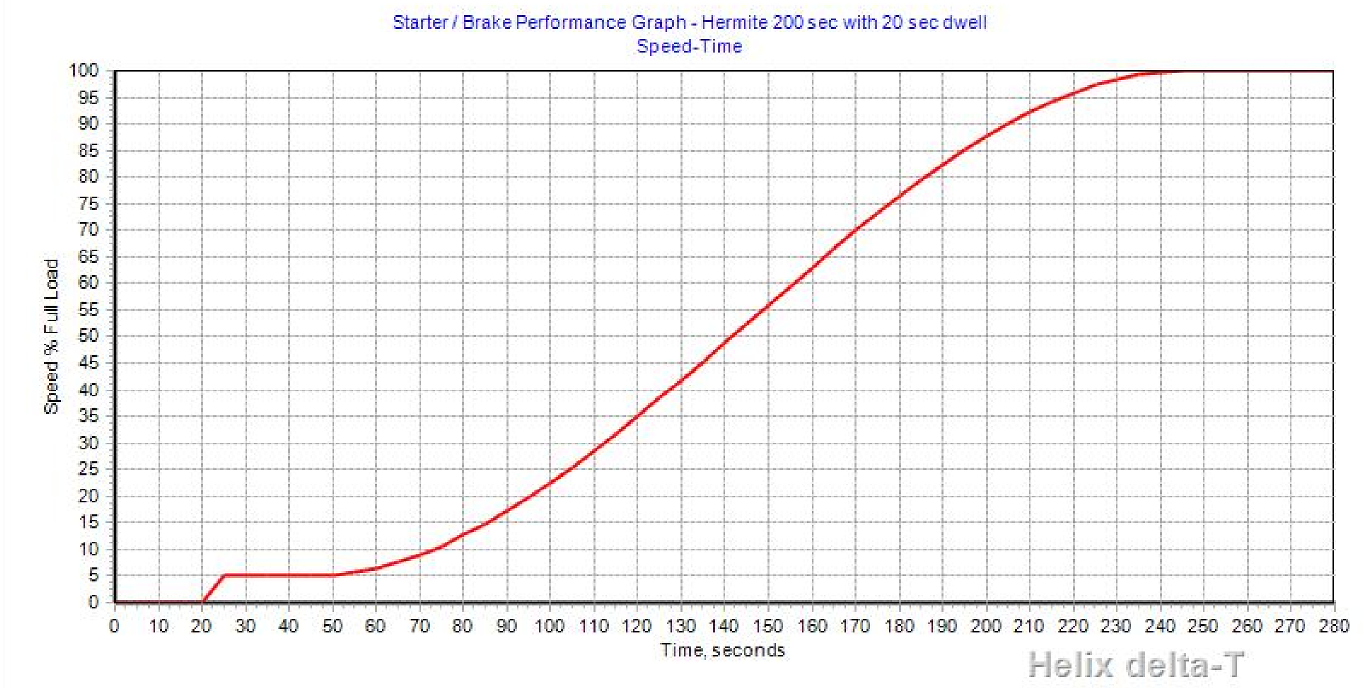
Nordell's model has a higher acceleration (in the middle portion) than Harrison's but a lower Jerk (first derivative of acceleration)

In delta-T, you are free to use any Velocity ramp you wish - merely type in the speed time values and the program will do the rest. You can also derive your own relationships using a spreadsheet program such as Excel and then paste the values into delta-T.

Hermite Cubic Spline Curve Starter

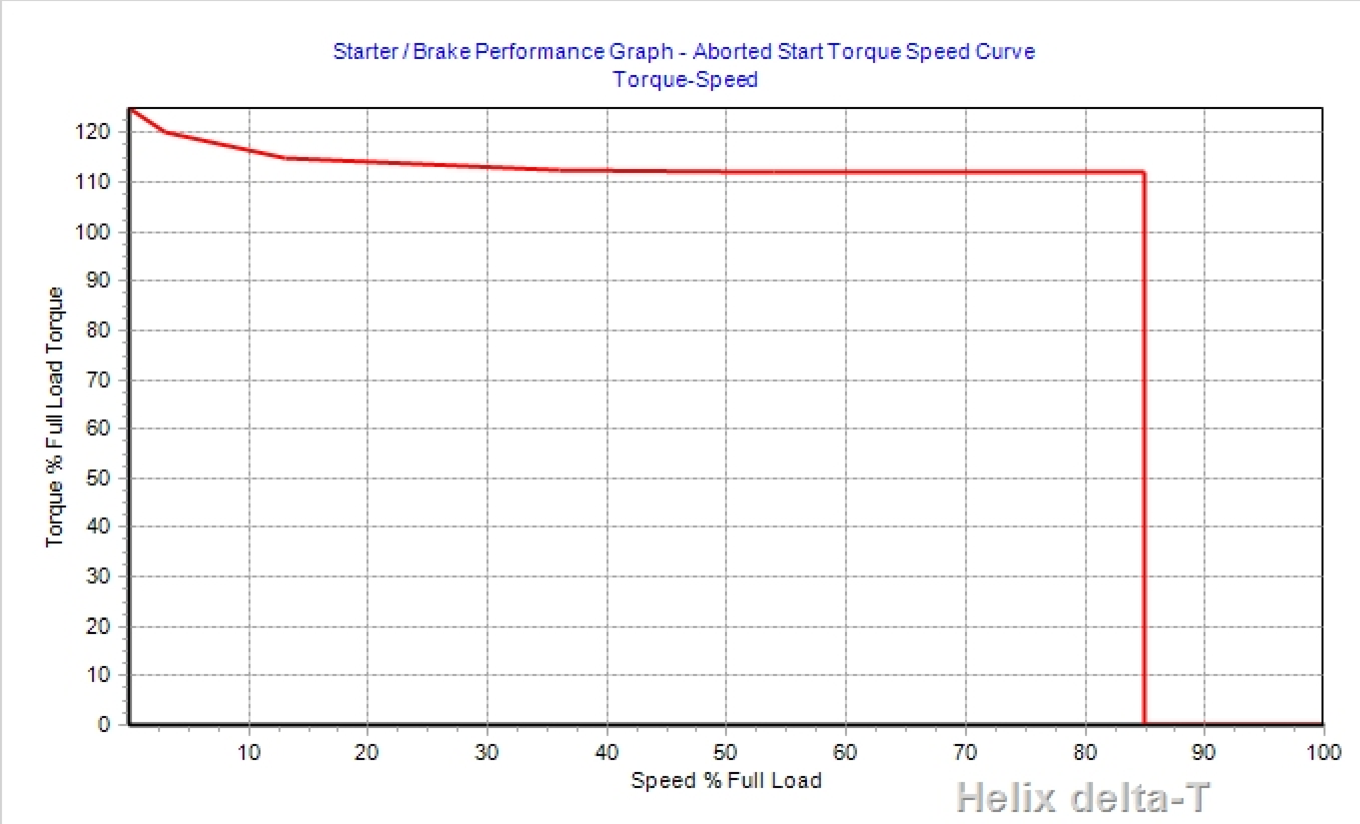
This shape of starting ramp allows a very soft start of the conveyor especially if a long time is used and it is also useful for conveyors with head and tail or tripper drives which are far apart. It allows a delay time to be built into the curve so that acceleration of the tail drives can be matched to the head drives. It also allows a dwell period to be added which allows the drive to start and ramp up to say 5% speed and it then holds the speed at this level for the dwell time before accelerating along the spline curve

The curve below has 20 second delay time, it then ramps up to 5% speed, holds it at this speed for a 20 second dwell time and then accelerates along a cubic spline S curve, reaching full speed after 245 seconds. Refer to Hermite Cubic Spline (http://en.wikipedia.org/wiki/Cubic_Hermite_spline) link for more details.



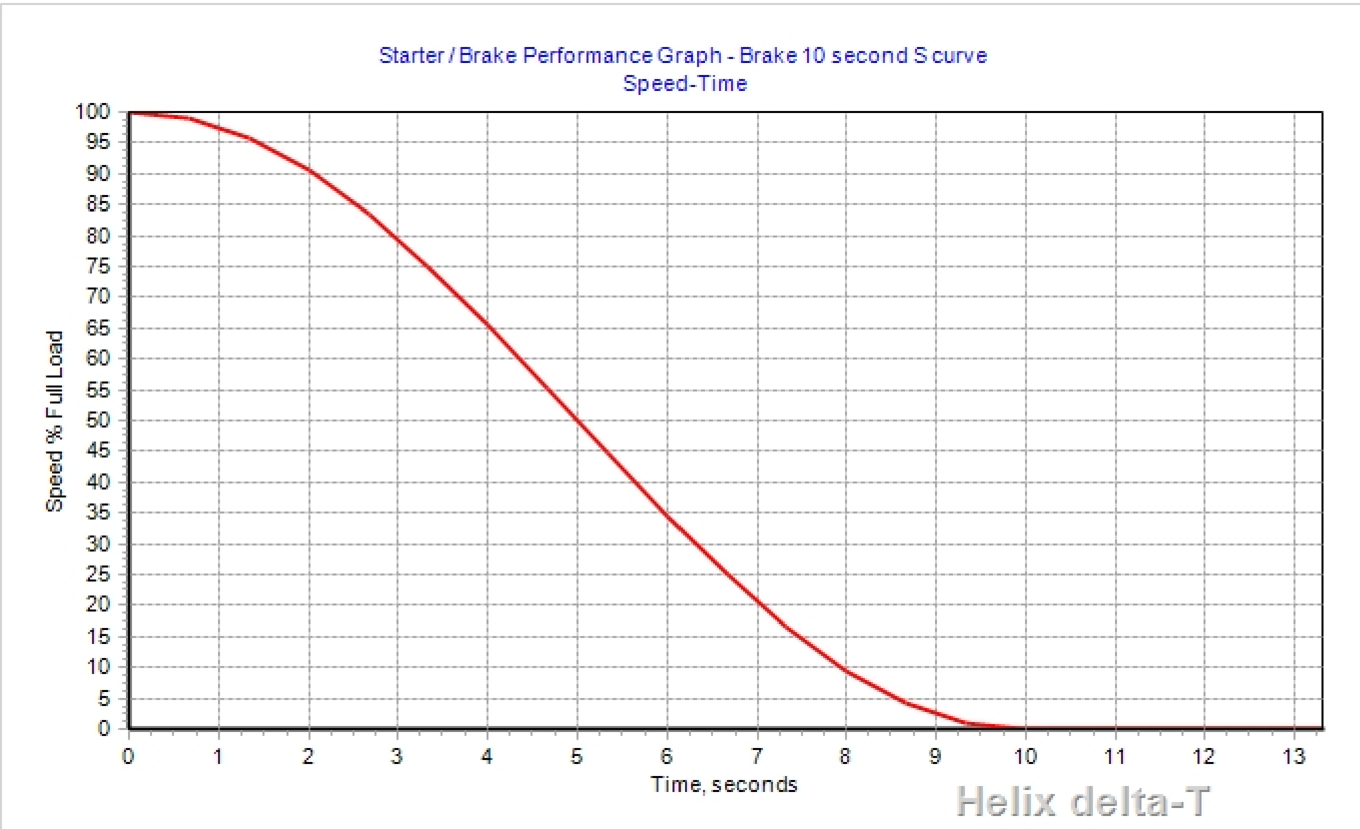
Aborted Start Torque Speed Curve

You can model an aborted start by truncating the Drive Torque vs Speed curve. For example, if the start is aborted at 85% of Full load Speed the following (simplified) Torque speed curve could be used to model the conveyor.



Braking

The Helix delta-T program allows you to program a Speed Time graph to apply to a braking stop. The principle is the same as the Speed time starting method except that it is applied when the conveyor is stopping. The full speed of the conveyor is taken as 100% speed and the brake pulley will follow the Speed Time you curve you input down to zero % speed. A sample is shown below.



VVVF and Variable Speed Starters

Variable Voltage Variable Frequency starters (VVVF) are basically electronic controllers which can control induction motor speed and torque by varying the electrical supply to the motor. They are also called Variable Speed Drives or VSD's. These starter can be programmed so that they will start a conveyor motor and force it follow a Speed Time curve such as the ones detailed above. They have speed loop feedback from the motor and control the motor speed to follow the programmed ramp by varying the torque the motor is developing. If the motor speed is falling behind the curve the torque is increased, if it is getting ahead of the curve the torque is decreased. This forces the motor to follow the programmed Speed Time curve. It is interesting to note the even though we program it to Speed Time parameters, it is still actually a torque control start.

These VVVF Drives can also be used to control the stopping of a conveyor by ramping down the torque in a controlled manner to follow a Speed Time curve such as the one shown under the Braking heading above. To to program this type of stopping use a Brake or Drive pulley with an S curve as shown above.

You can apply different Starting and Stopping characteristics to each individual Drive or Brake pulley (with delay times if required)

Horizontal Curves ...

HELIX delta-T6 Horizontal Curves

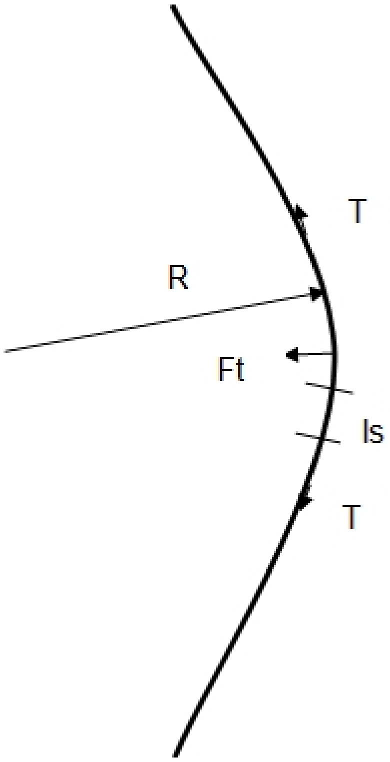
Video of Horizontally Curved Conveyor Belt Running Empty and then Full

Video of Horizontally Curved Conveyor Belt Running Empty and then Full - note reverse that when Empty the belt drift is towards the inside (high) of the curve but when the weight of the material is added the belt drift is to the outside (low) side of the curve. Helix allows you to calculate the belt drift under different loading and running or starting / stopping conditions. This conveyor was designed using the Helix delta-T program.

Helix delta-T version 6 has a powerful capability to design conveyors which are curved in the horizontal and vertical plane.

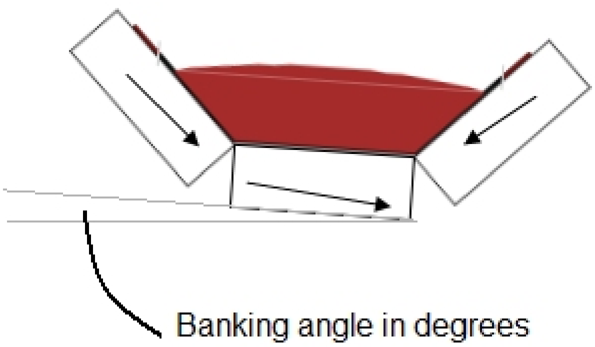
A picture of a horizontally curve conveyor is shown below - note the idlers are tilted up on the inside of the curve in order to prevent the belt from straightening and falling off the conveyor.

Horizontal Curve Calculation theory



The belt tension T in a curved belt has a resultant force Ft towards the centre of the curve. The resultant force Ft is given by: $Ft = \frac{T \times I_s}{R}$ where Ft is motivating force towards centre of curve, T is belt tension, Is is idler spacing and R is horizontal curve radius.

This motivating force needs to be balanced by tilting up the idler on the inside of the curve. The weight of the belt and material (if loaded) creates a balancing force to oppose the motivating force. The trick is to know how much to tilt the idler and ensure that the conveyor can operate under all conditions.



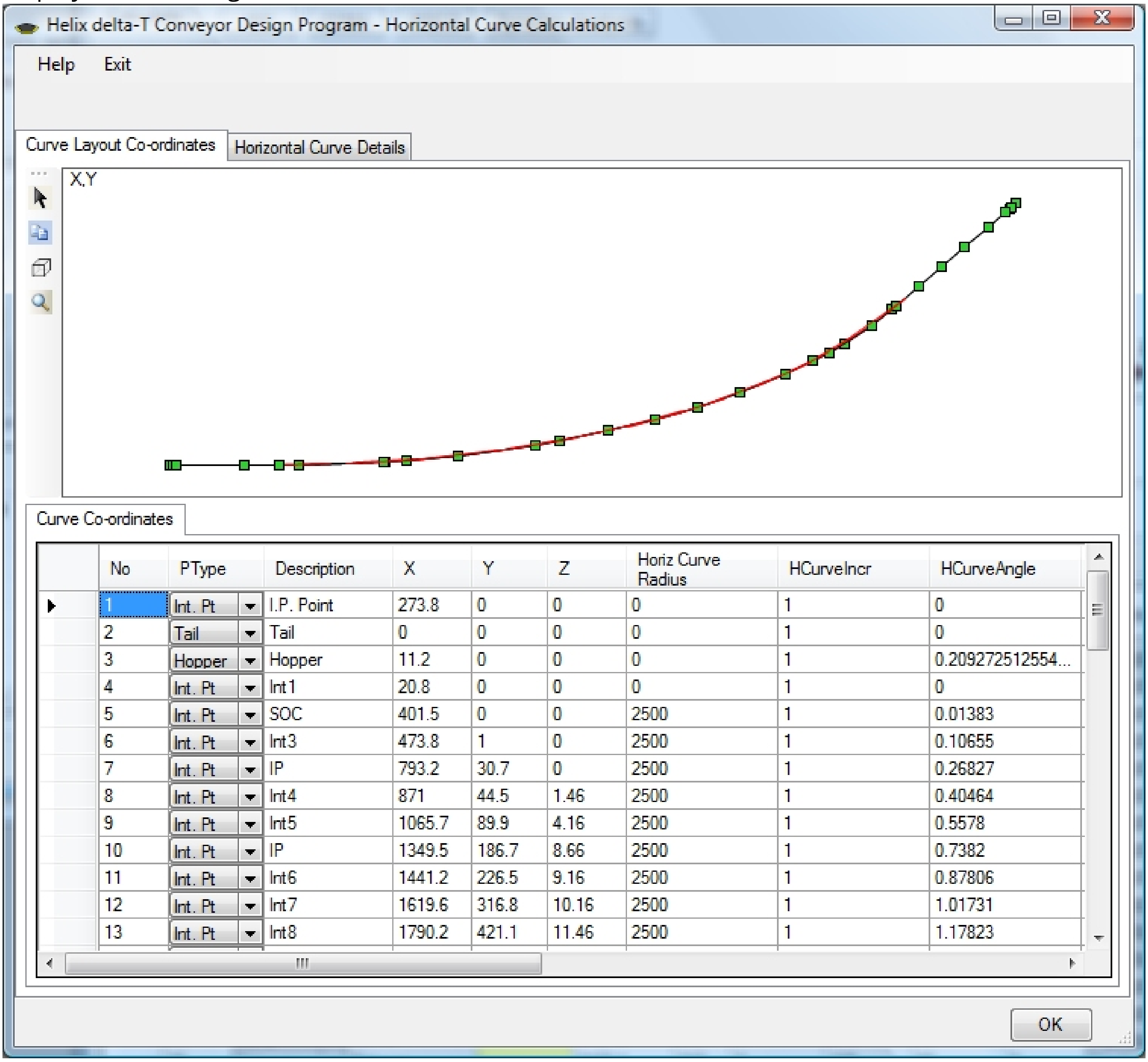
Negative Belt Drift - If you tilt the idlers up too much the belt will drift away from the centre of the curve and this is called a negative belt drift.

Positive Belt Drift - If the idler is not tilted up enough the forces will not be in balance and the belt will tend to drift towards the centre of the curve.

The objective is to select a banking angle which will result in negative belt drift under some operating conditions and positive belt drift under others and ensure that the belt and material will stay on the conveyor. If the banking angle required or belt drift is excessive you need to increase the curve radius or decrease the belt tension. Normally Helix Technologies aims to limit the banking angle to a maximum of about 8 degrees on the loaded side of the belt.

Horizontal Curve Calculations

To calculate the banking angles required and resulting belt drift in Horizontal curves requires you to first input the conveyor geometry including entering the X, Y, Z co-ordinates for the points along the conveyor. See the Entering X,Y.Z co-ordinates help topic. Once you have the conveyor geometry you can go to the Input, Input Horizontal Curves menu on the main form. This will display the following form:



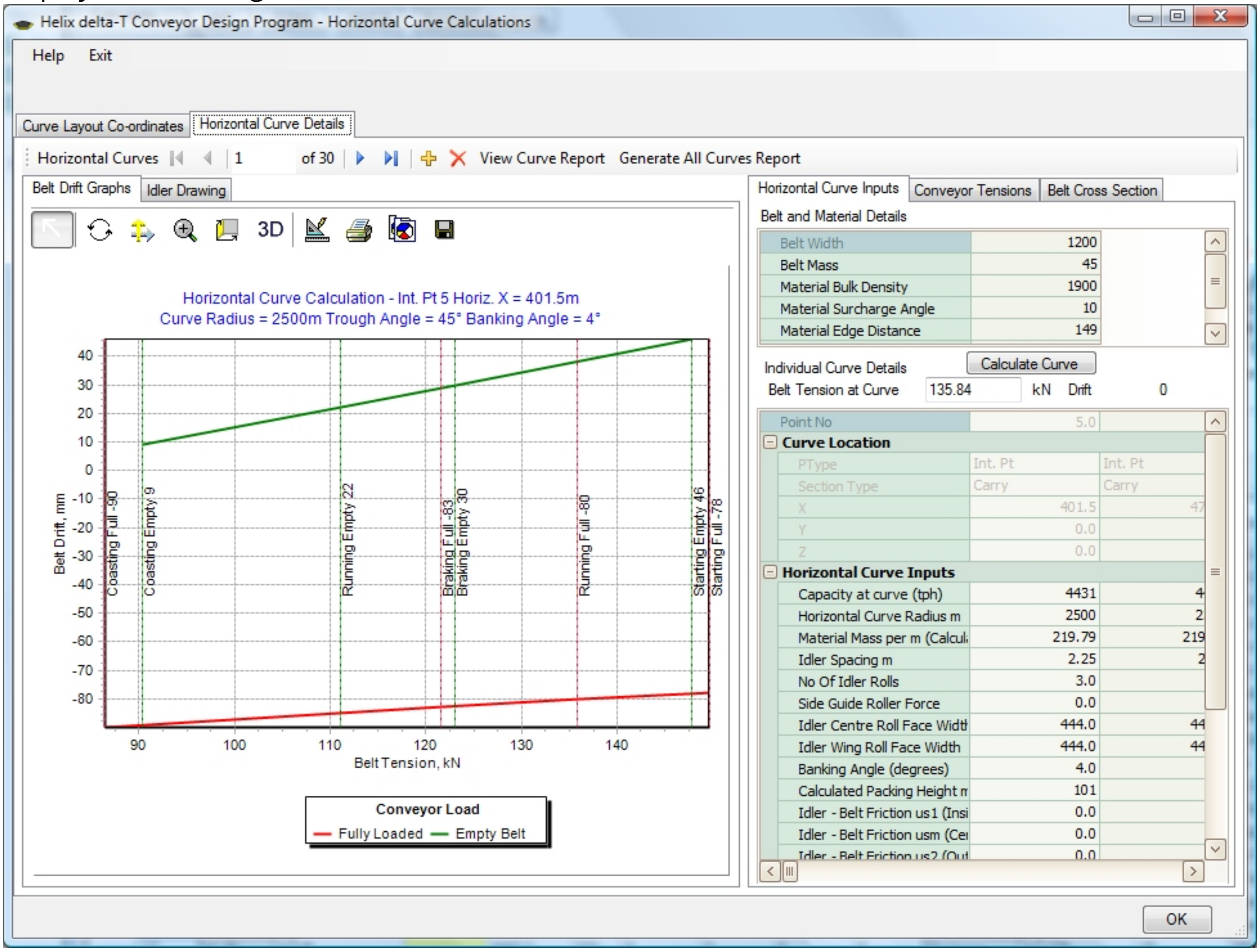
No	PType	Description	X	Y	Z	Horiz Curve Radius	HCurveIncr	HCurveAngle
1	Int. Pt	I.P. Point	273.8	0	0	0	1	0
2	Tail	Tail	0	0	0	0	1	0
3	Hopper	Hopper	11.2	0	0	0	1	0.209272512554...
4	Int. Pt	Int1	20.8	0	0	0	1	0
5	Int. Pt	SOC	401.5	0	0	2500	1	0.01383
6	Int. Pt	Int3	473.8	1	0	2500	1	0.10655
7	Int. Pt	IP	793.2	30.7	0	2500	1	0.26827
8	Int. Pt	Int4	871	44.5	1.46	2500	1	0.40464
9	Int. Pt	Int5	1065.7	89.9	4.16	2500	1	0.5578
10	Int. Pt	IP	1349.5	186.7	8.66	2500	1	0.7382
11	Int. Pt	Int6	1441.2	226.5	9.16	2500	1	0.87806
12	Int. Pt	Int7	1619.6	316.8	10.16	2500	1	1.01731
13	Int. Pt	Int8	1790.2	421.1	11.46	2500	1	1.17823

As can be seen from the above image the first sections of the conveyor are straight and the Y co-ordinates entered are all 0. Then from point 6 onwards the Y co-ordinates are increasing as the offset increases. The drawing is actually for a single horizontal curve but in order to improve accuracy of the geometry multiple points have been added along the curve path.

