HIPAVE

Overview

MINCAD Systems

rev. August 2005

HIPAVE- Powerful and user-friendly

- HIPAVE 5.0 is a major step forward in pavement design:
  - a fully integrated system with superior design power and ease of use

the best of the old and the new...

- HIPAVE 5.0 draws on the proven technology of earlier versions of CIRCLY software [used on thousands of pavement designs over 20 years] and APSDS (Airport Pavement Structural Design System.
- Our system introduces a number of powerful new features:
  - enormous input data flexibility
  - extensive data-base saving re-entry of frequently used data
  - new parameters easily defined

all important design inputs:

TRAFFIC

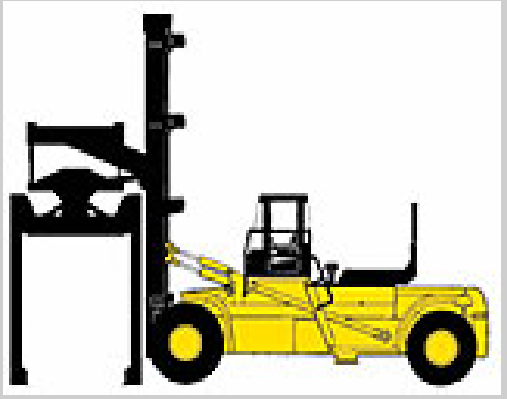
- any combination of vehicle types or load configurations
- any wheel layout
- braking or vertical loads
- varying contact stress distributions

MATERIALS

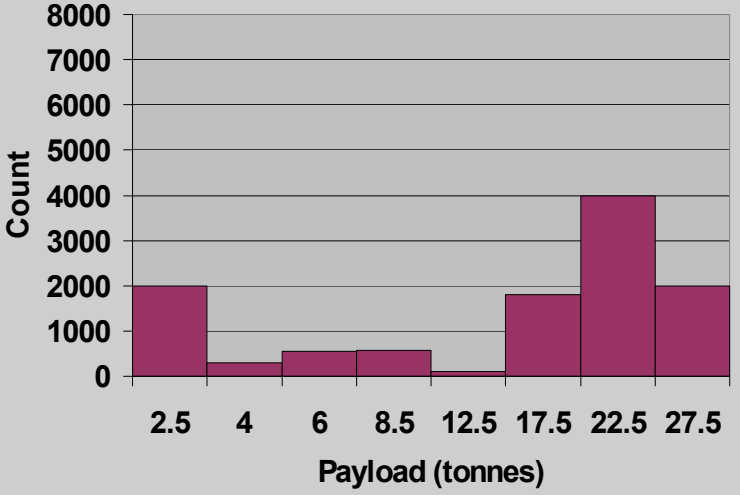
- any damage model
- isotropic or anisotropic