The radius of the curve is entered in the Horiz Curve Radius column, in this case it is a constant radius and it is drawn by the software as a red line. It is often best to draw the conveyor in a CAD drawing program and obtain the X,Y,Z points from the CAD drawing.

To calculate the banking angles required and resulting belt drift in Horizontal curves requires you to first input the conveyor geometry including entering the X, Y, Z co-ordinates for the points along the conveyor. See the Entering X,Y.Z co-ordinates help topic. Once you have the conveyor

geometry you can go to the Input, Input Horizontal Curves menu on the main form. This will display the following form:



The Horizontal Curves Datacontrol above the graph allows you to scroll through all the intersection points in the conveyor that are horizontal curves. as you scroll through the curves, the details of the curve are displayed in the Horizontal Curve Inputs tabsheet on the right hand side of the form. The inputs in these tables are extracted from other input data in the program but the following inputs relate specifically to the Horizontal curves:

Horizontal Curve Radius - this is a very important input, the larger the radius the less the resultant force towards the centre of the curve. Always use the maximum radius that can be incorporated in the conveyor.

Material Mass per m - this is a calculated value from the capacity on the conveyor section.

Idler Spacing - this input affects the motivating force, see formula at top of form.

Banking Angle - this is the angle at which the idler set is tilted up on the inside of the curve. If you alter this value and press Enter, the program will re-calculate the Belt Drift for all the operating conditions of the conveyor and draw them in the main Graph on the form.

Belt Drift Graph - this graph shows the amount the belt will drift for the particular load and operating case. For instance the Starting Empty belt drift is usually the highest positive belt drift and is shown by the intersection of the green graph with the "Starting Empty" vertical line. The Braking Full (or Coasting Full if no brakes are fitted) graph will usually be the highest negative belt drift calculated.

The Idler Face Widths also affect the calculations considerably, sometimes it is necessary to use an idler roll with a longer face width than you normally would for the belt selected. Getting more belt and material load on the centre roller increase the balancing forces. Three roll idlers are better than 2 roll idlers (even on the return belt run) because 2/3 of the belt and material are balancing versus half for a two roll system.

Idler to Belt Friction - some designers allow for a friction force between the belt and idler to counter the tendency of the belt to drift up the idlers. The inputs for the us1, usm and us2 are Coulomb friction factors. Helix recommends that these are set to zero because if the belt is wet the force will be considerably reduced.

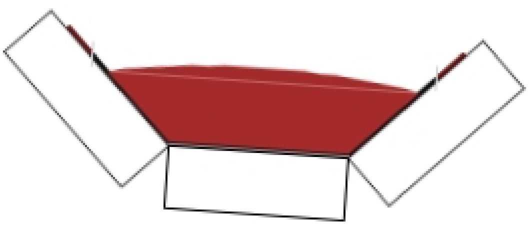
The Conveyor Tensions tab shows the belt tensions at the curve under the various operating conditions.

Horizontal Curve Inputs | Conveyor Tensions | Belt Cross Section

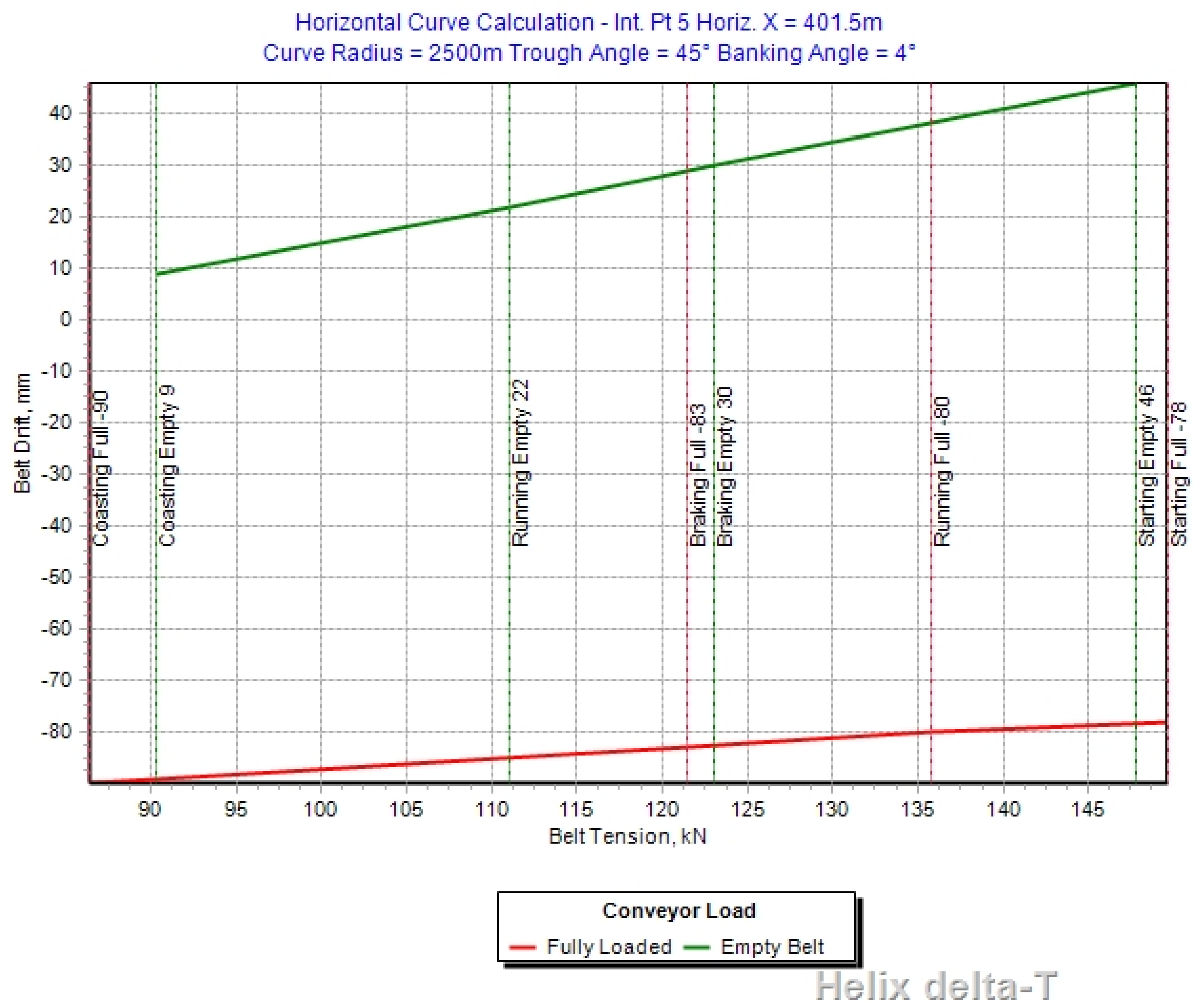
No	5.00	6.00	
PType	Int. Pt	Int. Pt	Int. Pt
Location Co-ordinates			
Desc	SOC	Int3	IP
X	401.50	473.80	79
Y	0.00	1.00	3
Z	0.00	0.00	
Calculated Belt Tensions			
Run Full Tension	124.46	128.68	14
Run Empty Tension	97.96	98.60	10
T1Stopped	57.96	57.96	5
Start Full Tension	138.59	143.66	16
Start Empty Tension	138.03	139.33	14
Braking Full Tension	110.44	111.28	11
Braking Empty Tension	113.50	113.70	11
Coasting Full Tension	75.39	76.65	8
Coasting Empty Tension	80.82	81.18	8
Horizontal Curve Tension Rise (Calcu	42.29	42.29	4
Capacity tph	4,431.00	4,431.00	4,43
Idler Spacing	2.25	2.25	
Material mass per m	219.79	219.79	21

Belt Tension Rise due to elongation of outside edge of belt in the horizontal curve
Add this tension to the maximum tension in the belt and ensure it is within limits

The Belt Cross Section Drawing tab shows a drawing of the carry idler tilted at the banking angle you input for the curve.



Copy data You can copy the Belt Drift Graphs into the Windows clipboard using the Copy button above the graph and then paste these graphs into a Word document as part of a report, or you can view and print the report using the button provided at the top of the form.



In the graph above the banking angle is bit too large because the negative drift is more than positive drift. This was done purposely on this conveyor as subsequent points along the horizontal curve have higher belt tensions resulting in more positive drift and it was decided to keep the whole curve at 4 degrees banking. you may of course vary the banking angle along the curve or even at each idler station if you wish, but this is harder to implement on site.

Adjustable Angle Idlers - it is good practice to provide a means of adjusting the banking of the idlers on site in order to allow fine tuning of the banking angle.

Side Guide Rollers - it is common to install side guide rollers to prevent the belt from slipping off the idler set completely in the case of excessive belt drift which may be cause by uneven loading or belt tension variations - refer photo at the top of this help topic for an example of the side guide rollers.

Belt Troughability - it is important the belt is flexible enough to trough correctly under the loaded and empty conditions.

Photo of Horizontally Curved Conveyor

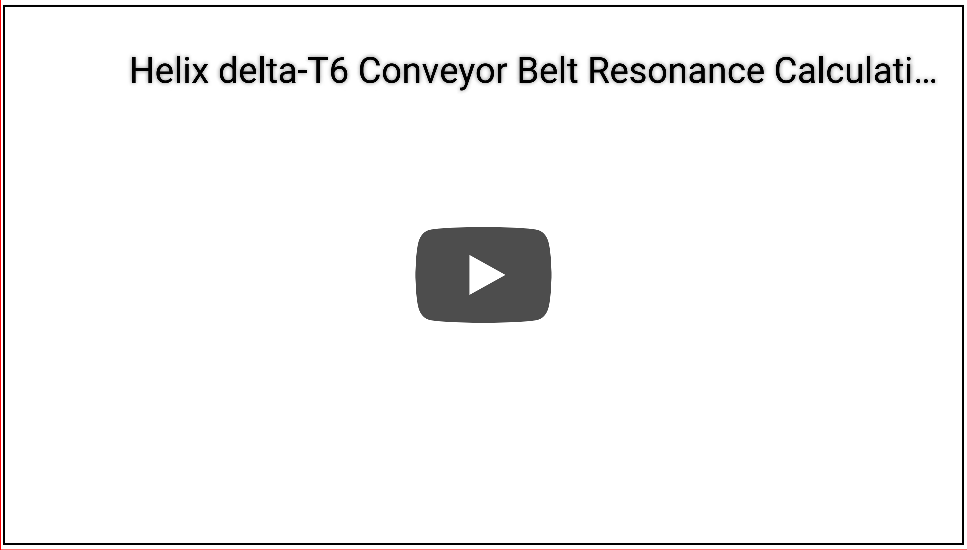
Curved Conveyor A photo of a 4400m long 4400tph Horizontally curved conveyor with 2000kW installed power. Helix delta-T was used for the design.

Horizontal Curve Reports can be generated and printed or saved for each curve

Belt Resonance ...

HELIX delta-T6 Belt Resonance / Flap

Video of Material Bunching caused by Belt Resonance



This conveyor is loaded evenly at the tail end but due to idler and belt resonance the material becomes bunched up. This occurs at certain belt speeds, idler spacings, conveyor load and belt tensions. Helix delta-T6 can calculate whether there will be belt resonance like this on conveyor sections and if present then you can alter the design to ensure this bunching and severe structural vibration does not occur on your conveyor.

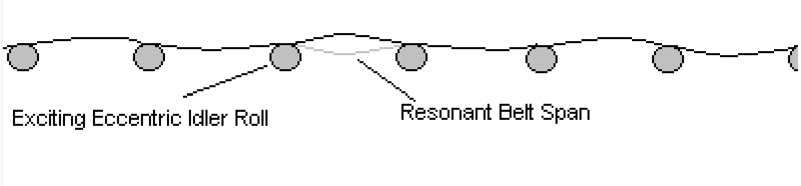
What is Belt Resonance?

The tensioned belt supported by the idlers may be modelled as a simply supported plate. This belt has an inherent natural frequency dependent on the span between idlers, mass of belt and material if present and the tension in the belt (similar to a guitar string). The rotating idler roll also has a natural frequency induced by its eccentricity. If the natural frequency of the belt and the rotating idler coincide, resonance occurs. This resonance can have a damaging effect on the idler rolls, bearings and the conveyor structure itself and should be avoided by altering either the idler spacing, belt speed, mass of belt or belt tension.

Apart from damage to conveyor equipment, the resonance can cause material bunching as shown in the video above. This has a detrimental effect on the operation of the plant and apart from causing vibration it can induce blockages and affect the flow through transfer chutes and the loading on downsteam conveyors. Also, material spillage is a major problem.

Helix delta-T Conveyor Design - Belt Flap Report

The delta-T program has a Design Report which calculates the Idler Roll frequency and the Belt Transverse Wave frequency for each section of conveyor, and if the belt frequency and the idler frequency fall within +/- 10% of each other, a warning flag will be raised. Multiple frequency modes are also calculated.

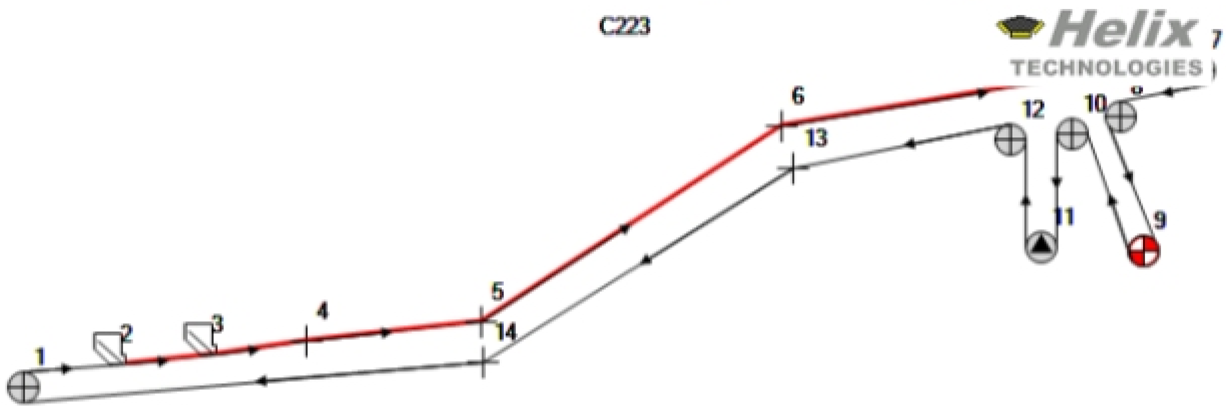


Belt and Idler Resonance Report

23 Mar 2010 17:25 **Conveyor Belt Resonance Report** Page 1/1

Helix Technologies Pty Ltd

Project	Demo Conveyor High Lift	Client	ABC Iron
Project No.	P9823	Prepared By	Peter Burrow
Conveyor No.	C223	Design Date	14 January 2010



Carry Roll Diameter	152	mm	Belt Speed	4.3	m/s
Return Roll Diameter	152	mm	Takeup Mass	26700	kg

Station / Section		Running Fully Loaded Belt Resonance									
Station	Description	Start Belt Tension kN	End Belt Tension kN	Belt Transverse Wave Frequency Range Hz	to Hz	Idler Roll Excitation Frequency Hz	Section Idler Spacing m	Critical Idler Spacing Start m	Critical Idler Spacing End m	Idler Spacing within +/- 10% m	Mode
1	Tail	121.01	142.78	19	20.68	9	1	2.11	2.3	Caution	1/2
2	Hopper	121.4	155.17	13.2	15.31	9	0.45	0.66	0.76	OK	
3	Hopper	142.78	169.73	14.57	16.13	9	0.45	0.73	0.81	Caution	1/2
4	Int. Pt	155.17	371.5	4.59	7.48	9	1.5	0.76	1.25	Warning	2
5	Int. Pt	169.73	418.4	4.84	7.96	9	1.5	0.81	1.33	Warning	2
6	Int. Pt	371.5	423.11	9.34	10.01	9	1.2	1.25	1.33	Caution	1
7	Head	422.81	421.65	11.95	11.93	9	3	3.98	3.97	OK	
8	Bend	427.57	134.83	12.01	6.69	9	3	4	2.23	OK	
9	Drive	127.76	130.92	6.51	6.59	9	3	2.17	2.2	OK	
10	Bend	136.43	138.09	6.74	6.78	9	3	2.24	2.26	OK	
11	Takeup	132.42	137.9	6.63	6.77	9	3	2.21	2.26	OK	
12	Bend	139.66	119.3	8.52	7.86	9	2.4	2.27	2.09	Caution	1
13	Int. Pt	137.9	119.63	6.77	6.3	9	3	2.26	2.1	OK	
14	Int. Pt	119.3	119.63	6.29	6.3	9	3	2.09	2.1	OK	

The Tension at the beginning and end of each conveyor section is used to calculate the belt sag and then the **Belt Transverse wave frequency**, resulting in a range of frequencies for the conveyor section. This range is compared to the **Idler Roll excitation frequency.**

Belt Resonance +/- Tolerance Band width

You can adjust the band width of the resonance calculations. In earlier versions of the Helix program the band width was fixed to +/- 10% but now you can input the tolerance to use for the warnings. For example for more accuracy use a value say 2%. This will only warn you if the belt frequency and the idler frequency are within +/- 2%. This input value is on the **Input Belt Details input form.**

The sample report shown above shows the calculated values for the Belt Transverse Wave frequency range and the Idler Roll excitation frequencies. If these two frequencies, or multiples of the frequencies, fall within plus or minus 10% of each other a warning flag is raised in the last column of the report. The second last column shows the critical idler spacing for the first mode, ie when n=1.

Usually, the carry side of the belt will be loaded and the mass of material will have a significant damping effect on the belt transverse wave amplitude.

The tensions used are for the conveyor running fully loaded, as this is mode in which the conveyor will be operated for most of the time. You can change the load on each section if required.

Avoid the Warning 2 and 3 cases

Helix Technologies have observed the behaviour of many conveyors and we have come to recognise that the belt flap case to avoid is the one with the mode 2 or 3 warning. In this case the belt transverse wave frequency is half the idler rotation frequency and this is the case which causes the material to bunch up on the belt inducing increasing vibrations which in turn cause more material to bunch up and so on. See picture of material bunching below and video above.

Example of Material Bunching - Warning mode 2 case

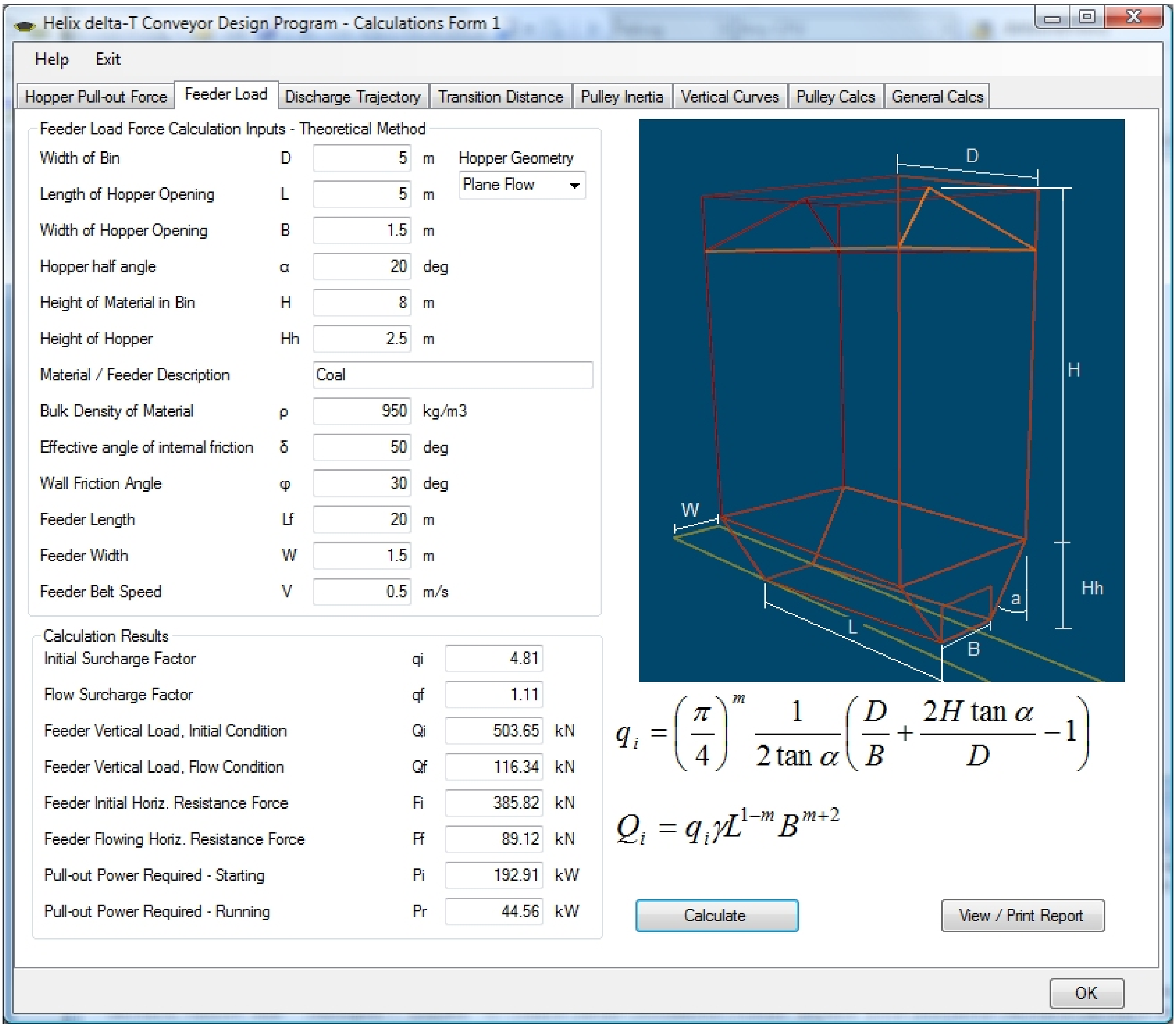
Mix up idler spacing

In order to prevent the resonance occurring it is recommended that the idler spacing be changed to random spacing. This moves the Belt Frequency as the spacing changes and so does not allow resonance to build up.