Sample Traffic Mix

Vehicle Model A

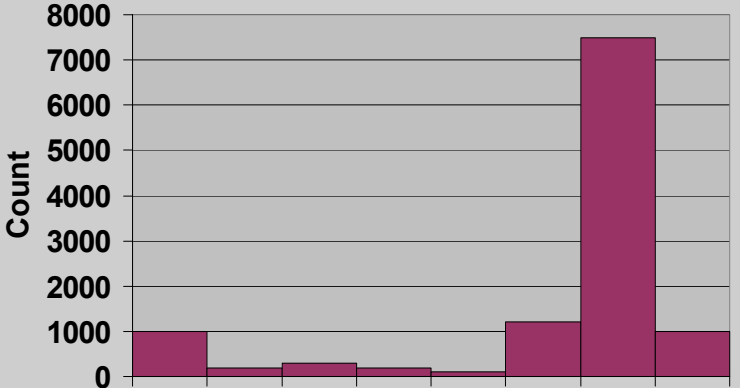


Vehicle Model A – Payload Distribution



Vehicle Model B

Vehicle Model B – Payload Distribution



Comprehensive range of vehicle types

Forklift, Mast Lift

Straddle Carriers

Tractor-Trailers, Trucks

Reach Stackers

Rubber Tyred Gantry

Standard Vehicle Library – automatically updated from webserver