Feeder Calculations ...

HELIX delta-T6 - Feeder Calculation - Theoretical Method

You can calculate the additional forces required to pull material out of a hopper or bin. Select the Calcs, Calculate Feeder Loads menu from the main form. The following form will be displayed:



This form allows you to calculate the Additional Tension required to pull a material out of a feeder, bin or hopper. This additional tension is mainly due to the shearing action required to pull the material out of the hopper opening. The method used here is the 'Theoretical' method developed first by arnold and McLean and the then refined by A.W. Roberts and others. Many papers have been published on this subject and some are quite complex, however, Helix have refined the inputs to those shown in this form. The material in the feeder will require testing in order to determine the wall frcition and effective angle of internal friction.

The initial surcharge factor qi is calculated and then the feeder vertical load is calculated using qi, see formula shown on form.

Alternatively, two other emperical methods of calculation are offered - **Bruff's** method and the method proposed in the Bridgestone conveyor design manual, see the **Calcs, Calculate Pull-out Force from Hopper** menu.

Input your feeder and material data and then once you have obtained the feeder vertical and horizontal pull out loads you can use the method shown below to model the belt feeder conveyor.

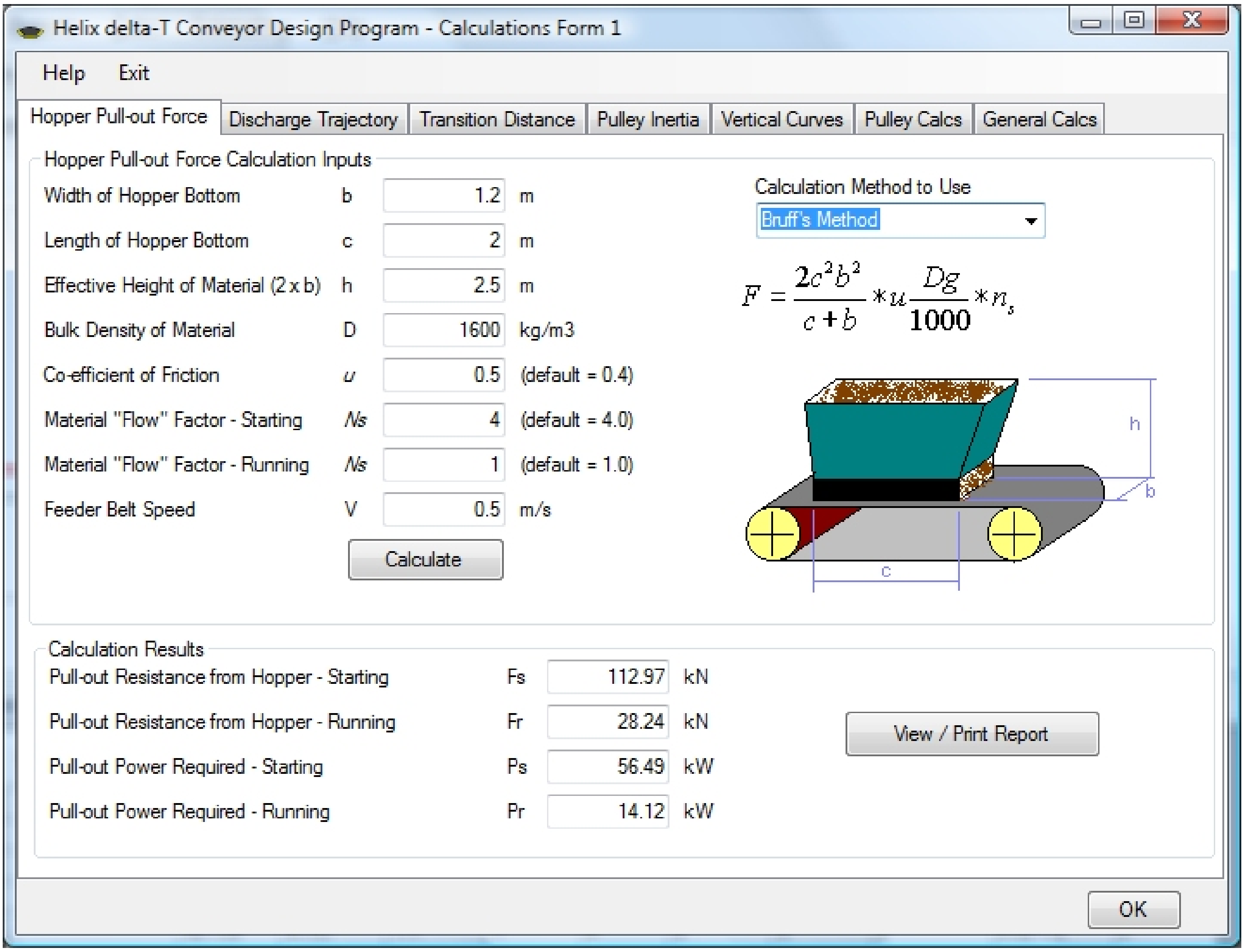
Once you have the magnitude of these Pullout force tensions, you should design the Feeder as a normal conveyor and add the Pullout Tension as a Tension Adjustment in the Input Sections form.

You will note that two Tensions are given:

- Starting or Initial Pull-out force
- Running or Flow conditions Pullout force

The higher Starting force is required to overcome the interlocking (or bridging) of the material whilst stationary. Once it is flowing, the force required reduces.

HELIX delta-T6 - Feeder Calculation - Bruff's Method



This form allows you to calculate the Additional Tension required to pull a material out of a hopper. This additional tension is mainly due to the shearing action required to pull the material out of the hopper opening. The methods shown and used are quick estimation methods and it must be pointed out that the design of feeders and calculating the loads is a complex subject and requires testing of the material properties which is beyond the scope of this program. The methods shown here do not require any testing or special material properties and are provided as an estimate of loads.

Once you have the magnitude of these Pullout force tensions, you should design the Feeder as a normal conveyor and add the Pullout Tension as a **Tension Adjustment** in the Input Sections form.

Two methods of calculation are offered - **Bruff's method** and the method proposed in the **Bridgestone** conveyor design manual. Generally, Bruff's method is more conservative and is the preferred choice for safety. The Bridgestone method is more conservative when the depth of material in the hopper is large.

You will note that two Tensions are given:

- Starting or Initial Pull-out force
- Running or Flow conditions Pullout force

Belt Feeder Calculation Procedure in Helix delta-T6

- Build a model of the conveyor
- Go to Calcs, Feeder Calculations and enter the hopper dimensions and material properties
- Press Calculate
- Transfer the Feeder Flowing Horizontal Resistance Force Ff to the Conveyor Sections, Tension Adjustment column.
- Re-calculate the Conveyor using ISO, CEMA or VISCO buttons
- The Tension Adjustment will have been added to the conveyor model - details can be seen in the Tension Calculation Reports
- Note the conveyor absorbed and installed power and the Starting Torque Factor which depends on starting method and motor.

Now you should substitute the Running Pullout Tension with the Starting Pullout Tension in the Tension adjustment and re-calculate the conveyor. If the absorbed power is less than the Installed Power x Starting Torque factor then there is sufficient power and torque to start the conveyor. A numeric example is shown below:

Conveyor Speed = 1.0m/s, belt power = Te x Belt Speed.

Effective Tension (3kN) and Absorbed power without Tension Adjustment = 3kW say.

Calculate hopper and add a Running Tension adjustment of 2kN say. Te is now 5kN and absorbed power 5kW. Installed power is selected as 7.5kW motor started Direct on Line with starting torque factor of 200% FLT.

The Starting Tension adjustment is (say) 4 x Running = 8kN say. So for starting the Te becomes 3 + 8 = 11kN or 11kW and we have available 7.5kW x 200% = 15kW so it is OK.

After Calculations are done you can view, Print or Export the report.

The following references are shown if you would like to research these methods further.

References

- McClean A.G, Arnold P.C, 'A simplified approach for the evaluation of feeder loads for mass flow bins', Powder & Bulks Solids Technology Vol.3 No.3
- A.W Roberts et.al, 'Wall Pressure-Feeder Load Interactions in Mass Flow Hopper/Feeder Combinations', Bulk Solids Handling Vol 6 No.4
- A. E Maton, 'Belt Feeder Design: Starting Load Calculations', Bulk Solids Handling 8 2009

Additonal Calculations ...

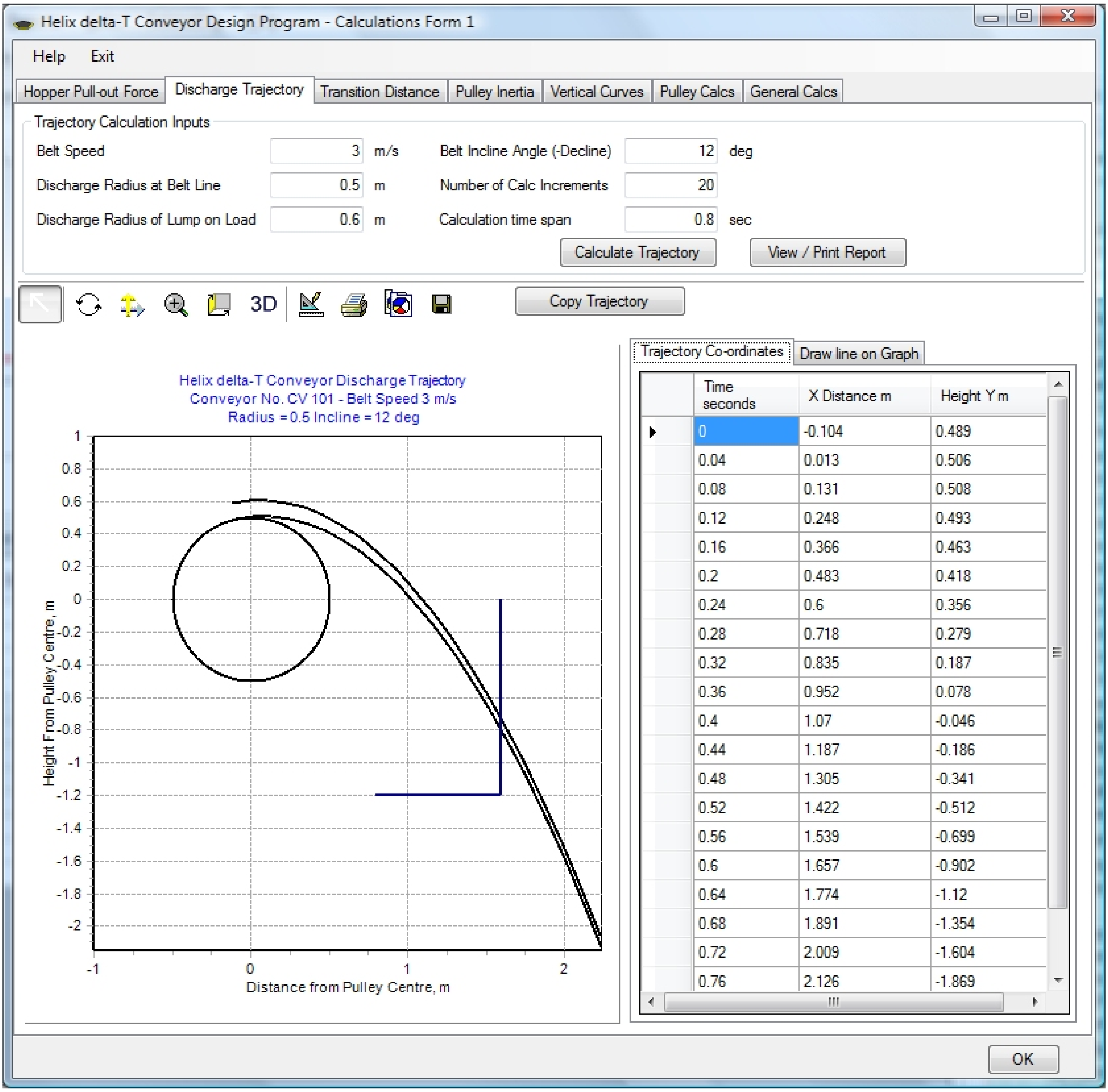
HELIX delta-T6 - Additional Calculations

Helix delta-T6 has a number of additional calculations for things such as:

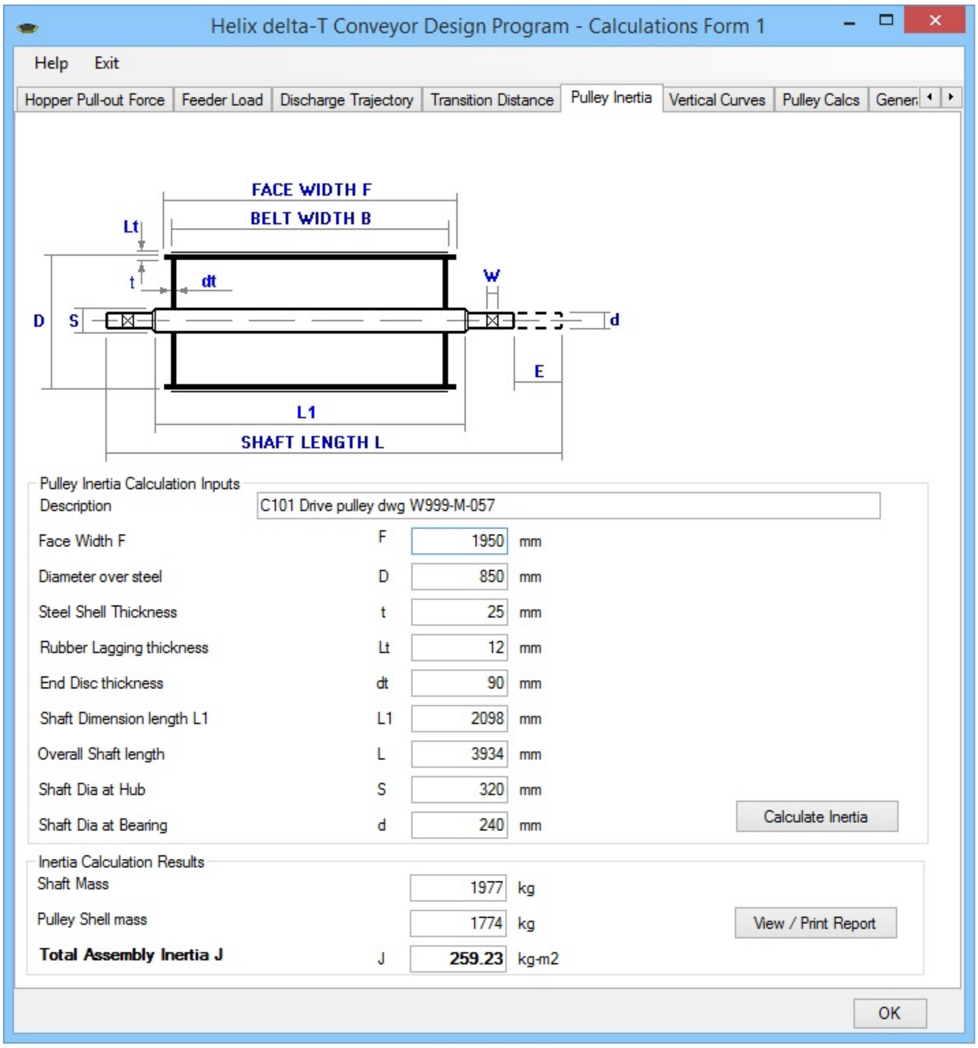
- Belt Turnover Calculator - see Belt Turnovers (/DeltaT6/BeltTurnovers)
- Discharge Trajectory
- Trough Transition Lengths
- Pulley Inertia
- Pulley Wrap Angle Calculation
- Drive Traction Calculation
- Pulley Bearing L10h life
- Vertical Curve Lift-off radius
- Vertical Curve Buckling Radius
- Vertical Curve Edge Tension Radius
- Horizontal Curve Banking Angle and Belt Drift
- And more...

You can view a sample report by clicking the following link: Sample Design report - pdf file (/DownloadFiles/Helix_delta-T6_Sample_Report01.pdf)

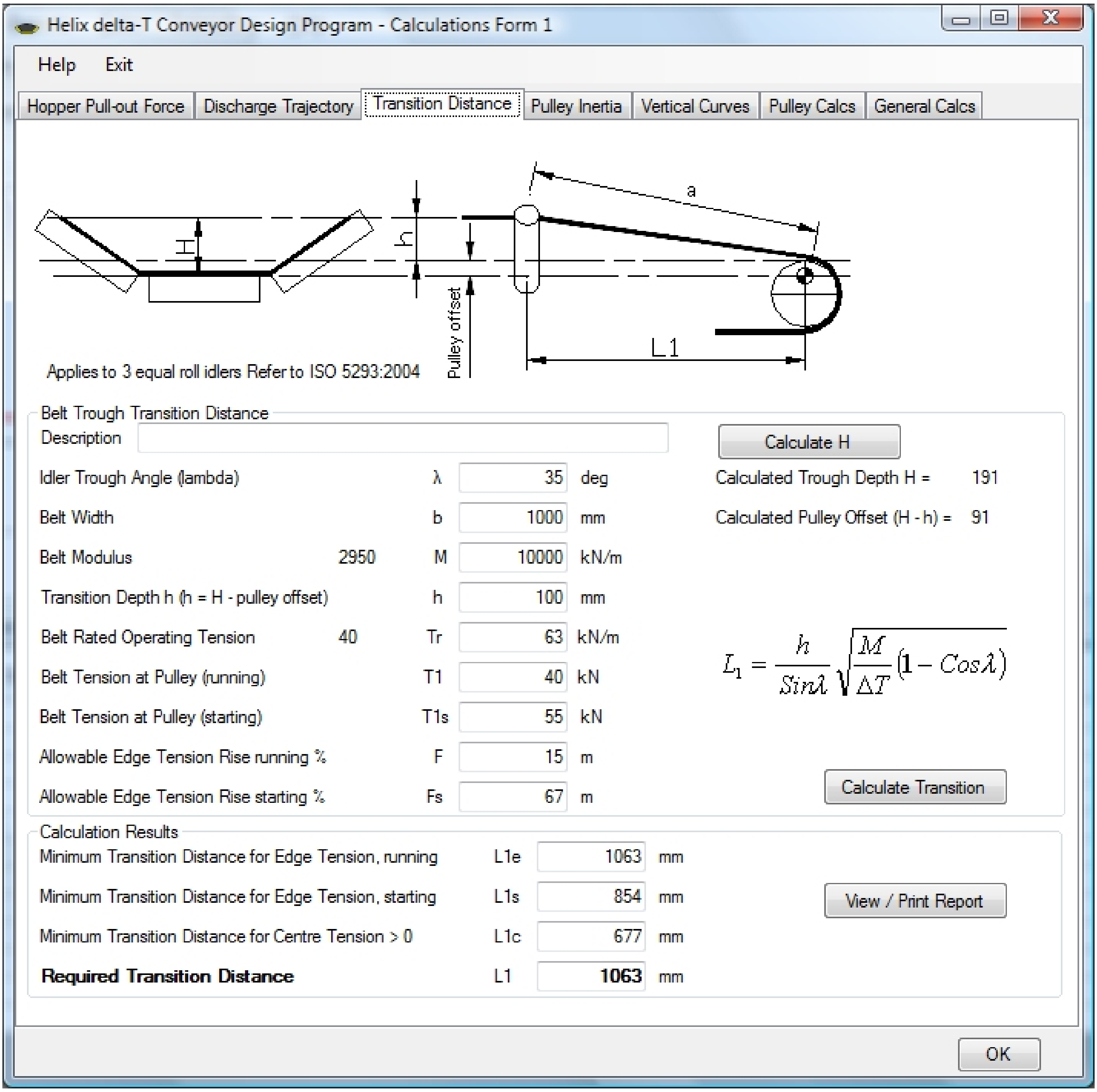
Discharge Directory Calculation



Pulley Inertia Calculation



Trough Transition Calculation



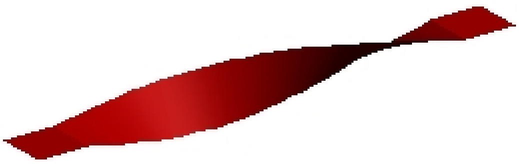
There are many more calculations - see the Demo program Calcs Menu.

Belt Turnovers ...

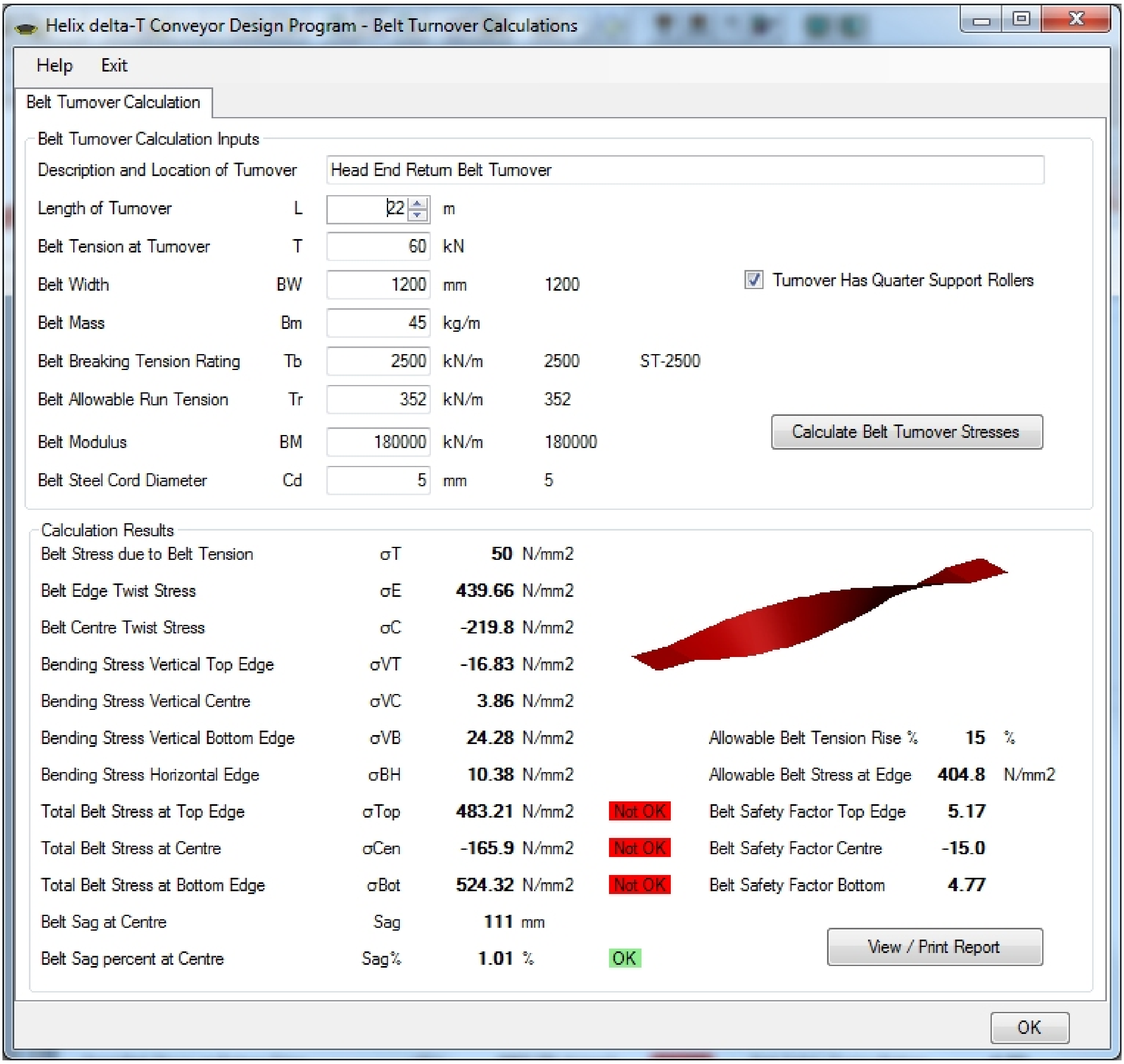
HELIX delta-T6 - Belt Turnover Calculations

Belt Turnovers are sometimes used on conveyors to flip the belt over through an angle of 180 degrees. This is often used in order to keep the belt cover which is in contact with the idlers on the carry side of the belt also in contact with the idlers on the return side of the belt. This is an advantage when the belt has a Low Resistance Rubber cover on the bottom cover and it is then turned over after the discharge and drive pulleys so that the low resistance rubber is utilised on the return run as well as the carry run. The belt is then turned back over at the tail end of the conveyor. Another advantage of the turnover is that material which may be stuck to the carry side of the belt will be shed by gravity, idler roller contact and vibrations on the return run.

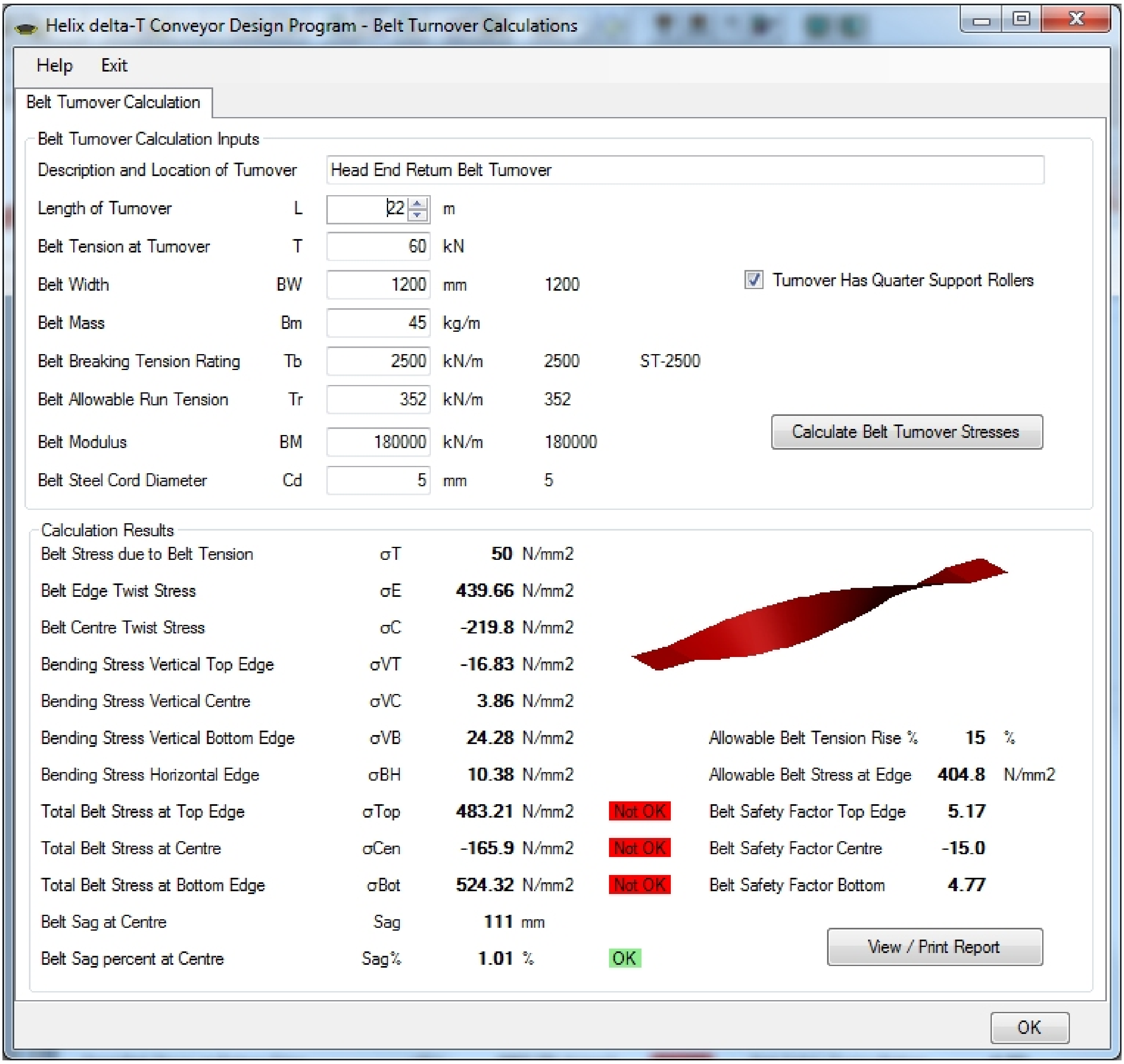
Twisting the belt through 180 degrees causes the belt edge to be elongated and this increases the edge tension in the belt with a corresponding reduction in center tension, similar to the belt transition from troughed to flat at a discharge pulley. A calculation of the magnitude of this tension rise as well as the belt sag between supports is required in order to ensure the belt is not overstressed. Also, the belt should not be subjected to compressive forces (negative tensions) at the centre. Twisting the belt 180 degrees over too short a length will result in excessive edge tension and or compressive centre tensions.



Use the main form main menu Calcs, Calculate Belt Turnover to open the calculation form.



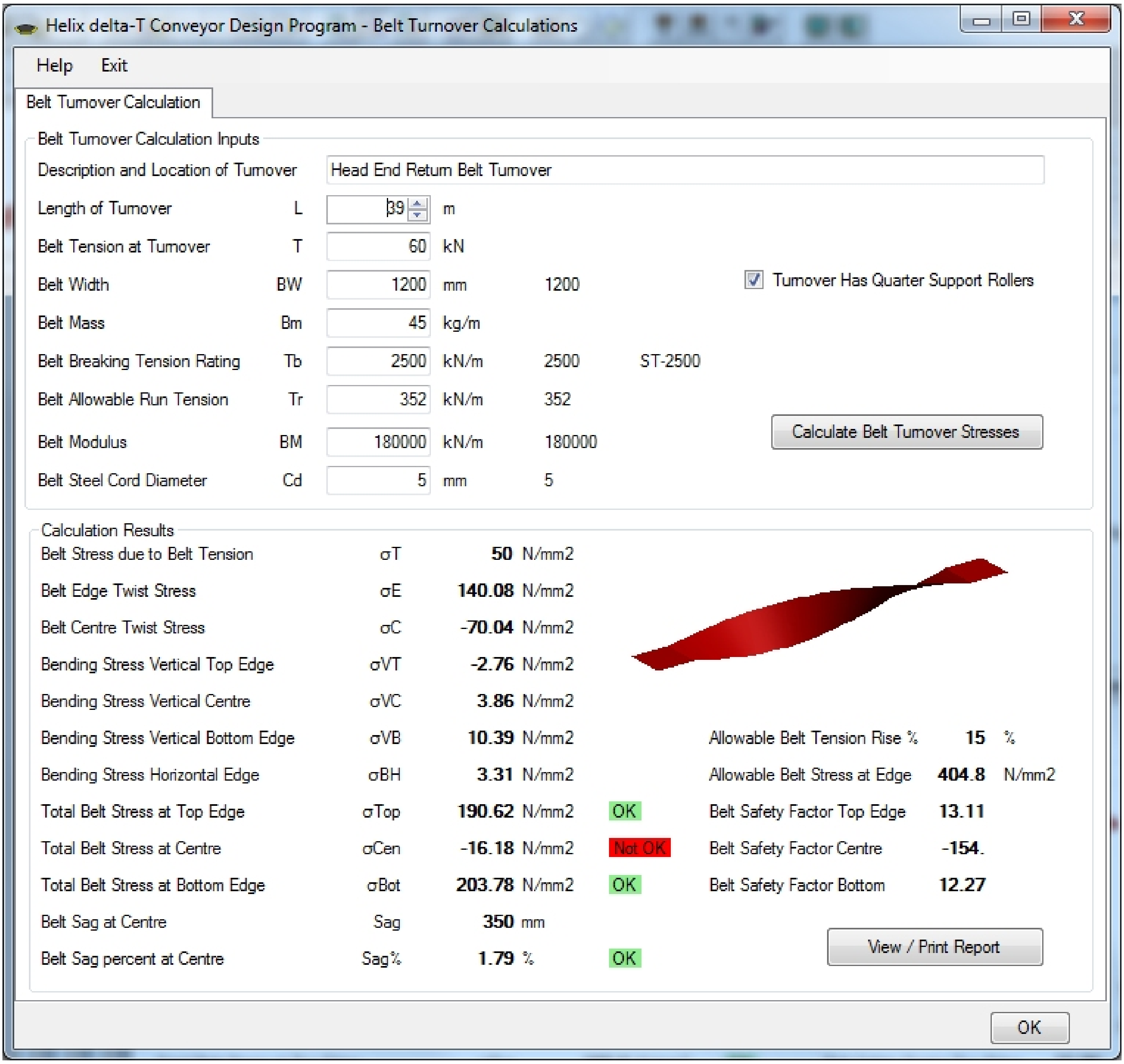
Use the main form main menu Calcs, Calculate Belt Turnover to open the calculation form.



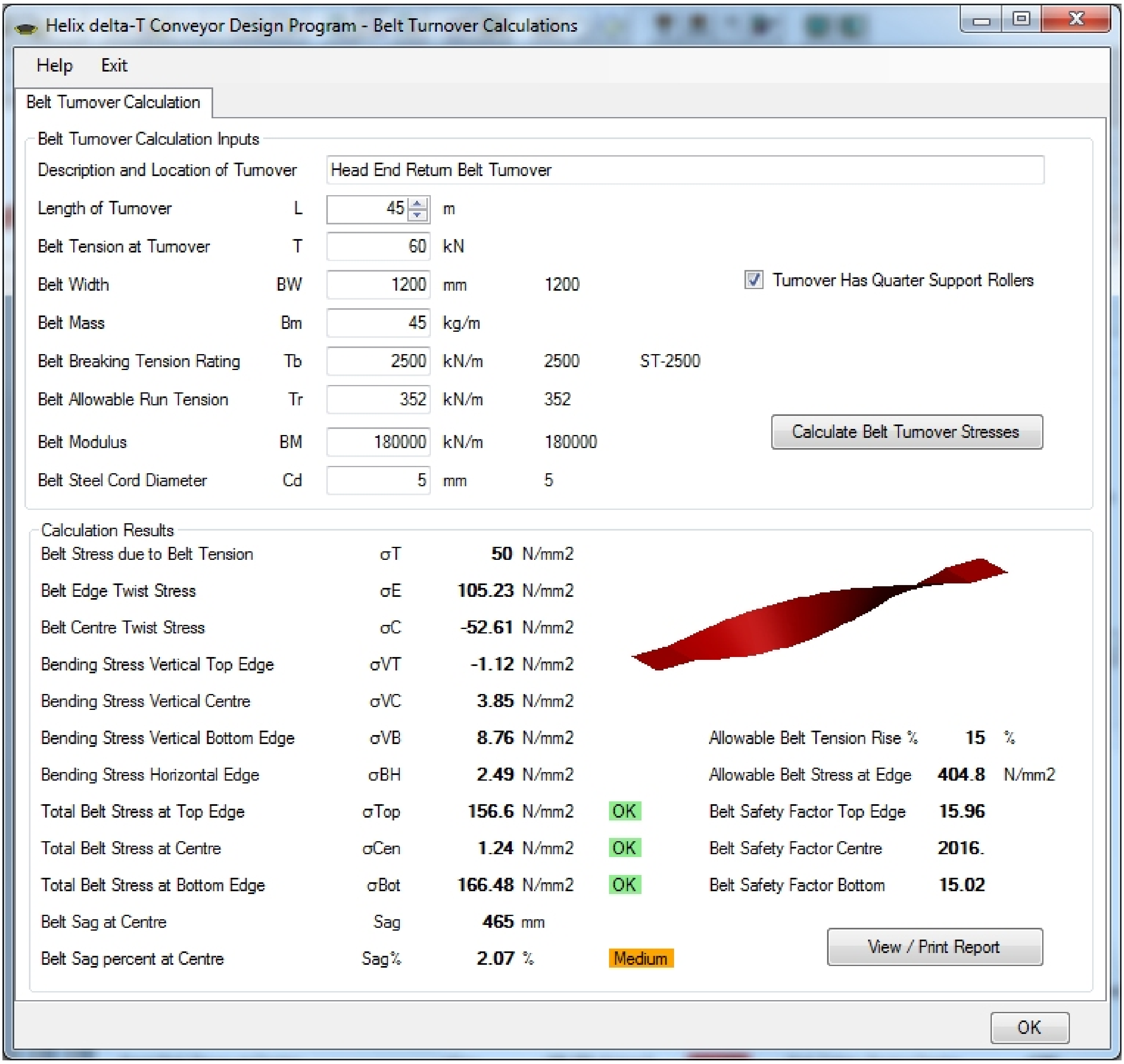
Enter the Belt Tension at the turnover, belt width, belt mass, belt strength and allowable run tension, belt modulus and if it is a steel belt enter the cord diameter. If the belt is a fabric belt the cord diameter can be entered as 1mm.

If the belt has quarter turn support rollers (angled at 45 degrees) to support the belt in the turnover, check the Turnover Has Quarter Support Roller checkbox to ON, leave it off of there are no intermediate support rollers. This check box does not refer to a set of vertical support rollers at the midpoint. The Quarter turn support rollers help to reduce the belt sag in the turnover.

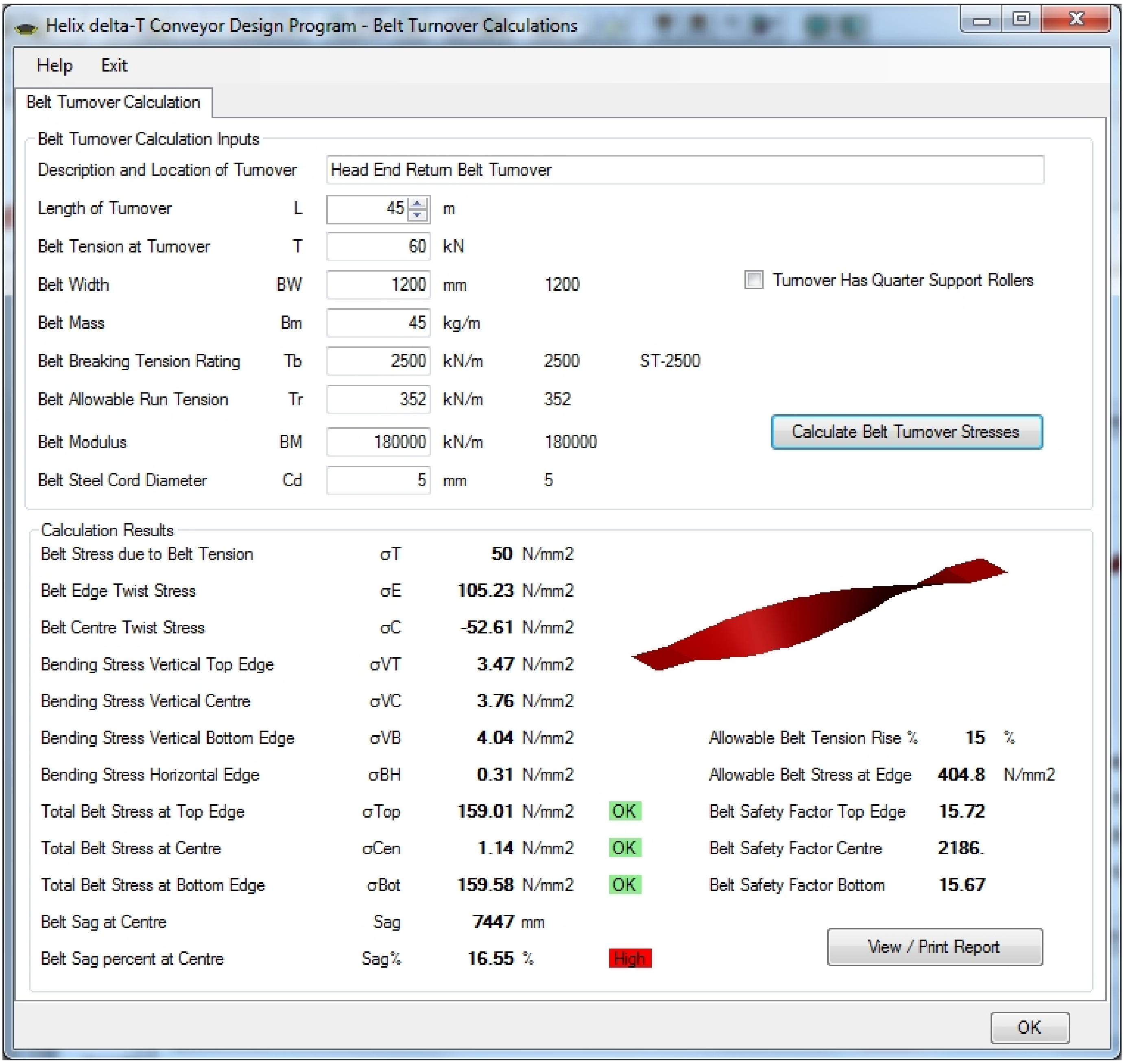
Now use the spin button on the Length of Turnover input box to find the shortest turnover length which does not have a negative centre tensions. In the example above the 22m long turnover has excessive edge tension and negative centre tension, flagged by the Red **Not OK** warning labels. Increasing the turnover length to 39m, as shown below, reduces the edge tension to acceptable values but the centre tension is still negative.



Increasing the turnover length to 45m, as shown below, reduces the edge tension to acceptable values and increases the centre tension to positive values.



The belt sag has increased to 465mm and this is just over 2% of the length of the turnover between quarter support rolls.



The case without quarter support rolls has a very large sag of 7447mm and is flagged as High sag because the sag exceeds 5% of span. A flag of Medium is shown for sag between 2% to 5% but there is no specified limit, the amount of acceptable sag is up to the designer.

The belt edge tension and centre tension stresses are calculated from the elongation of the belt due to twisting. The belt sag is calculated as for a catenary using only the first term of the series.

SAG $$y = \frac{S^2 (Wb + Wm) \cdot g}{8 \cdot T} \quad \text{and} \quad y = \frac{\% sag \cdot S}{100}$$

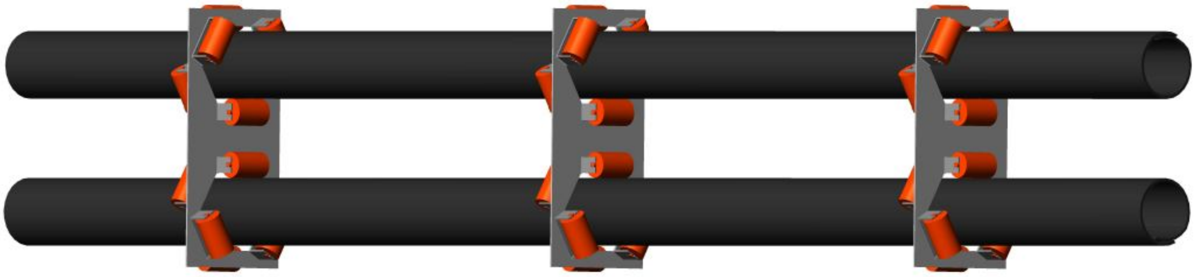
Bending stresses in the steel cords are generally low and are calculated from the curvature in the cables due to belt sag.

You should use the minimum turnover length which yields acceptable edge tension and positive centre tension and depending on the belt tension in the turnover, quarter support rolls will probably be required in order to limit the belt sag to acceptable levels.

Repeat the calculations for all belt tensions which will be experienced in the Turnover. You can print out the calculation report by using the **View / Print Report** button

Pipe Conveyors ...

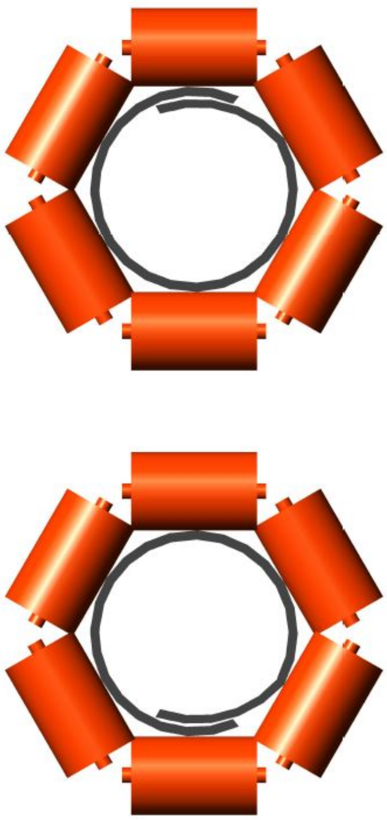
Pipe Conveyors

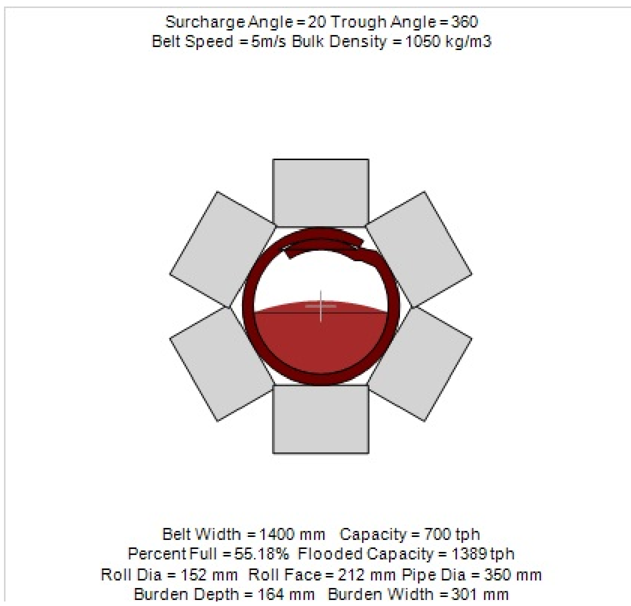


The Helix delta-T6 Conveyor Design program has the ability to design Pipe Conveyors. In a Pipe Conveyor, the belt is formed into a circular tube which fully encloses the conveyed material. The conveyor belt is an open trough under the loading chute and it is trained and formed into an enclosed tube for the length of the conveyor until it is once again opened to a troughed shape at the discharge pulley.

Download an example report of a Pipe Conveyor modeled in the Helix delta-T6 Conveyor Design Program: Demo 22 Existing PipeConveyor PC01 Coal 1000tph 4km Helix delta T6 Design Report.pdf (/DownloadFiles/Demo_22ExistingPipeConveyorPC01Coal1000tph4km_DesignReport.pdf)

In Helix delta-T6 a **Pipe Conveyor** is denoted by selecting or inputting **6 Roll Idlers and a 360 degree Troughing Angle.**





A typical Pipe Conveyor cross-sectional view. The belt is formed into a tubular shape by 6 idler rollers.

Summary of Pipe conveyor Advantages

- Conveyed Material is fully enclosed and weather protected

- Enclosing the conveyed material has environmental benefits with limited spillage
- Pipe Conveyors can generally navigate tighter (smaller radius) vertical and horizontal curves than conventional troughed conveyors
- Maximum lump size = 25% to 33% of Pipe Diameter (use lower % for high proportion of lumps)
- Maximum Loading = < 70% of load area for small lumps
- Maximum Loading = < 60% of load area for larger lumps
- Even / Constant Load Feed is required to prevent overloading
- Maximum Incline angle can be larger than for troughed conveyors, up to ~27 degrees for sluggish flowing material
- Maximum Recommended Idler rotation speed is 600 - 750 rpm
- Tube Fold Transition Length: Allow at least 25 to 40 x D for Folding and unfolding belt for Fabric belts (use larger value for large Pipe Dia)
- Tube Fold Transition Length: Allow at least 40 to 50 x D for Folding and unfolding belt for Steel belts (use larger value for large Pipe Dia)

Summary of Pipe conveyor Disadvantages

- Special Belt is required. The conveyor Belt must be designed for the Pipe Conveyor application and have correct transverse stiffness for the application
- The belt must be stiff enough to be self supporting in tube form
- The belt edge sections must be flexible in the transverse direction to allow for the overlap folding
- Steel cord belts have transverse fabric layers to ensure sufficient self supporting stiffness
- Pipe Diameter (D) = Belt width / 4
- Maximum lump size = 25% to 33% of Pipe Diameter (use lower % for high proportion of lumps)
- Maximum Loading = < 70% of load area for small lumps
- Maximum Loading = < 60% of load area for larger lumps
- Material Surcharge Angle does not affect load capacity
- Even / Constant Load Feed is required to prevent overloading
- Belt Thickness affects the load area of the tube
- Maximum Incline angle can be larger than for troughed conveyors, up to ~27 degrees for sluggish flowing material
- Maximum Recommended Idler rotation speed is 600 - 750 rpm
- Tube Fold Transition Length: Allow at least 25 to 40 x D for Folding and unfolding belt for Fabric belts (use larger value for large Pipe Dia)
- Tube Fold Transition Length: Allow at least 40 to 50 x D for Folding and unfolding belt for Steel belts (use larger value for large Pipe Dia)
- Carry side belt resistance is normally higher than for a similar capacity troughed conveyor due to less load area availability and higher proportion of belt mass to material conveyor material mass
- Return belt resistance is normally substantially higher than conventional troughed conveyors due to larger number of return belt rollers (rim drag is increased)

Calculation Methods

Helix Troughed Conveyor Calculation Method

The Helix delta-T6 Program has three main methods of estimating the conveyor resistances, namely:

- **ISO** 5048 (DIN 22101) Method
- **CEMA** method
- **VISCO** method - this method uses the rubber rheology properties to calculate the **indentation resistance** of the rubber belt on the conveyor idler rollers and also calculates the **material and belt flexure losses**, the **idler rotation (rim drag) losses** and the **belt to idler scuffing losses**. These four components make up the total resistance to movement of the conveyor belt. This VISCO method is also used to calculate conveyor resistance using Low Resistance Rubber (LRR).

The above methods have been successfully used to design many thousands of conventional troughed conveyors by Helix users in more than 30 countries.

The **VISCO** method is considered to be the most flexible and most accurate method of estimating the conveyor resistance because it allows the user to adjust multiple input values for different types of equipment which all affect the total conveyor resistance. For Example:

- The user can specify the belt top and bottom cover rubber properties.
- The user can specify the belt and material flexure factor.
- The user can specify the Idler Rotation Resistance.
- The user can specify the Idler Scuffing Resistance.

The above main resistances are all influenced by the load per m on the belt, the belt speed V, the idler spacing, the number of rollers, the idler roll diameter, belt top and bottom cover rubber properties (indentation hysteresis losses), the current belt tension which affects the amount of belt sag and resulting material and belt flexure losses, the accuracy of the idler vertical and horizontal alignment.

In the Helix delta-T program, the user can adjust all of these parameters and see the effects on the conveyor. A Sensitivity Analysis can be performed to arrive at an optimised conveyor design which will have the lowest total cost of ownership i.e capital, maintenance and operating cost.

Helix Pipe Conveyor Calculation Method

The resistance of a Pipe Conveyor may also be broken down into four main categories, namely:

1. Belt to Idler Indentation Resistance
2. Material and Belt Flexure losses
3. Idler Rotation (Rim Drag) Resistances
4. Belt to Idler scuffing losses

1. Belt to Idler Indentation Resistance

In a Pipe Conveyor, the folded belt adds additional load on the idler rolls imparted by the stiffness of the belt. There are also more idler rollers (normally 6 for Pipe Conveyor vs 3 for a Troughed Conveyor) and more idler face length is in contact with the belt.
The gravitational force resulting from the mass of the material and belt is taken on the three lower idlers, as it is in a conventional troughed belt.
The upper two wing rollers and the top centre roller also have indentation losses due to the folding of the stiff belt into a tubular shape.
There is also a resultant force on the lower three rollers due to the belt tension in a Convex vertical curve.
In a Concave vertical curve, there is a resultant force applied to the three upper rollers due the

belt tension.
In addition, the wing rollers (the two on each side of tube) must also take the resultant force due to the tensioned belt being curved around Horizontal curves.

The belt to idler indentation forces in a Pipe Conveyor may be summarised as follows:

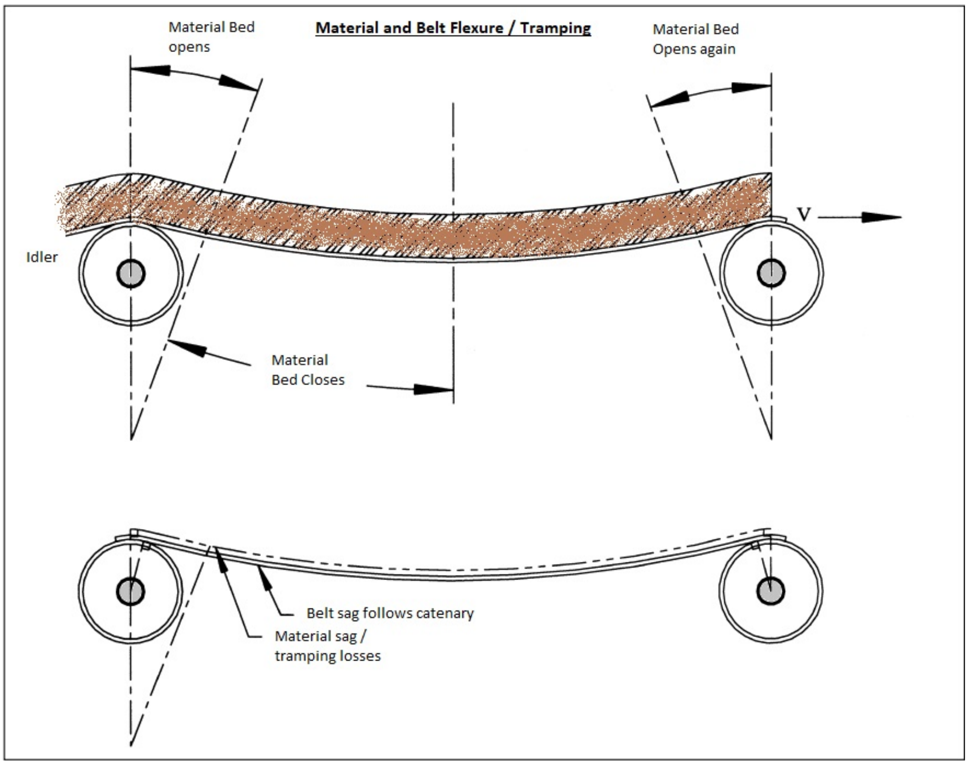
- Belt Folding force - on 4 side rollers and top roller
- Gravitational Forces due to belt and material mass - on bottom centre and lower wing rollers
- Convex Curve Belt Deviation Load - on bottom centre and lower wing rollers
- Concave Curve Belt Deviation Load - on top centre and upper wing rollers
- Horizontal Curve Belt Deviation Load - on lower wing and upper wing rollers on inside of curve

In the Helix delta-T6 program, when you perform a Pipe Conveyor calculation, all of these individual indentation losses are calculated for each section of the conveyor and added to arrive an equivalent friction factor f for indentation resistance.

The user can see the resulting proportion of conveyor resistance attributed to **Indentation, Flexure, Rolling Resistance and Belt Scuffing** in the Viscoelastic Friction Factor Report.

2. Material and Belt Flexure Resistance

In a Pipe Conveyor, as well as a Troughed Conveyor, the belt will tend to sag down to some extent between supporting idlers under gravitational forces induced by the material and belt mass.



The pipe tube will also tend to bulge slightly between idler stations and there is a resulting resistance loss due the flexure of the material and belt as it deforms in travelling from one idler station to the next. The total material and belt flexure loss is a function of the belt tension, the amount of belt sag, the resistance of the material moving / shearing (internal co-efficient of friction of the material) and amount of belt flexure resistance due to its stiffness. Estimating this flexure loss is performed as described in the Belt and Material Flexure Calculation help topic in the Helix delta-T6 Program.

Adjusting the Material Flexure

To adjust the amount of resistance due to belt and material flexure you need to adjust the **Material Flexure Adjustment Factor** input value on the Viscoelastic Belt Properties Input Form. The default input value is set to 1.0 and this is the setting required for Iron Ore. You need to adjust this input value to reflect the relative internal co-efficient of friction of the material being transported. For example, if it is say dry Wheat, use a factor of 0.8 or even 0.7, and if the material is very hard, sharp angular ore or rock, use a value of say 1.1 or 1.2. The amount of flexure also depends on the amount of belt sag and also the troughing angle of the Idlers, the sag is calculated automatically and adjusted for each section.

3. Idler Rotation Resistance

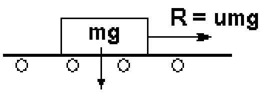
In a Pipe Conveyor, as well as a Troughed Conveyor, the idler rollers have a resistance to rotation. The amount resistance depends on the manufacture of the idler, bearing and seal type. The actual value of the resistance can vary considerably from idler to idler and for a pipe conveyor, due to the higher number of idler rollers, this resistance can have a considerable effect on the total Pipe Conveyor resistance.

4. Idler Skew and Tilt Resistance

If the idler rolls are not aligned perpendicular to the belt travel direction, a scuffing resistance results. The magnitude of this scuffing resistance depends on the amount of misalignment as well as the co-efficient of friction between the belt and idler roll. The co-efficient of friction will in turn depend on whether the belt surface is dry, wet or moist.

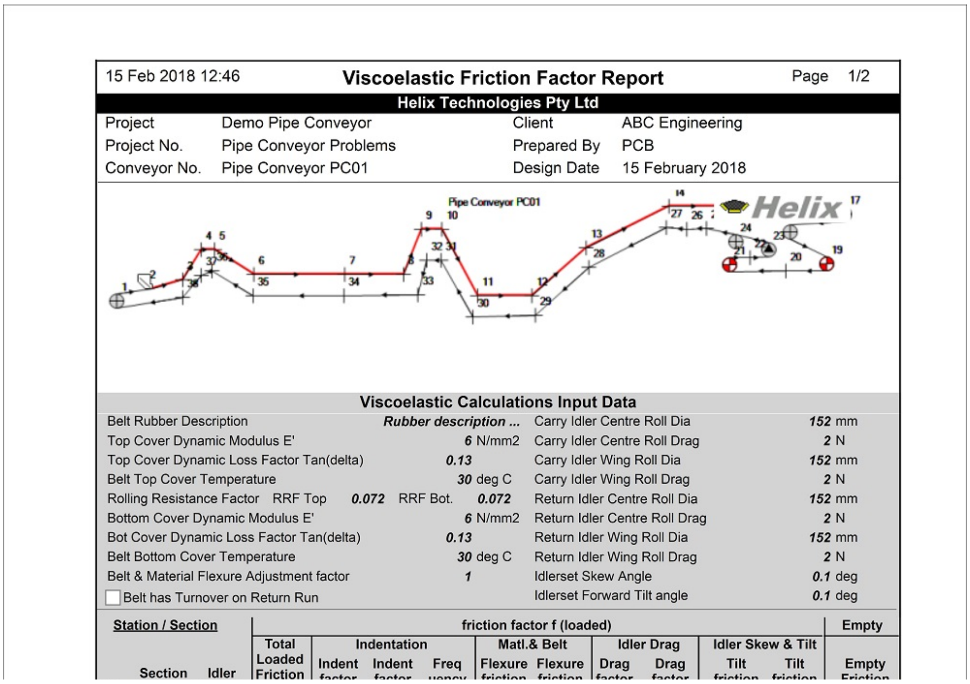
Pipe Conveyor Friction Factor

The conveyor resistances for each section of the conveyor are calculated using the methods shown in the Viscoelastic calculation method as described above. The four main resistance components (Indentation, Flexure, Idler Rotation and Skew and Tilt resistance) are then added to give a total resistance **R** for each section of conveyor. This total section resistance in Newtons is then used to back calculate the Friction factor μ because the masses and idler loads m are known.



Pipe Conveyor Friction Factor Report

The following report shows the values of each component of the conveyor resistances.



15 Feb 2018 12:46 **Viscoelastic Friction Factor Report** Page 1/2

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Project	Demo Pipe Conveyor	Client	ABC Engineering
Project No.	Pipe Conveyor Problems	Prepared By	PCB
Conveyor No.	Pipe Conveyor PC01	Design Date	15 February 2018

Viscoelastic Calculations Input Data

Belt Rubber Description	*Rubber description ...*	Carry Idler Centre Roll Dia	*152* mm
Top Cover Dynamic Modulus E'	*6* N/mm2	Carry Idler Centre Roll Drag	*2* N
Top Cover Dynamic Loss Factor Tan(delta)	*0.13*	Carry Idler Wing Roll Dia	*152* mm
Belt Top Cover Temperature	*30* deg C	Carry Idler Wing Roll Drag	*2* N
Rolling Resistance Factor RRF Top *0.072* RRF Bot.	*0.072*	Return Idler Centre Roll Dia	*152* mm
Bottom Cover Dynamic Modulus E'	*6* N/mm2	Return Idler Centre Roll Drag	*2* N
Bot Cover Dynamic Loss Factor Tan(delta)	*0.13*	Return Idler Wing Roll Dia	*152* mm
Belt Bottom Cover Temperature	*30* deg C	Return Idler Wing Roll Drag	*2* N
Belt & Material Flexure Adjustment factor	*1*	Idlerset Skew Angle	*0.1* deg
☐ Belt has Turnover on Return Run		Idlerset Forward Tilt angle	*0.1* deg

Station / Section		friction factor f (loaded)										Empty
		Total	Indentation			Matl.& Belt		Idler Drag		Idler Skew & Tilt		
Section	Idler	Loaded Friction	Indent	Indent	Freq	Flexure	Flexure	Drag	Drag	Tilt	Tilt	Empty

No	Length	Spacing	factor f	factor fi	factor %	uency rad/s	friction fm	friction %	factor fr	factor %	friction ft	friction %	Friction factor f
1	5.10	1.00	0.0396	0.00646	16.3	1671	0.00045	1.1	0.03088	77.9	0.00183	4.6	0.0396
2	5.33	1.00	0.0247	0.00859	34.8	1257	0.00111	4.5	0.01315	53.3	0.00183	7.4	0.0396
3	98.45	1.00	0.0247	0.00859	34.8	1257	0.00110	4.5	0.01315	53.3	0.00183	7.4	0.0396
4	102.22	1.00	0.0247	0.00859	34.8	1257	0.00109	4.4	0.01315	53.3	0.00183	7.4	0.0396
5	263.45	1.00	0.0322	0.01610	50.1	1257	0.00107	3.3	0.01315	40.9	0.00183	5.7	0.0568
6	577.95	1.00	0.0324	0.01634	50.5	1257	0.00105	3.2	0.01315	40.6	0.00183	5.7	0.0574
7	282.91	1.00	0.0330	0.01703	51.6	1257	0.00100	3.0	0.01315	39.8	0.00183	5.6	0.0590
8	84.10	1.00	0.0337	0.01780	52.8	1257	0.00095	2.8	0.01315	39.0	0.00183	5.4	0.0607
9	93.48	1.00	0.0342	0.01824	53.4	1257	0.00093	2.7	0.01315	38.5	0.00183	5.4	0.0616
10	160.04	1.00	0.0344	0.01851	53.8	1257	0.00091	2.7	0.01315	38.2	0.00183	5.3	0.0621
11	355.62	1.00	0.0345	0.01861	53.9	1257	0.00091	2.6	0.01315	38.1	0.00183	5.3	0.0625
12	505.50	1.00	0.0349	0.01898	54.5	1257	0.00089	2.6	0.01315	37.7	0.00183	5.3	0.0635
13	380.84	1.00	0.0291	0.01331	45.7	1257	0.00085	2.9	0.01315	45.1	0.00183	6.3	0.0504
14	641.13	1.00	0.0318	0.01605	50.4	1257	0.00080	2.5	0.01315	41.3	0.00183	5.8	0.0565
15	415.65	1.00	0.0324	0.01668	51.4	1257	0.00077	2.4	0.01315	40.6	0.00183	5.7	0.0578
16	64.00	1.00	0.0243	0.00859	35.3	1257	0.00074	3.0	0.01315	54.1	0.00183	7.5	0.0395
17	39.12	1.00	0.0406	0.00756	18.6	1429	0.00029	0.7	0.03088	76.1	0.00183	4.5	0.0406
18	15.00	1.00	0.0406	0.00756	18.6	1429	0.00029	0.7	0.03088	76.1	0.00183	4.5	0.0406
19	25.00	1.00	0.0406	0.00756	18.6	1429	0.00029	0.7	0.03088	76.1	0.00183	4.5	0.0406
20	44.60	1.00	0.0408	0.00756	18.5	1429	0.00051	1.2	0.03088	75.7	0.00183	4.5	0.0408

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15 Feb 2018 12:46

f factor - Viscoelastic Calculations

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Station / Section			friction factor f (loaded)										Empty
			Total	Indentation			Matl.& Belt		Idler Drag		Idler Skew & Tilt		
No	Section Length	Idler Spacing	Loaded Friction factor f	Indent factor fi	Indent factor %	Freq uency rad/s	Flexure friction fm	Flexure friction %	Drag factor fr	Drag factor %	Tilt friction ft	Tilt friction %	Empty Friction factor f
21	44.60	1.00	0.0408	0.00756	18.5	1429	0.00051	1.2	0.03088	75.7	0.00183	4.5	0.0408
22	10.00	1.00	0.0412	0.00756	18.4	1429	0.00091	2.2	0.03088	75.0	0.00183	4.5	0.0412
23	26.03	1.00	0.0412	0.00756	18.4	1429	0.00090	2.2	0.03088	75.0	0.00183	4.5	0.0412
24	11.06	1.00	0.0412	0.00756	18.4	1429	0.00089	2.2	0.03088	75.0	0.00183	4.5	0.0412
25	415.65	1.00	0.0412	0.00756	18.4	1429	0.00088	2.1	0.03088	75.0	0.00183	4.5	0.0412
26	641.13	1.00	0.0450	0.01144	25.4	1429	0.00084	1.9	0.03088	68.6	0.00183	4.1	0.0450
27	367.23	1.00	0.0458	0.01228	26.8	1429	0.00075	1.6	0.03088	67.5	0.00183	4.0	0.0458
28	519.25	1.00	0.0448	0.01140	25.4	1429	0.00068	1.5	0.03088	68.9	0.00183	4.1	0.0448
29	355.62	1.00	0.0513	0.01797	35.0	1429	0.00064	1.2	0.03088	60.2	0.00183	3.6	0.0513
30	160.04	1.00	0.0526	0.01929	36.7	1429	0.00060	1.1	0.03088	58.7	0.00183	3.5	0.0526
31	93.48	1.00	0.0536	0.02035	37.9	1429	0.00057	1.1	0.03088	57.6	0.00183	3.4	0.0536
32	84.10	1.00	0.0542	0.02097	38.7	1429	0.00055	1.0	0.03088	56.9	0.00183	3.4	0.0542
33	282.91	1.00	0.0545	0.02122	38.9	1429	0.00055	1.0	0.03088	56.7	0.00183	3.4	0.0545
34	577.95	1.00	0.0551	0.02184	39.6	1429	0.00053	1.0	0.03088	56.1	0.00183	3.3	0.0551
35	263.45	1.00	0.0568	0.02358	41.5	1429	0.00050	0.9	0.03088	54.4	0.00183	3.2	0.0568
36	102.22	1.00	0.0586	0.02541	43.4	1429	0.00047	0.8	0.03088	52.7	0.00183	3.1	0.0586
37	98.45	1.00	0.0595	0.02628	44.2	1429	0.00046	0.8	0.03088	51.9	0.00183	3.1	0.0595
38	10.39	1.00	0.0407	0.00756	18.6	1429	0.00045	1.1	0.03088	75.8	0.00183	4.5	0.0407
Totals:			8223.05	0.45					0.00		0.00	0	

Designers Comments

This is a demonstration model of an existing pipe conveyor. The pipe diameter is too small for the load capacity - pipe is 77% full and this is larger than 70% recommended. This may result in material spillage and opeing of the pipe tube and is not recommended. Also, the horizontal and vertical curve radii used are 300m - this is too small for the pipe conveyor and will cause excessive belt tension rise in the curves and also cause the belt to collapse in the curves. Curve radii should be increased and load decreased. See Curve Calculation for Pipe Conveyor under Calcs menu in Helix delta-T6.

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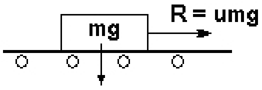
You can see from the above report that in the carry sections of the Pipe Conveyor, the total friction factor varies in sections with no horizontal curves and increases in the curved sections. (increases from 0.0247 in section 4 with no horizontal curve to 0.0322 in section 5 with 300m radius horizontal curve)
On the return belt sections from 26 onwards, the friction factor is higher than carry sections at about 0.045 to 0.056; However, this does not mean the section resistance is higher in the return run because the mass is much lower as there is no material being transported.



Resistance **R** is lower on the return belt even though **μ** is higher because **m** is much lower.

Proportions of Indentation, Flexure, Idler Drag and Idler Skew (Scuffing) Losses

In the report shown above you can see the proportions of the resistances as a percentage of the total for each section:
Carry side (Section 11)

- Indentation loss is about 53.9%
- Flexure loss is about 2.6%
- Idler Drag loss is about 38.1%
- Idler Skew loss is about 5.3%
- Total μ = 0.0345

Corresponding **Return side** (Section 29)

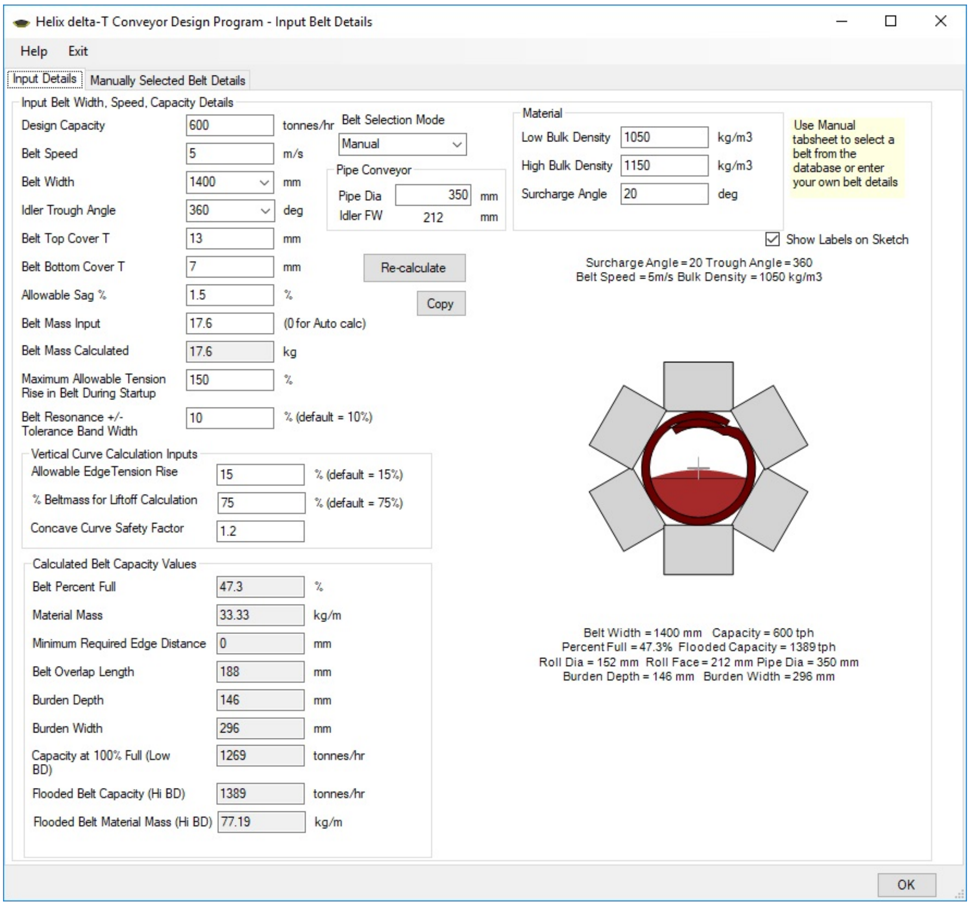
- Indentation loss is about 35.0%
- Flexure loss is about 1.2%
- Idler Drag loss is about 60.2%
- Idler Skew loss is about 3.6%
- Total μ = 0.0513

It is clear that there is lower Flexure loss on the return run (no material) and the additional idlers make the Idler drag losses proportionally higher on the return side than on the carry side. Indentation losses are lower on the return run than the carry side due to no material mass. The proportions of each resistance component can vary widely depending on the belt rubber properties, belt speed, idler spacing and idler rim drag. The designer should explore different settings to get an optimal design.

Steps for Design of a Pipe Conveyor

In Helix delta-T6 a **Pipe Conveyor** is denoted by selecting or inputting **6 Roll Idlers and a 360 degree Troughing Angle**.

- Build the model of the conveyor in the normal way as described in the Getting Started help topic in the Helix delta-T6 Program.
- In the Input, **Input Carry Idlers** form, select a suitable Pipe Conveyor Idler and ensure the **Number of Rolls is set to Six (6)**
- In the Input, **Input Return Idlers** form, select a suitable Pipe Conveyor Idler and ensure the **Number of Rolls is set to Six (6)**
- In the **Input Belt Details** form you need to select a Belt Width and the corresponding recommended Pipe Diameter of Belt Width / 4 will be displayed
- In the **Idler Trough Angle** dropdown, select the **360** degree option
- The belt and tube cross-section will be drawn and the percentage full etc. calculated for you



- Now you can go to the Input Carry Idlers form, press the **Open Idler Database** button and select a suitable idler from the **Helix Pipe Conveyor** idlers category. Choose an idler for the Belt Width and Pipe Diameter you have input in Belt Details.
- The **Pipe Conveyor Idlers** which are in the Helix delta-T Idler Database are presented as a design guide only. The Pipe Conveyor Idler database is derived from the Sandvik Carry idler data with the Idler Face width, Bearing Centres and Support Centre dimensions adjusted to suit the selected Pipe Diameter. These specific idler dimensions are theorectical only, designers must obtain real idler data from their own manufacturer for final design.
- Repeat the pipe conveyor Idler Selection process described above for the **Return Idlers**
- The **Number of Idler Rolls** must be six (6) for a Pipe Conveyor
- Now return to the to Belt Input Details form and the Belt Cross-section will be redrawn with the selected Idlers and Belt Width
- The cross-section above shows the percentage full and belt overlap length as well as the chosen idlers. Note the idler rolls overlap each other slightly in this diagram, these are staggered idler panels with Offset idlers
- Ensure the conveyor material low and high bulk density are correct, adjust if necessary
- Adjust the belt speed to yield a pipe percentage full of less than 70% for fine material or less than say 60% full for material with large lumps.
  The Maximum Belt speed will depend on the Idler Load and Bearing life and should be adjusted to give an idler rotation speed of less than 600 rpm.
- There are no known published **maximum belt speed** limits for Pipe Conveyors, but as for Troughed conveyors, a speed higher than about 5.0m/s is considered an upper limit, especially with 152mm diameter rollers. Belt Speeds exceeding 5.0m/s may result in resonance problems, material shifting in the pipe tube which can cause material bunching and force the belt to open and spill material. There are many factors which can affect the Belt Resonance / Material Bunching phenomenon such as belt tension, belt sag, idler spacing, idler roll diameter, idler rotation speed (belt seed) and caution should be exercised in selecting a reasonable belt speed which is not too high. Details and videos of Belt

Resonance and Material bunching are shown in the Helix website at Helix Conveyor Design - Belt Resonance (/DeltaT6/BeltResonance)
- Complete all Input Values in all the other forms in the main form **Input Menu** including the Takeup, Drive and Motor Inputs etc.
- You also need to complete all the Viscoelastic Belt Input Details and the Viscoelastic Idler Input Details.
- Once all Input values have been completed, you can do the conveyor calculation using the **VISCO** method. Pipe Conveyor calculations must be performed using the VISCO method. The ISO and CEMA methods will **not** yield correct belt tensions and power for a Pipe Conveyor, but are included for comparison purposes only.
- Once you have completed all inputs and the VISCO calculation method, you can view all the results by using the Reports menu
- The next step for Pipe Conveyors is to check the suitability of the Vertical and Horizontal curve radii. Use the Horizontal Curve Calculations help topic in the Helix delta-T6 Program for further explanation.

Summary of Design Guidelines for Pipe Conveyors

Pipe Conveyors have some additional features compared to conventional troughed conveyors, i.e the belt has to be formed into a tube after the loading point and it also has to be opened from tube to flat at the discharge pulley. These sections of the belt are called transitions; they are similar to the Trough Transition in a conventional Troughed belt conveyor, except that the edge length (hypotenuse) is longer as the belt goes from flat at the pulley to more than 360 degrees of closure.

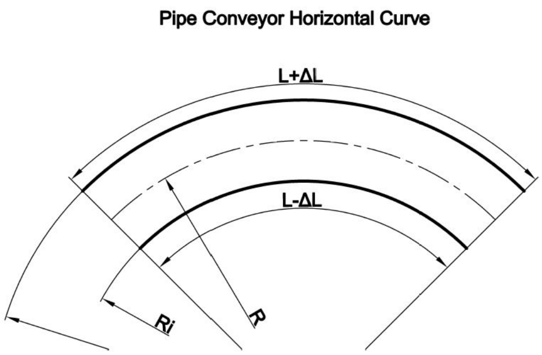
- Conveyor Belt must be designed for the Pipe Conveyor application and have correct transverse stiffness for the application
- Belts can be Fabric or Steel cord reinforced
- The belt must be stiff enough to be self supporting in tube form
- The belt edge sections must be flexible in the transverse direction to allow for the overlap folding
- Steel cord belts have transverse fabric layers to ensure sufficient self supporting stiffness
- Pipe Diameter (D) = Belt width / 4
- A Larger Pipe Diameter requires an increased belt transverse stiffness to maintain the tubular shape
- A Smaller Pipe Diameter requires less belt transverse stiffness to maintain the tubular shape than a larger diameter pipe
- Maximum lump size = 25% to 33% of Pipe Diameter (use lower % for high proportion of lumps)
- Maximum Loading = < 70% of load area for small lumps
- Maximum Loading = < 60% of load area for larger lumps
- Material Surcharge Angle does not affect load capacity
- Belt Thickness affects the load area of the tube
- Even / Constant Load Feed is required to prevent overloading
- Idler Trough Angle must be set to **360** degrees for Pipe Conveyor
- The **No. of Idler Rolls** must be **six (6)** for a Pipe Conveyor
- Maximum Incline angle can be larger than for troughed conveyors, up to ~27 degrees for sluggish flowing material
- Maximum Recommended Idler rotation speed is 600 - 750 rpm
- Tube Fold Transition Length: Allow at least 25 to 40 x D for Folding and unfolding belt for Fabric belts (use larger value for large Pipe Dia)

- Tube Fold Transition Length: Allow at least 40 to 50 x D for Folding and unfolding belt for Steel belts (use larger value for large Pipe Dia)
- Carry side belt resistance is normally higher than for a similar capacity troughed conveyor due to less load area availability and higher proportion of belt mass to material conveyor material mass
- Return belt resistance is normally substantially higher than conventional troughed conveyors due to larger number of return belt rollers (rim drag is increased)
- The **VISCO calculation method** must be used Pipe Conveyors
- Check the minimum Curve Radius required for a each curve in Pipe Conveyor. Refer to the Horizontal Curve Calculations help topic for an explanation.

The required minimum length of the transition is governed by limiting the edge tension rise and also limiting the center tension drop which results for the edges being stretched.

Pipe Conveyors - Horizontal and Vertical Curve Calculations

Pipe Conveyor Curves



$$BeltModulus = \frac{Stress}{Strain}$$

$$\Delta L = \frac{\Delta T \times L}{BeltModulus \times BeltWidth}$$

$$\Delta T = \frac{\Delta L \times BeltModulus \times BeltWidth}{L}$$

In a Pipe Conveyor curve, the portion of the belt furthest away from the centre of the curve is stretched while the portion or half of the belt on the inside of the curve is compressed into a shorter length. The belt is under tension and the change in tension Δ delta T is added to the outside portion of the belt and a corresponding reduction in tension is applied to inside portion of the belt because the average tension across the belt width remains a constant.

We need to ensure that the rise in tension does not exceed the working tension of the belt and also ensure that the reduction in tension on the inside does not force the belt into compression because it will buckle.

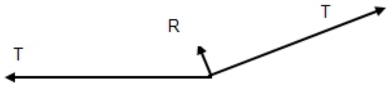
The Pipe Conveyor Curve Calculations must be performed **for each Vertical and Horizontal curve** in the pipe conveyor.

Design of curves for a Pipe Conveyor

One the main advantages of Pipe Conveyors is that they can negotiate relatively small radius Horizontal curves when compared to conventional Troughed conveyors. Each vertical and horizontal curve in a Pipe Conveyor needs to be checked for:

1. Belt Tube Outside belt tension rise - too high a tension will over-stress the belt
2. Belt Tube Inside belt tension fall - too low a tension will make the belt go into compression and cause tube and belt buckling
3. Concave Vertical curves must have sufficient radius to ensure that the belt does not tend to lift off the lower idlers and cause the tube to be compressed against the upper idler rollers.

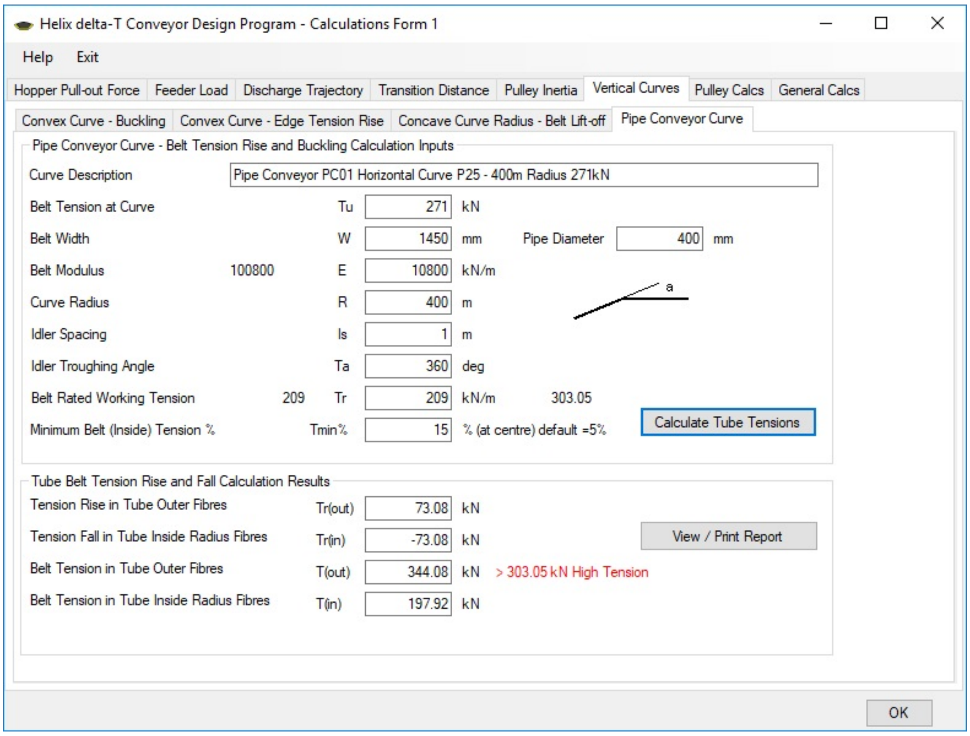
The belt lift is caused by the belt tension resultant force from the change in vertical angle. This calculation is the same as for a Troughed conveyor.



4. Concave and Convex vertical curves have a Belt Tube Outside (upper half) belt tension rise - too high a tension will over-stress the belt
5. Concave and Convex vertical curves have a Belt Tube Inside (lower half) belt tension fall - too low a tension will make the belt go into compression and cause tube and belt buckling

The required minimum concave curve radius for belt lift off for Item no. 3 above is calculated as it is for Troughed conveyors and is shown in the Vertical Curves Report.

For each Concave and Convex vertical curve and each Horizontal Curve in a Pipe a Conveyor, the **Calculate Pipe Conveyor Curve** calculation under the main form **Calcs** menu must be used to check for high and low tensions in the curve. Refer to the Calcs menu shown below.



- Enter the input values for the curve under consideration. You can enter a **Curve Description** which shows the location of each curve so that this description can be used to identify which curve has been calculated.
- Enter the **Belt Width** and **Pipe Diameter** in mm
- Enter the **Belt Modulus**, **Curve Radius** and **Idler Spacing**
- Enter the **Trough Angle**. It must be 360 degrees for a pipe conveyor
- Enter the **Belt Rated Working Tension** in kN/m width
- Enter the **Minimum Tension** as a percentage of Rated Tension. Default value is 5% minimum belt tension, less than this may result in belt buckling due to the belt going into compression
- Press the **Calculate Tube Tensions** button
- The program will calculate the rise in tension in the outer half of the belt. The belt is stretched through a further distance in the outside of the curve and travels through a shorter distance in the inside of the curve.
- Curve radius plan view here

Pipe Conveyor Curve Calculation Report - Tension too low

After doing the Pipe Conveyor Curve Calculation as described above, you can View and Print a report for each curve in the Pipe Conveyor

22 Jan 2018 11:44 **Pipe Conveyor Curve Calculation** Page 1/1

Helix Technologies Pty Ltd

Project	Demo Pipe Conveyor	Client	ABC Engineering
Project No.	Pipe Conveyor Problems	Prepared By	PCB
Conveyor No.	Pipe Conveyor PC01	Design Date	19 January 2018

Pipe Conveyor Curve - Belt Tension Rise and Buckling Calculation

Input Data

Curve Description		*Pipe Conveyor PC01 Horizontal Curve P25 - 400m Radius 100kN*	
Belt Tension at Curve	Tu	*100*	kN
Belt Width	W	*1450*	mm
Pipe Conveyor Tube Diameter	D	*400*	mm
Belt Modulus	E	*10800*	kN/m
Curve Radius	R	*400*	m
Idler Spacing	Is	*1*	m
Idler Trough Angle	Ta	*360*	deg
Belt Rated Working Tension	Tr	*209*	kN/m
Minimum Belt (Inside) Tension %	Tmin%	*15*	%

Calculation Results

Tension Rise in Tube Outer Fibres	Tr(out)	73.08	kN	
Tension Fall in Tube Inside Radius Fibres	Tr(in)	-73.08	kN	
Belt Tension in Tube Outer Fibres	T(out)	173.08	kN	
Belt Tension in Tube Inside Radius Fibres	T(in)	26.92	kN	< 45.46 kN Low Tension - Belt may buckle

Tension at inside of curve is below the minimum required tension of 15% of belt rated tension. (The 15% value is a design input value, a minimum of at least 5% is recommended)

Pipe Conveyor Curve Calculation Form - Tension too high

Helix delta-T Conveyor Design Program - Calculations Form 1

Help Exit

Hopper Pull-out Force | Feeder Load | Discharge Trajectory | Transition Distance | Pulley Inertia | Vertical Curves | Pulley Calcs | General Calcs

Convex Curve - Buckling | Convex Curve - Edge Tension Rise | Concave Curve Radius - Belt Lift-off | Pipe Conveyor Curve

Pipe Conveyor Curve - Belt Tension Rise and Buckling Calculation Inputs

Curve Description			Pipe Conveyor PC01 Horizontal Curve P25 - 400m Radius 271kN		
Belt Tension at Curve		Tu	271	kN	
Belt Width		W	1450	mm	Pipe Diameter 400 mm
Belt Modulus	100800	E	10800	kN/m	
Curve Radius		R	400	m	
Idler Spacing		Is	1	m	
Idler Troughing Angle		Ta	360	deg	
Belt Rated Working Tension	209	Tr	209	kN/m	303.05
Minimum Belt (Inside) Tension %		Tmin%	15	% (at centre) default =5%	Calculate Tube Tensions

Tube Belt Tension Rise and Fall Calculation Results

Tension Rise in Tube Outer Fibres	Tr(out)	73.08	kN	
Tension Fall in Tube Inside Radius Fibres	Tr(in)	-73.08	kN	View / Print Report
Belt Tension in Tube Outer Fibres	T(out)	344.08	kN	> 303.05 kN High Tension
Belt Tension in Tube Inside Radius Fibres	T(in)	197.92	kN	

OK

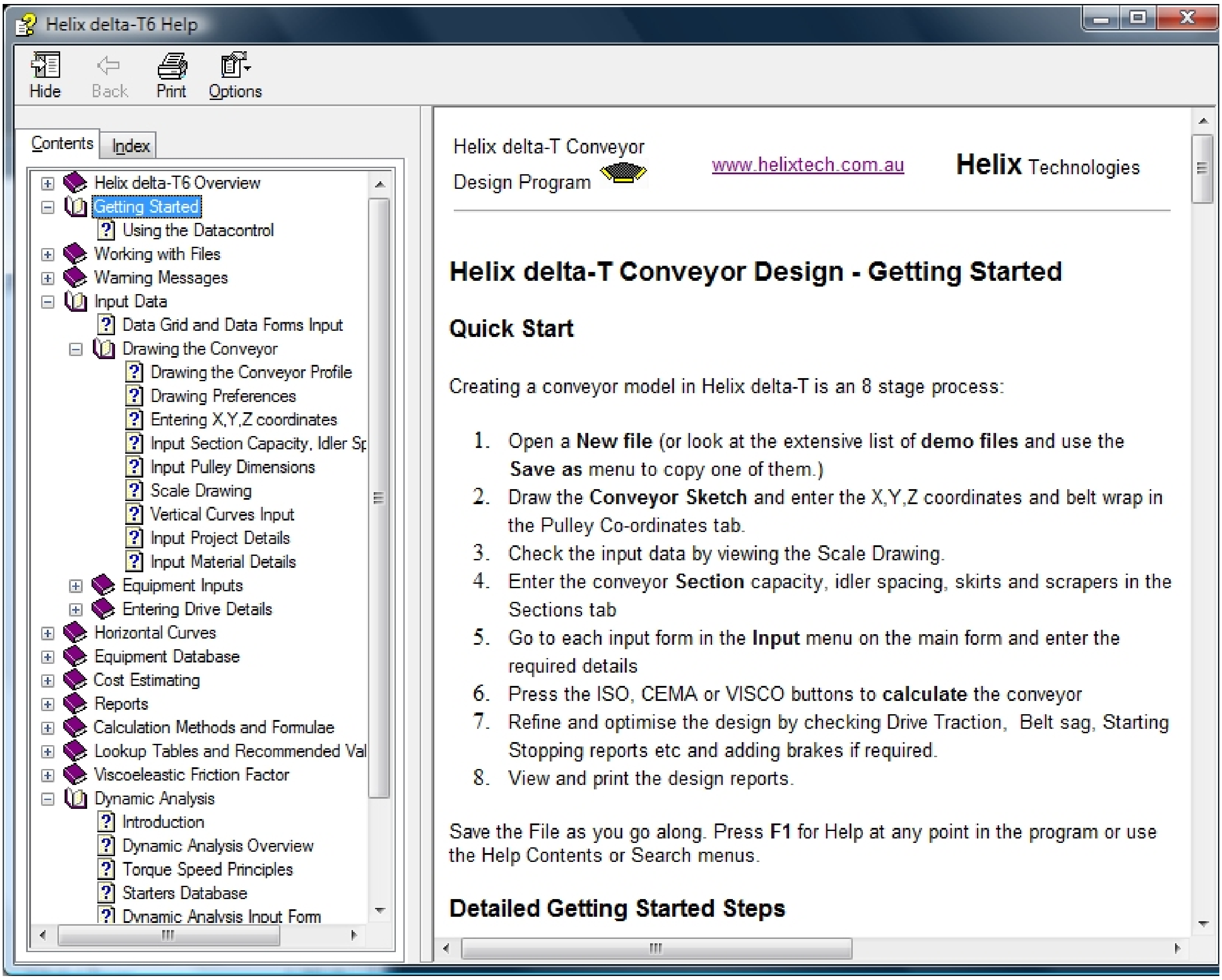
Tension at outside of curve is above the rated tension of the belt.

Documentation ...

HELIX delta-T Documentation and Help Files

Helix delta-T6 is supplied with a very comprehensive context sensitive Help file with index and search facilities.

Helix delta-T6 Help File



To get help anywhere in the program all you need to do is press F1 and the relevant Help topic will be opened to guide you through steps of using the program.

The Help file has

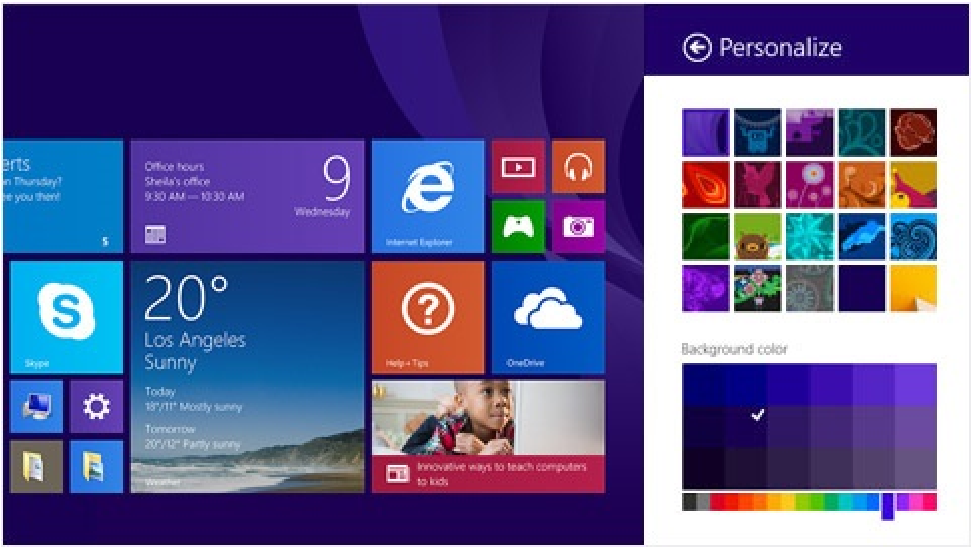
- 111 Topics
- 511 Local Links
- 131 Internet links
- 279 Graphics

The Help file shows the user the formulae and calculation methods used. There is a Step by Step **Getting Started guide** and the program is provided with more than 30 sample conveyor design files so that you can see samples on how to build models of all types of conveyors from Belt Feeders to long overland conveyors with multiple drives and horizontal curves.

This all adds to up to a very good help tool and it is also a valuable reference. You can download a copy of the Helix delta-T6 Help file from the Downloads page on this website or click this link: Helix delta-T6 Help file - 39Mb file size (/DownloadFiles/DeltaT6Help.zip)

System Requirements ...

HELIX delta-T System Requirements



Helix delta-T6 can run on Windows® XP, Vista® and Windows® 7, 8, 8.1 and 10 on both 32bit and 64bit systems.

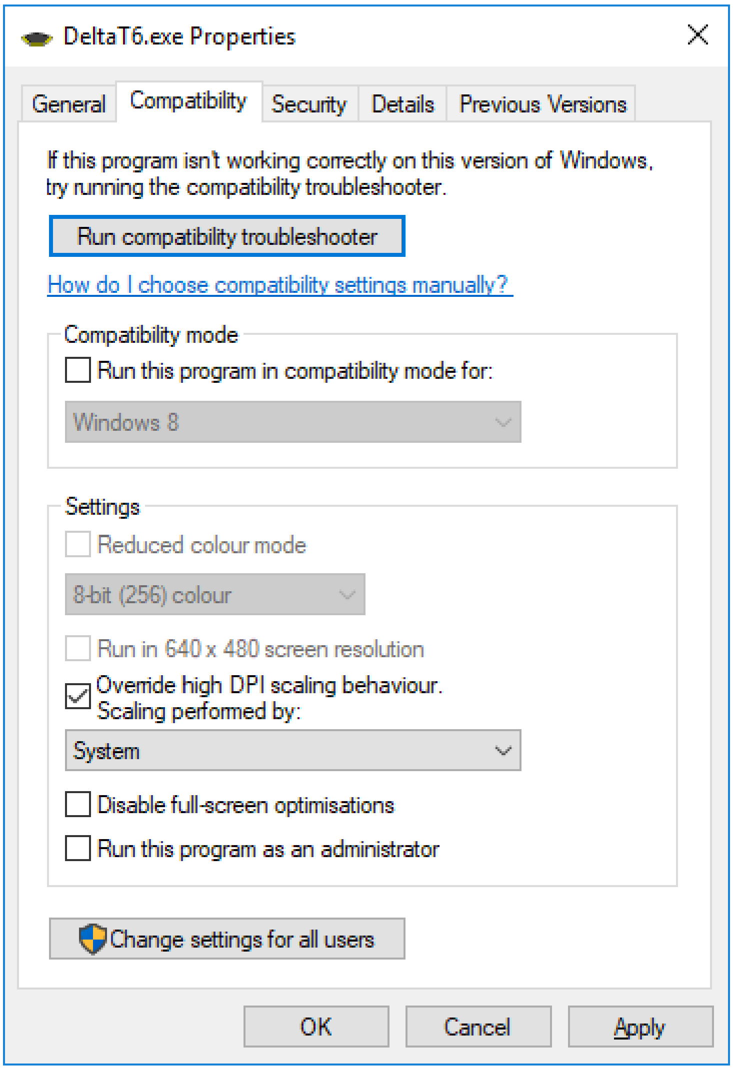
To run the Helix delta-T6 program you need the following:

- Personal computer which can run Windows XP or later
- Windows® XP, Vista® or Windows® 7, 8, 8.1, 10
- 32bit or 64bit operating system
- 1 Gb of RAM or more. For the Dynamic Analysis version at least 2GB RAM is recommended
- 90 Mb of Hard Disk space
- Internet Connection for installing software
- USB port (for optional USB dongle version)
- 1360 x 768 or better resolution monitor
- Printers, plotters and networks supported by Windows XP or later (Optional)
- Touch screen or Mouse and keyboard

New High Resolution PC's

Some modern Windows 10 PC's have an adjustable / custom scaling setting and these settings may not display properly in Helix delta-T6 and other older software. Use the following settings to ensure proper operation.

- Open Windows Explorer, Navigate to the Helix delta-T6 installation Directory
- Right click on the DeltaT6.exe file and select properties
- In the Compatibility Tab make the following settings

- 

- Click Apply and then run the Helix delta-T6 program

Software versions ...

HELIX delta-T6 - Software Versions

Helix delta-T is supplied in 3 main licensed versions:

- Demo Version - evaluation only
- Standard Version < 1000tph
- Professional Version - unlimited
- Dynamic Analysis Version

Demo version - Demo purposes

Static Analysis only - Limited to a fixed conveyor capacity of 77 tonnes per hour, 777 or 7777 tonnes per hour. It is also limited to a maximum of 30 day's use. Most other functions are functional. Free download to all, but remains licenced to Helix Technologies.

Standard Version - Up to 1000tph

Static Analysis only. Limited to a maximum conveyor capacity of 1000 tonnes per hour and only one drive pulley allowed in system. No Horizontal Curve design.

Professional Version - Unlimited

Static Analysis only. Unlimited - may have any conveyor capacity, any number of conveyor sections or flights, any number of drives and pulleys, any number of loading hoppers etc. The Professional Version is suitable for designing large capacity and overland conveyors and includes Horizontal curves.

Dynamic Analysis Version - includes Pro ver + flexible belt analysis

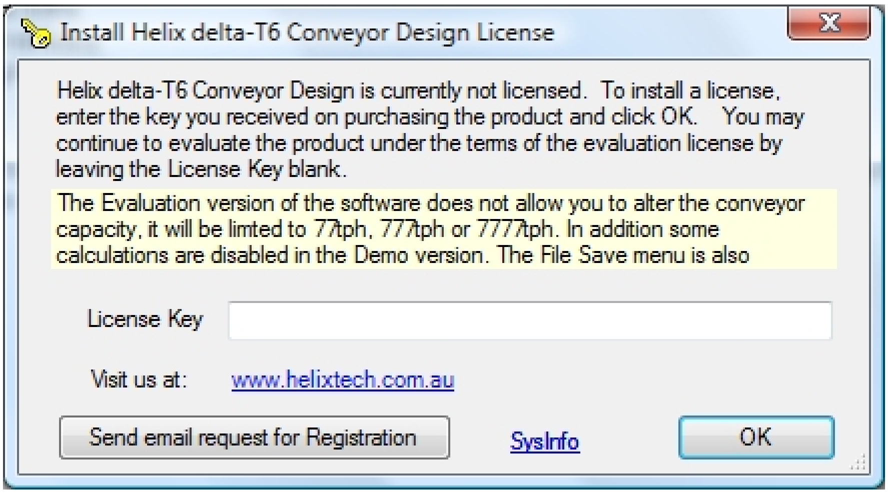
Static and Dynamic Analysis. This version of the Helix delta-T Conveyor Design Program has all the features of the Professional version plus a very powerful Dynamic Analysis section which performs 'Flexible Body' dynamic calculations of the conveyor. The designer can model what happens during the starting and stopping of the conveyor. It provides detailed graphical output of the Belt Velocities, Belt Tensions, Takeup movement etc. at any point along the conveyor during starting or stopping and under different load conditions.

Software Licensing

In addition there are Registration Code versions or USB Dongle key version of each of the above.

Registration Code version

The Registration code version can be installed on a computer after internet download. The download links are provided after purchase of a license. When it is run for the first time it will prompt the user to enter a Registration Code. There is a button on the registration form which will send the user's computer details to Helix Technologies and Helix will return a registration code which can be pasted into the Registration form to unlock the software.



USB Dongle version

This version is normally supplied locally in Australia only. The USB dongle version can be installed on a computer after internet download or from CD ROM disc. This version requires a special USB Dongle key from Helix Technologies to be plugged into a USB port on the computer where you want to use the delta-T6 program.

When you run the program it will check for a valid dongle and run if one is found or exit if the dongle is not present.

This dongle version can be installed on network server computer with a program shortcut installed on the work station PC's on the network and the program can then be run by clicking the shortcut, provided that the dongle is present on the workstation PC.

A Typical USB Dongle 

Network Licenses

Helix delta-T6 has a new Helix Network License Manager software for multiple concurrent users. This licensing system uses a License Manager program installed on a server computer which controls the number of concurrent users on the network through a TCP/IP port on the server. This means the software can be installed on as many computers as required and it is then activated on a specific computer via TCP/IP communication with the server and License Manager program.

Prices of the multiple user Network version depends on the number of licenses and the mix of Dynamic, Professional and Standard versions of the program. Please contact sales@helixtech.com.au (mailto:sales@helixtech.com.au) for pricing.

Feature List ...

HELIX delta-T6 Version Features

HELIX delta-T6 is offered in different versions. The following list shows the main features and functions available in each of the different versions.

Helix Delta-T6 Features				
Version:	**Standard**	**Professional**	**Dynamic Analysis**	**Remarks**
General				
Conveyor Capacity	Up to 1000 tph	Unlimited	Unlimited	
Static Analysis Calculations	✔	✔	✔	Rigid Belt
Dynamic Analysis Calculations			✔	Flexible Belt
Number of Drive Pulleys	One	Unlimited	Unlimited	Each Pulley can have one or two drives
Horizontal Curve Design		✔	✔	Banking angle and Belt Drift
Calculation Method				See Calculation Methods (/DeltaT6/CalcMethods)
CEMA	✔	✔	✔	5th Edition
ISO 5048	✔	✔	✔	Based on DIN 22101
Viscoelastic	✔	✔	✔	Uses Belt Rubber Rheology
Automatic Friction Factor calculation	✔	✔	✔	
Manual Friction Factor override	✔	✔	✔	User can input f for each conveyor section
Temperature Corrector for Friction Factor	✔	✔	✔	
Draw Conveyor Profile				
Sketch Conveyor Profile on screen	✔	✔	✔	
Drag and Drop Pulleys in sketch	✔	✔	✔	
Add any number of Pulleys	✔	✔	✔	
Draw any Pulley Wrap Angle	✔	✔	✔	
Draw any Conveyor Configuration	✔	✔	✔	
Draw Scale Drawing of Conveyor	✔	✔	✔	
Draw 3D Model of Conveyor	✔	✔	✔	
Draw Vertical Curve Dynamically	✔	✔	✔	
Draw Horizontal Curve Dynamically		✔	✔	
Equipment Databases				
Belts	✔	✔	✔	
Idlers	✔	✔	✔	
Pulleys	✔	✔	✔	
Motors	✔	✔	✔	
Gearboxes	✔	✔	✔	
Fluid Couplings	✔	✔	✔	
High and Low Speed Shaft Couplings	✔	✔	✔	
Brakes	✔	✔	✔	
Holdbacks	✔	✔	✔	
VVVF Variable Speed Starters	✔	✔	✔	See Equipment Databases (/DeltaT6/EquipDatabases)
Conveyor Sections / Flights				
Unlimited number of Flights	✔	✔	✔	
Unlimited Length of Conveyor	✔	✔	✔	
Vary Idler Spacing by Section	✔	✔	✔	
Vary Skirt Length	✔	✔	✔	
Input Scrapers & Ploughs	✔	✔	✔	
Manually Override Friction Factor f	✔	✔	✔	
Friction factor adjustment factor f	✔	✔	✔	
Import Conveyor Sections / Flights				
Import XYZ from CAD DXF file	✔	✔	✔	
Import XYZ from CSV (Excel®) text (.txt) file	✔	✔	✔	
Auto Add Return Belt XYZ Points	✔	✔	✔	

Version:	**Standard**	**Professional**	**Dynamic Analysis**	**Remarks**

Helix Delta-T6 Features				
Version:	Standard	Professional	Dynamic Analysis	Remarks
Import XYZ from Beltstat™ BCK file	✔	✔	✔	
Take-up Calculations				
Allow user Takeup Mass Input	✔	✔	✔	
Automatic Takeup Mass Calculation	✔	✔	✔	
Check Belt Sag over all sections	✔	✔	✔	
Vertical Gravity Takeup	✔	✔	✔	
Horizontal Gravity Takeup	✔	✔	✔	
Horizontal Winch Takeup	✔	✔	✔	
Traction Check for Running / Starting / Braking	✔	✔	✔	
Lock Take-up on Stopping			✔	Lock in belt stretch to prevent excessive belt sag
Conveyor Drives				See Dynamic Starting (/DeltaT6/DynamicStarting)
Head, Tail, Tripper, Return Drives	✔	✔	✔	
Multiple / Unlimited Drive Pulleys in any position		✔	✔	Can have two motors on each drive pulley
Starting Torque Factor input	✔	✔	✔	Full and Empty Start Factor
Backstop Torque Calculation	✔	✔	✔	
Add Inertia Flywheels	✔	✔	✔	
Input Speed vs Torque Curves			✔	DOL, Slip Ring WR Motors, Fluid Couplings etc.
Input Time vs Speed Velocity Ramp			✔	DC, VVVF Variable Speed Drives
Brakes and Stopping				
Input Braking Torque on Drive Pulley	✔	✔	✔	
Input Braking Torque on Brake Only Pulley		✔	✔	
High or Low Speed Brake location	✔	✔	✔	
Brake Caliper Selection	✔	✔	✔	
Brake Disc Sizing & Inertia Calc	✔	✔	✔	
Brake Disc Temperature Rise Calculation	✔	✔	✔	
Add Inertia Flywheels	✔	✔	✔	
Calculate Braking / Coasting Distance	✔	✔	✔	
Calculate Discharge Volume Braking / Coasting	✔	✔	✔	
Velocity Ramp Stopping Control			✔	
Belt Tension & Friction Calculations				
ISO 5048	✔	✔	✔	Based on DIN 22101
CEMA	✔	✔	✔	5th edition
Viscoelastic	✔	✔	✔	Uses Belt Rubber Rheology
Temperature Correction Kt	✔	✔	✔	
Fixed Friction Factor Calculation	✔	✔	✔	
User Controlled Friction Factor	✔	✔	✔	
Automatic Friction Factor Calculation	✔	✔	✔	
Reduced Friction on Declines >2.5% slope	✔	✔	✔	Applied to CEMA - for ISO use f=0.012
Suitable for Overland Conveyors		✔	✔	Dynamic analysis recommended for 800kW and up
Suitable for Wide Idler Spacing Friction & Power Calculations	✔	✔	✔	
Flexible Body Dynamic Analysis Tension calculations			✔	See Dynamic Analysis (/DeltaT6/DynamicAnalysis)
Variable Friction Factor during Starting and Stopping Calculations			✔	Adjusts friction to belt tension and sag during starting / stopping
Tension Summary Report				
Running Full Belt Tensions	✔	✔	✔	See Design Reports (/DeltaT6/DesignReports)
Running Empty Belt Tensions	✔	✔	✔	

Version:	Standard	Professional	Dynamic Analysis	Remarks

Helix Delta-T6 Features				
Version:	**Standard**	**Professional**	**Dynamic Analysis**	**Remarks**
Running Levels & Inclines Loaded Belt Tensions	✔	✔	✔	
Running Levels & Declines Loaded Belt Tensions	✔	✔	✔	
Starting Fully Loaded Belt Tensions	✔	✔	✔	
Starting Empty Belt Tensions	✔	✔	✔	
Braking Fully Loaded Belt Tensions	✔	✔	✔	
Braking Empty Belt Tensions	✔	✔	✔	
Coasting Fully Loaded, Empty Belt Tensions	✔	✔	✔	
Bar and Line Graphs of Belt Tensions	✔	✔	✔	
Belt Sag Check	✔	✔	✔	
Take-up Travel / Belt Stretch	✔	✔	✔	
Dynamic Tensions Starting / Stopping			✔	
2D and 3D surface plot of Dynamic Tensions and Belt Velocities			✔	
Vertical Curves				
Concave and Convex Curves	✔	✔	✔	
Belt Lift off Calculation	✔	✔	✔	Running Full/Empty, Starting Full/Empty, Braking full/Empty
Worn Belt Allowance for Lift off	✔	✔	✔	
Edge Tension Rise	✔	✔	✔	
Limit Centre Tension	✔	✔	✔	
Maximum Buckling Radius	✔	✔	✔	
Dynamic Drawing of Vertical Curves on Screen for Geometric Design	✔	✔	✔	
Horizontal Curves				
Draw Curve Dynamically on Plan		✔	✔	
Calculate Curve Motivation Force		✔	✔	
Calculate Banking Balancing Forces		✔	✔	Balancing force for belt, material and friction
Input Banking Angle and view Belt Drift		✔	✔	
Input Centre and Wing Roll Dimensions		✔	✔	
Calculates Belt Drift for Running and Starting Conditions		✔	✔	See Horizontal Curves (/DeltaT6/HorizontalCurves)
View Results Graphically		✔	✔	Easy to see all belt drift conditions on one graph for each curve point
View and Print Horizontal Curve Report		✔	✔	Detailed View of the calculations
Pulley & Shaft Calculations				
Shaft Deflection at Hub	✔	✔	✔	
Shaft Torsion / Strength	✔	✔	✔	
Running Tensions	✔	✔	✔	
Starting Tensions	✔	✔	✔	
Multiple Shaft & Bearing Combinations	✔	✔	✔	
Pulley Inertia's Calculated	✔	✔	✔	See Horizontal Curves (/DeltaT6/HorizontalCurves)
Pulley & Shaft Rationalisation by changing database selection setting	✔	✔	✔	Use Database to rationalise from a sub-set of pulleys and shafts
Shaft Calculations to AS1403 Standard	Separate Program	Separate Program	Separate Program	See Helix delta-D (/DeltaT6/DeltaD)
Pipe Conveyors				See Pipe Conveyors (/DeltaT6/PipeConveyors)
Pipe Conveyor calculation using Visco Method	✔	✔	✔	Uses Belt Rubber Rheology
Resistance and losses include: Belt to Idler Indentation Resistance, Material and Belt Flexure losses, Idler Rotation (Rim Drag) Resistances, Belt to Idler scuffing losses	✔	✔	✔	

Version:	**Standard**	**Professional**	**Dynamic Analysis**	**Remarks**

Helix Delta-T6 Features				
Version:	Standard	Professional	Dynamic Analysis	Remarks
Calculate Horizontal and Vertical Curves	✔	✔	✔	Generate individual reports on each Curve
Pipe Conveyor Idlers added to Idler Database as a guideline	✔	✔	✔	
Pipe Cross Section	✔	✔	✔	Easy to see Pipe Conveyor Cross Sectional image that includes relavent belt and material properties
Conveyor Starting and Stopping - Static Analysis				
System Equivalent Masses	✔	✔	✔	
Drive & Pulley Inertia Calcs	✔	✔	✔	
Belt Tension Rise % - Static	✔	✔	✔	Check belt safety factor starting and stopping
Starting Time Loaded, Empty	✔	✔	✔	
Stopping Time Loaded, Empty for Braking and Coasting	✔	✔	✔	Match stopping times for downstream conveyors
Stopping Distance Full & Empty	✔	✔	✔	
Discharge Volume Braking & Coasting	✔	✔	✔	
Individual Drive Starting Torque factor	✔	✔	✔	
Conveyor Starting and Stopping - Dynamic Analysis				See Dynamic Analysis (/DeltaT6/DynamicAnalysis)
Graph of Belt Velocity vs Time at any pulley or point during Starting / Stopping			✔	
Graph of Belt Tension vs Time at any pulley or point during Starting / Stopping			✔	
Takeup Movement Plotted vs Time			✔	
Graph of Pulley Torque vs Time at any Pulley for Starting and Stopping			✔	
Obtain maximum belt tensions at any pulley or point			✔	Check Belt Safety Factor and Pulley Stresses
Obtain minimum belt tensions at any pulley or point			✔	Design out excessive belt sag by adding flywheels or brakes - essential for long conveyors
View Holdback Torque on pulleys			✔	Correctly size the holdbacks for actual runback belt tensions due to gravity and belt contraction forces
Dynamic Analysis Presentation			✔	PowerPoint Presentation - ppt file (/DownloadFiles/Helixdelta-TConveyorDynamicAnalysisPresentation.ppt)
Additional / Quick Calculations				See Additional Calcs (/DeltaT6/AdditionalCalcs)
Discharge Trajectory	✔	✔	✔	
Hopper Pull-out Force - Basic	✔	✔	✔	
Hopper Pull-out Force - Bruff's Method	✔	✔	✔	Belt Feeder Design
Hopper Pull-out Force - Theoretical Method (TUNRA)	✔	✔	✔	Belt Feeder Design
Belt Turnover Calculator	✔	✔	✔	See Belt Turnovers (/DeltaT6/BeltTurnovers)
Pulley Inertia	✔	✔	✔	
Pulley Wrap Angle Calculation	✔	✔	✔	
Drive Traction Calculation	✔	✔	✔	
Pulley Bearing L10h life	✔	✔	✔	
Vertical Curve Lift-off radius	✔	✔	✔	
Vertical Curve Buckling Radius	✔	✔	✔	
Vertical Curve Edge Tension Radius	✔	✔	✔	
Horizontal Curve Banking Angle and Belt Drift		✔	✔	
Equipment Schedules from Multiple Design Files				Extract lists from multiple conveyor design files

Version:	Standard	Professional	Dynamic Analysis	Remarks

Helix Delta-T6 Features				
Version:	**Standard**	**Professional**	**Dynamic Analysis**	**Remarks**
Design Summary	✔	✔	✔	
Pulley & Shaft Lists	✔	✔	✔	
Idlers	✔	✔	✔	
Motors	✔	✔	✔	
Gearboxes and Fluid Couplings	✔	✔	✔	See Belt Turnovers (/DeltaT6/BeltTurnovers)
Brakes and Holdbacks	✔	✔	✔	
Belt Tension Comparison Report	✔	✔	✔	For example compare existing conveyor belt tensions with proposed upgraded conveyor
Printing and Exporting Reports				View reports on screen or export to file formats
Number of Reports	70+	70+	80+	
Print Multiple Reports in one file	✔	✔	✔	
PDF Files	✔	✔	✔	
MS Word RTF files	✔	✔	✔	
CSV and Excel files	✔	✔	✔	
Drawing of Conveyor	✔	✔	✔	
3d model	✔	✔	✔	
Tension Graphs - Bar Graphs	✔	✔	✔	
Tension Graphs - Line Graphs	✔	✔	✔	
Dynamic Analysis Graphs 2D and 3D			✔	See Dynamic Analysis (/DeltaT6/DynamicAnalysis)
Help Files				See Documentation (/DeltaT6/Documentation)
Electronic Help File	✔	✔	✔	Includes Contents, Index and Find
Context Sensitive	✔	✔	✔	Press F1 anywhere in the program for Help
Windows Format CHM format	✔	✔	✔	Based on HTML
Print your own Hardcopy manual	✔	✔	✔	Print the Help file by chapter or individual Help topic
Computer Operating System Compatability				See System Requirements (/DeltaT6/SystemRequirements)
Windows XP ®	✔	✔	✔	Requires Service Pack 3 or later
Windows Vista ®	✔	✔	✔	
Windows 7 ®	✔	✔	✔	
Windows 8 and 8.1 ®	✔	✔	✔	
Windows 10 ®	✔	✔	✔	
Version:	**Standard**	**Professional**	**Dynamic Analysis**	**Remarks**

Pulley Shaft Design...

End of Helix Delta-T6 Conveyor Design Brochure

Helix Delta-D Pulley Shaft Design Program

Helix Delta-D program is a separate software package from Helix delta-T6

HELIX delta-D Pulley Shaft Calculation Program

Helix delta-D is an easy to use pulley shaft calculation program provided to perform conveyor pulley shaft size calculations. The program requires pulley and shaft dimensions as well as conveyor belt tensions for starting and running.

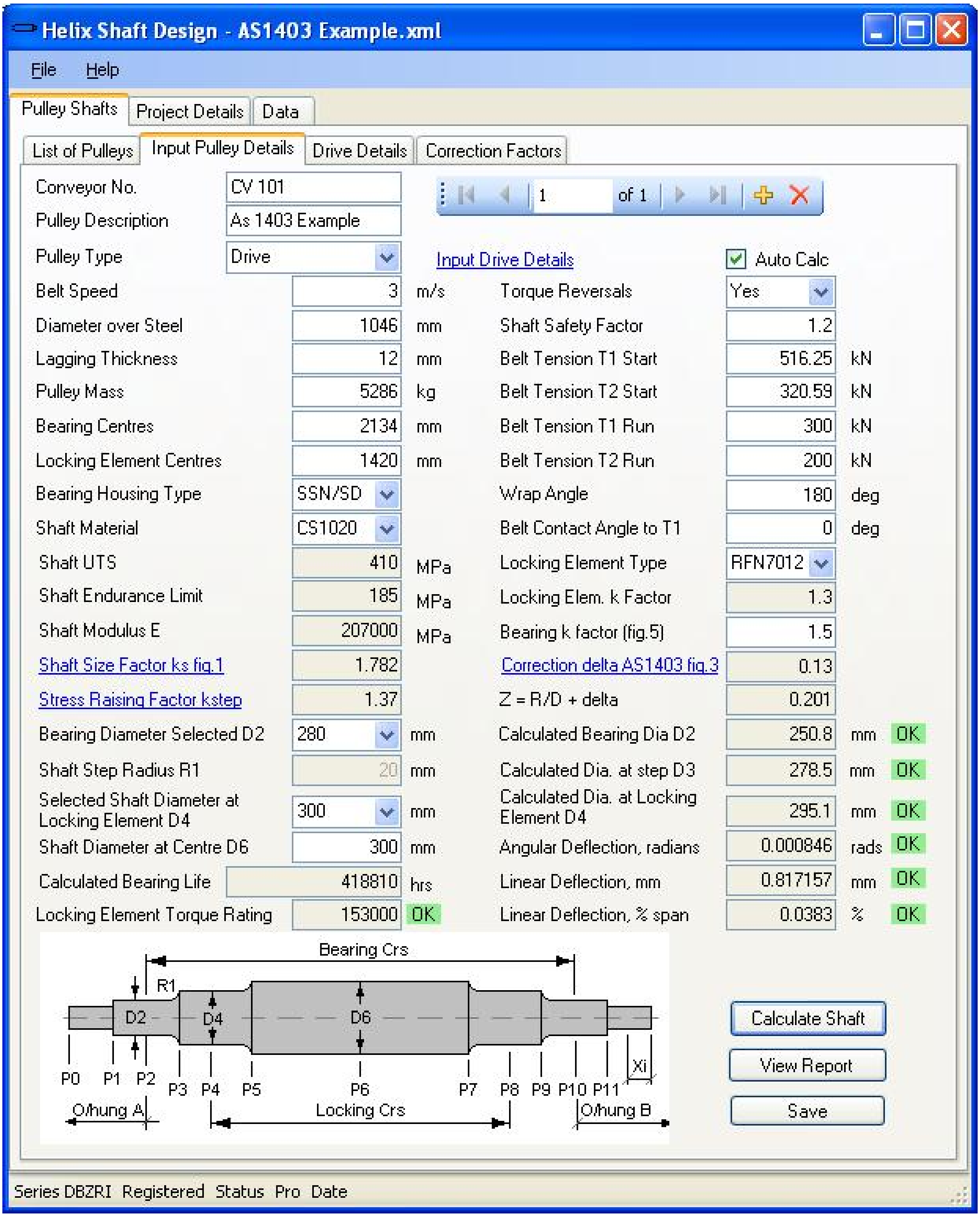
This program is based on **Australian Standard AS 1403 - Design of rotating steel shafts.** A copy of the Australian Standard AS1403 may be obtained from Australian Standards website (http://www.saiglobal.com)

Click the following link to see a sample calculation report based on the worked example given in AS1403 Appendix F on page 45 - Worked Example Calculation AS 1403 (PDF file 89kb) AS1403 Worked Example Design report - pdf file (/DownloadFiles/HelixDeltaDShaftReport-AS1403ExamplePage45.pdf)

The program allows the user to open a new project file and then quickly add new pulleys to the list. Enter dimensions and belt tensions, select the shaft material and locking element types and then press calculate to obtain the shaft sizes required at the locking element and bearing. You can quickly and easily add new pulleys and rationalise the sizes required in order to minimise capital and spares holding cost.

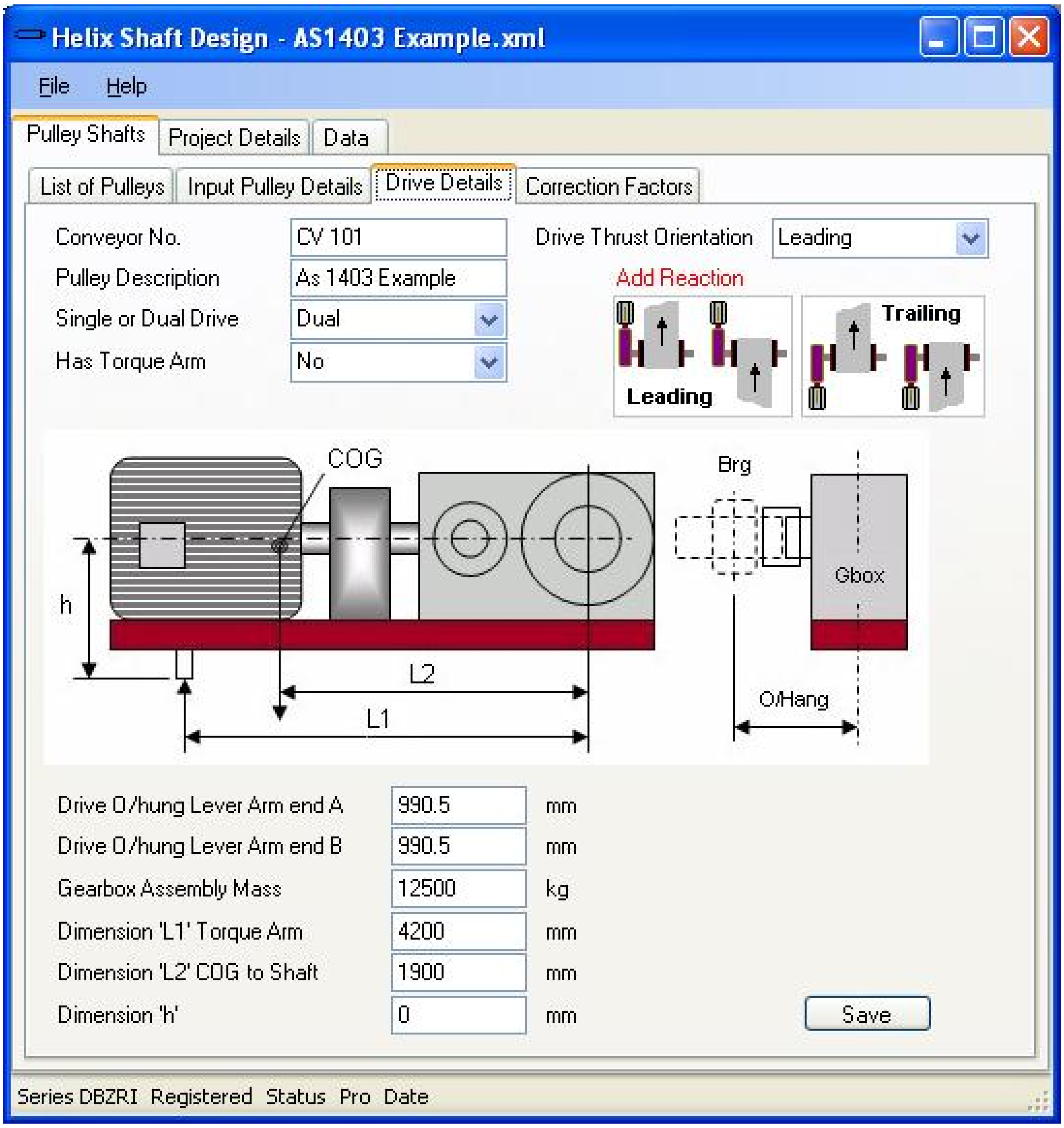
The main input data required is as shown in the images below.

Main Shaft Input Form



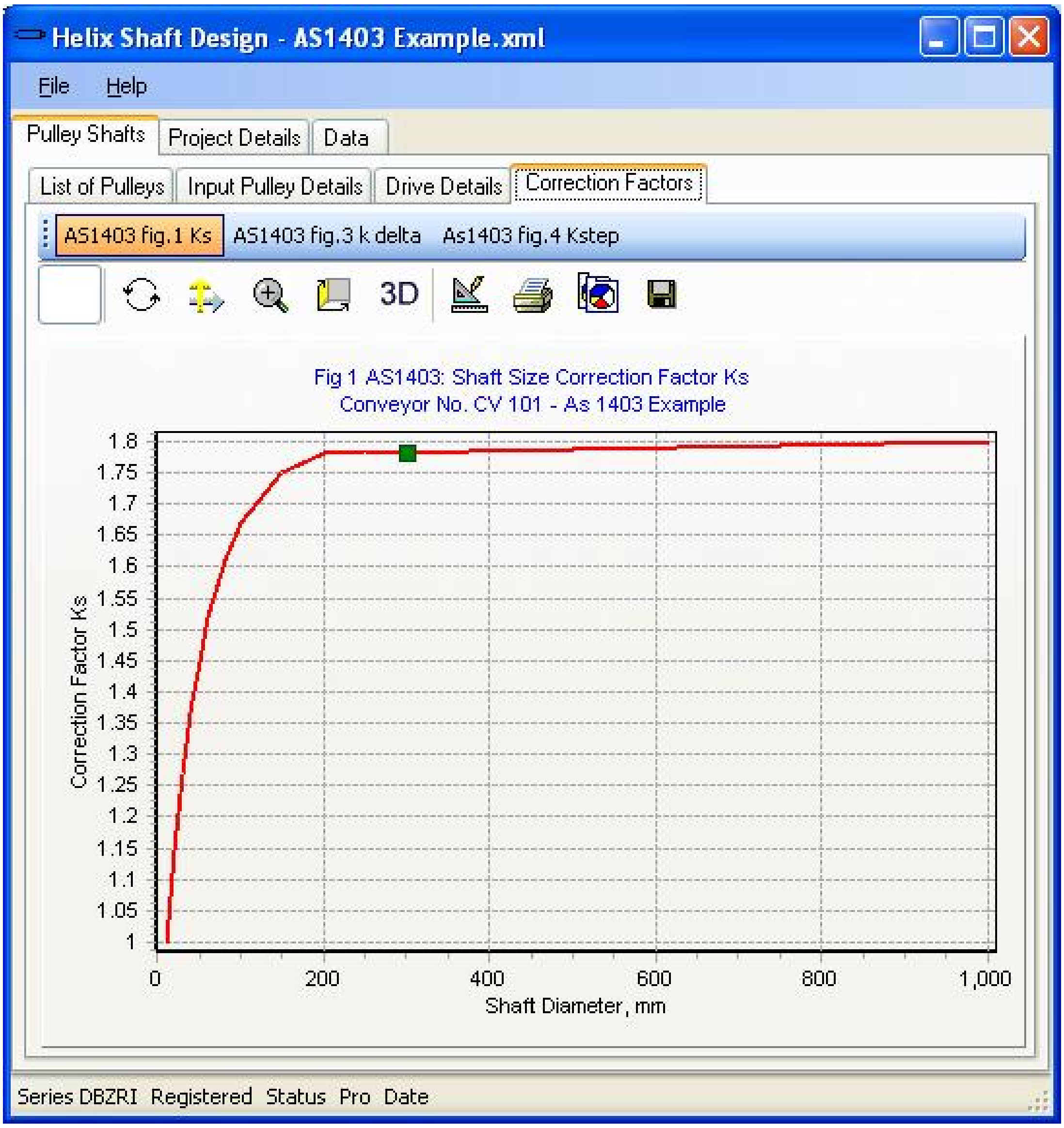
Easy to use inputs are provided on a compact form with drop down boxes for materials, shaft sizes, locking elements etc. Choose a trail diameter and press Calculate to see if the shaft you selected is OK. In addition to AS 1403 requirements, the program also calculates the shaft deflection and provides warnings if the deflection exceeds recommended values.

Drive Details Input Form

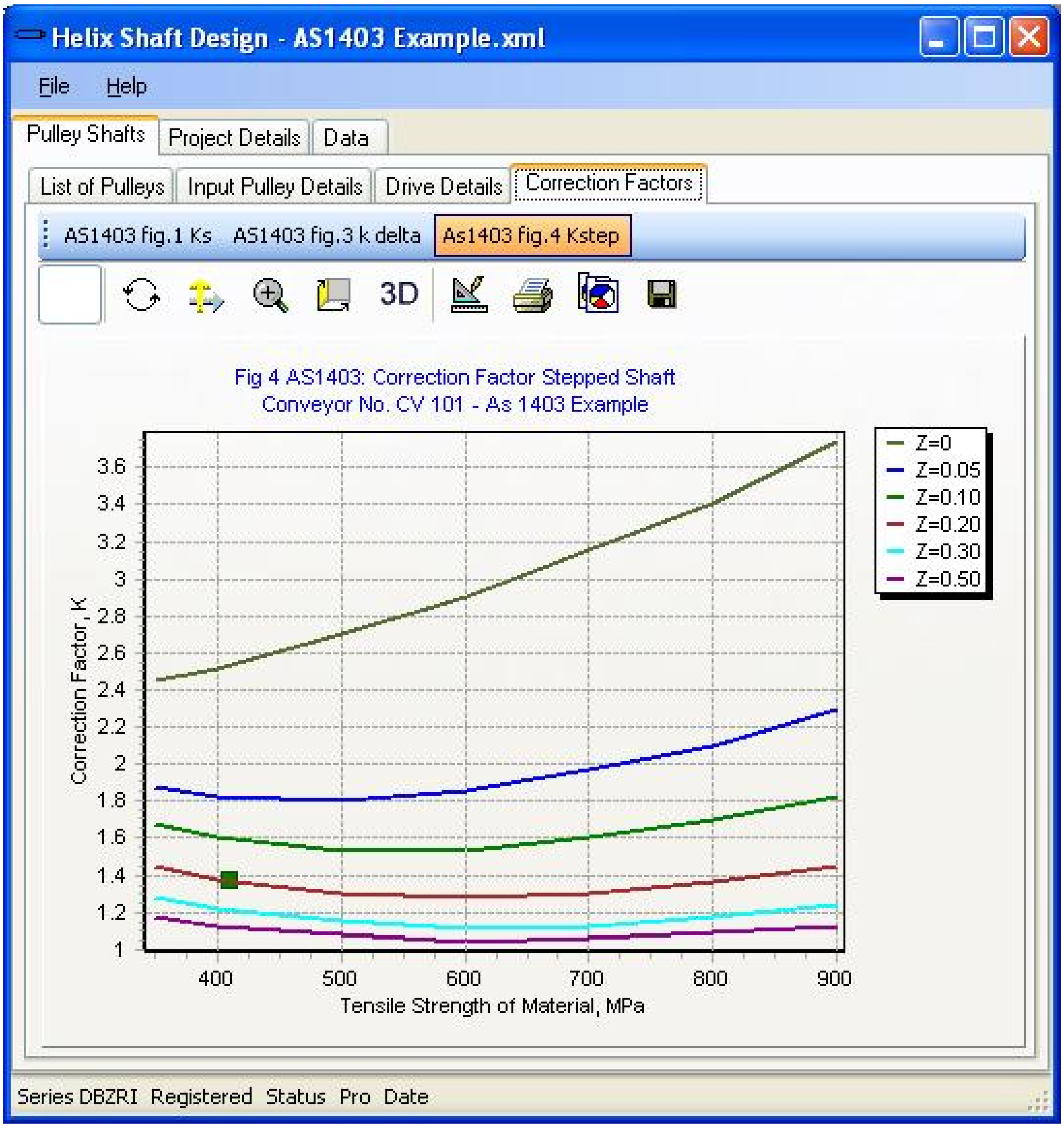


Easy to understand inputs prompt the user to enter the required data for drive shafts so that overhung loads etc. can be calculated.

Stress Raising Correction Factors are calculated automatically

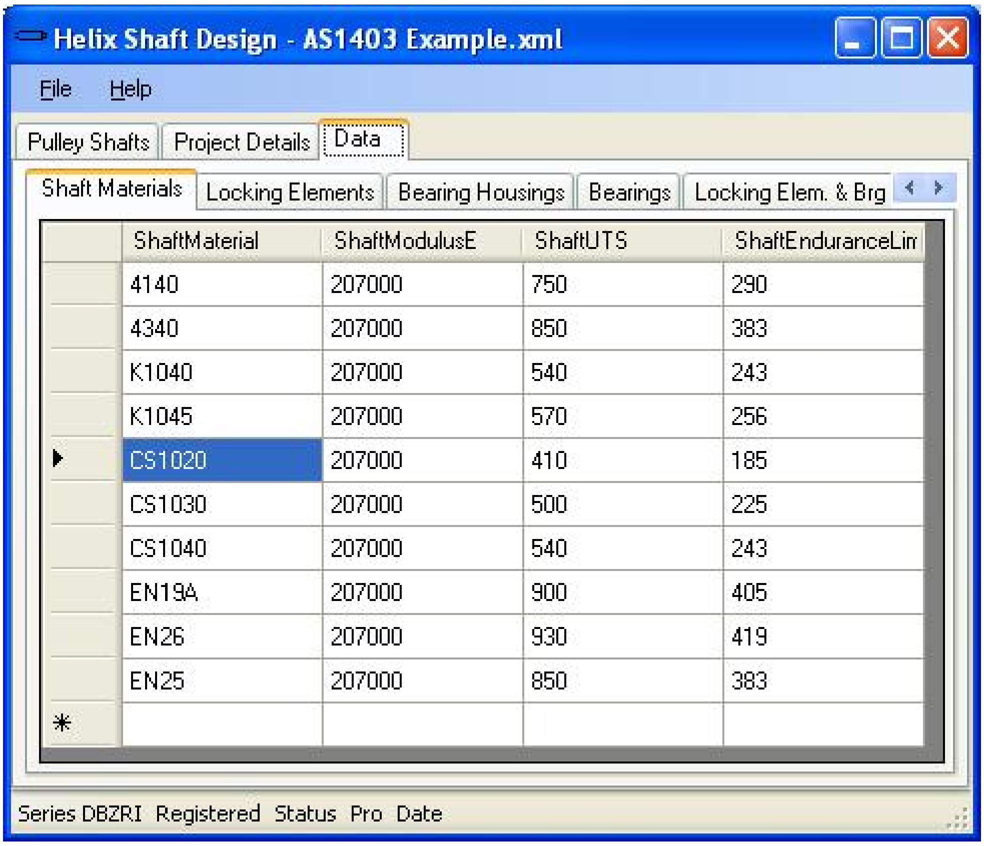


Stress Raising Correction Factors are calculated automatically



AS1403 Stress Raising Correction factors are automatically looked up and calculated for you.

Lookup Data for Shaft Materials, Bearings, Locking elements is provided



Quality Control

Click the following link to see a sample calculation report based on the worked example given in AS1403 Appendix F on page 45 - Worked Example Calculation AS 1403 (PDF file 89kb) AS1403 Worked Example Design report - pdf file (/DownloadFiles/HelixDeltaDShaftReport-AS1403ExamplePage45.pdf)

Disclaimer

This program has been developed specifically for the design of Conveyor Pulley Shafts and is not intended as a general shaft design tool. It must be used by qualified persons experienced in pulley shaft design as the use of the program, and the interpretation of the calculation results, requires an understanding of the shaft design process. The shaft sizes calculated are dependent on the dimensions entered and input data for belt tensions as well as the material properties and stress raising factors used and no guarantee or warranty is given to users of this program.

Home ...