vehicle Specs

Internet

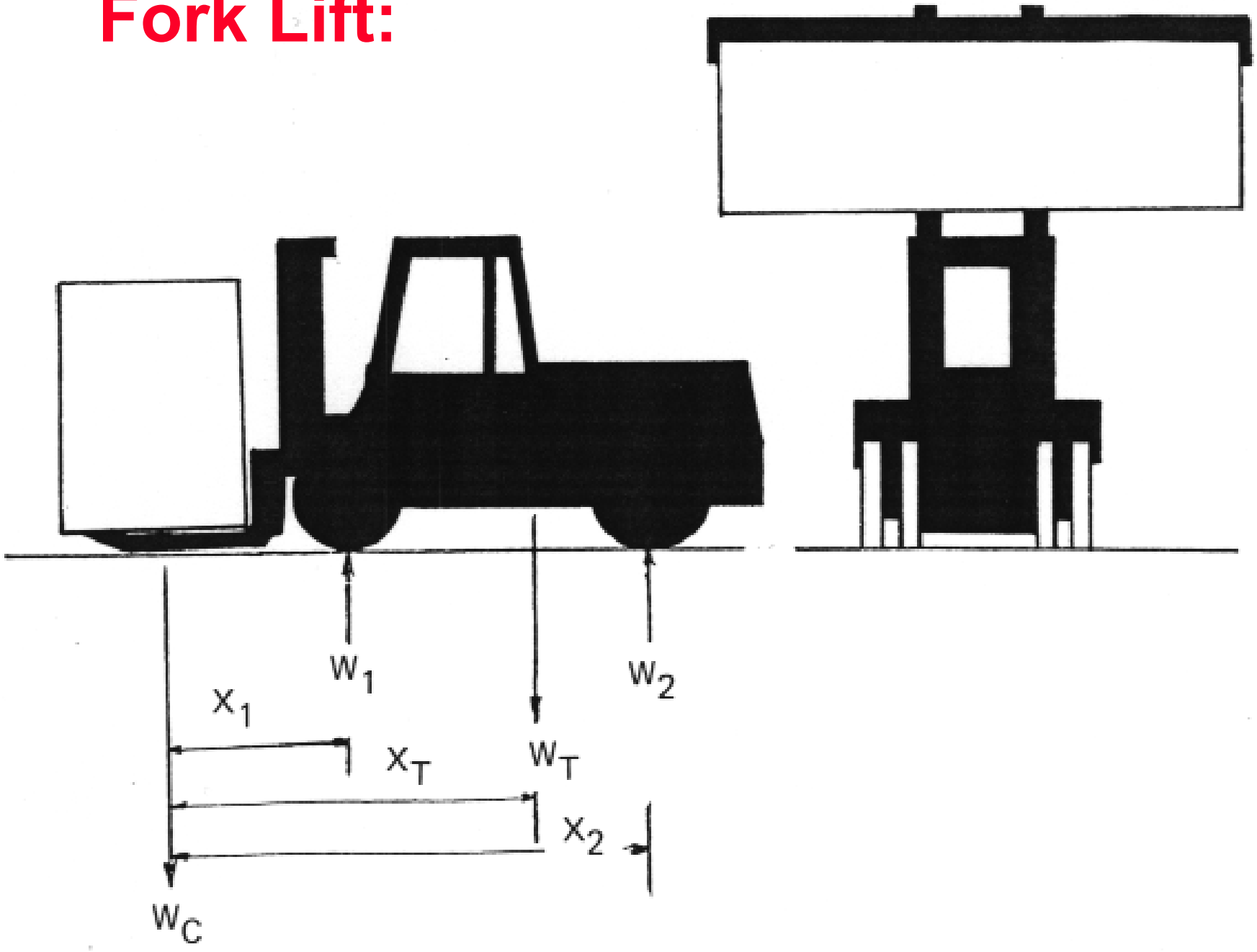
XML

Standard Vehicle Librar

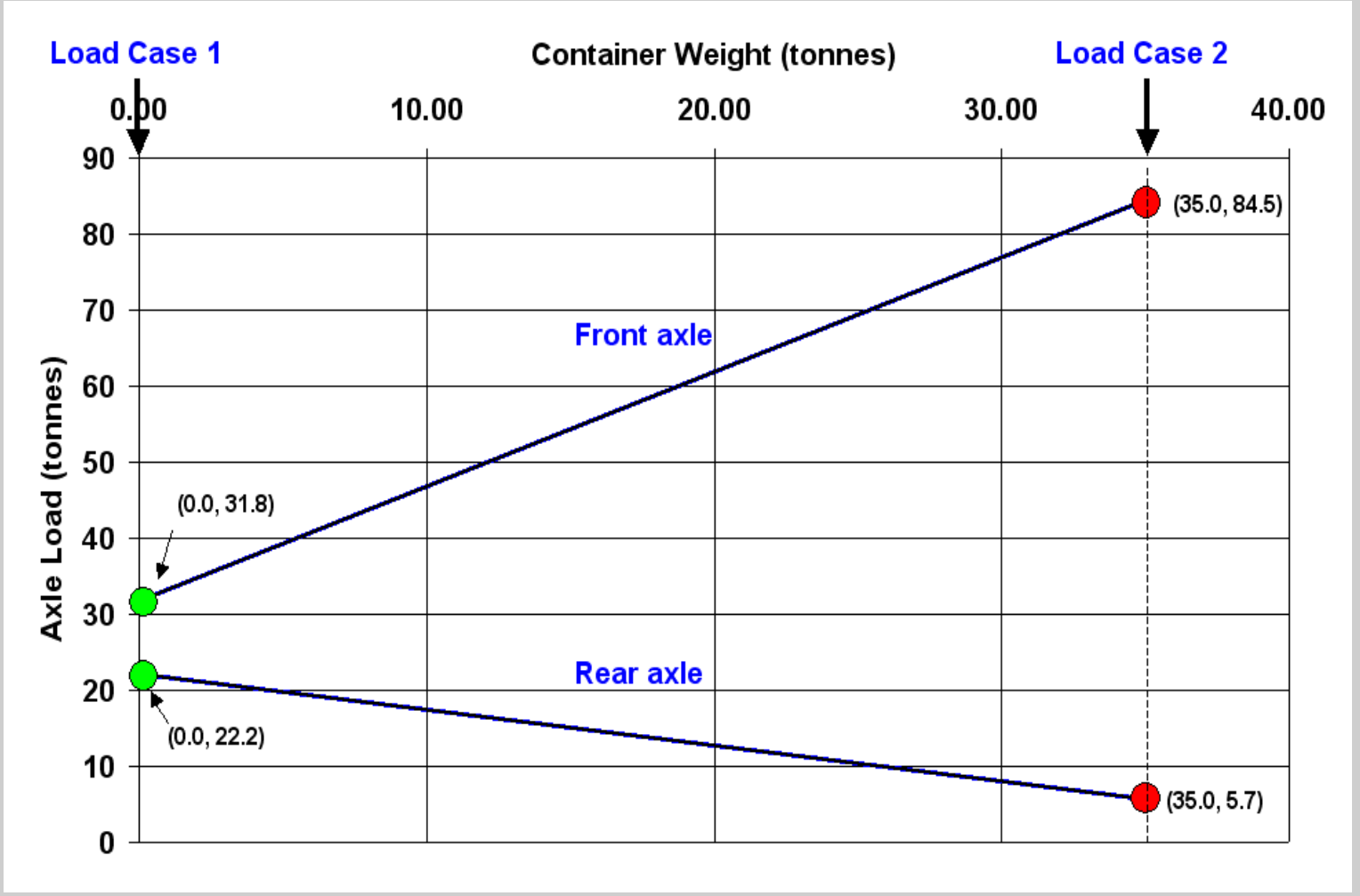
Mincad webserver

Automatic Calculation of Wheel Loads for Container Vehicles…

Fork Lift:



Fork Lift: Axle Load vs. Container Mass



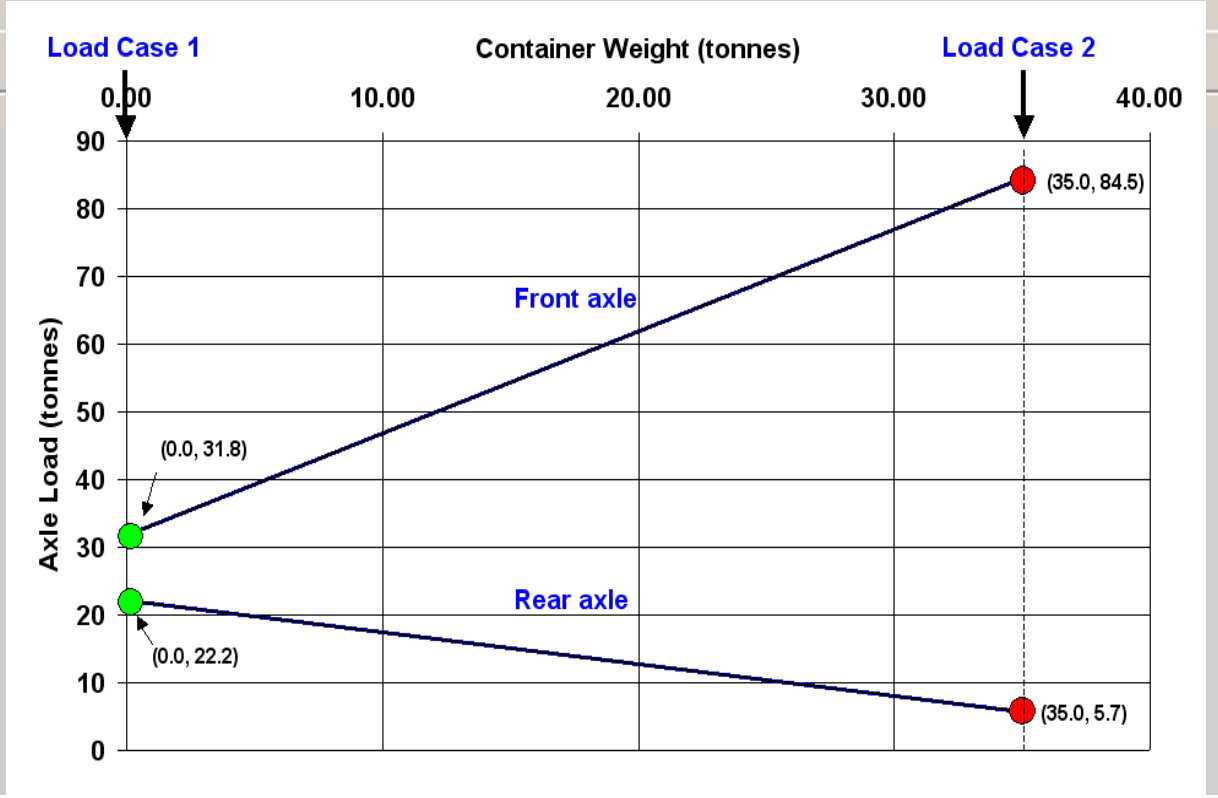
HIPAVE: Axle Load vs. Container Mass

Kalmar DCD370-12

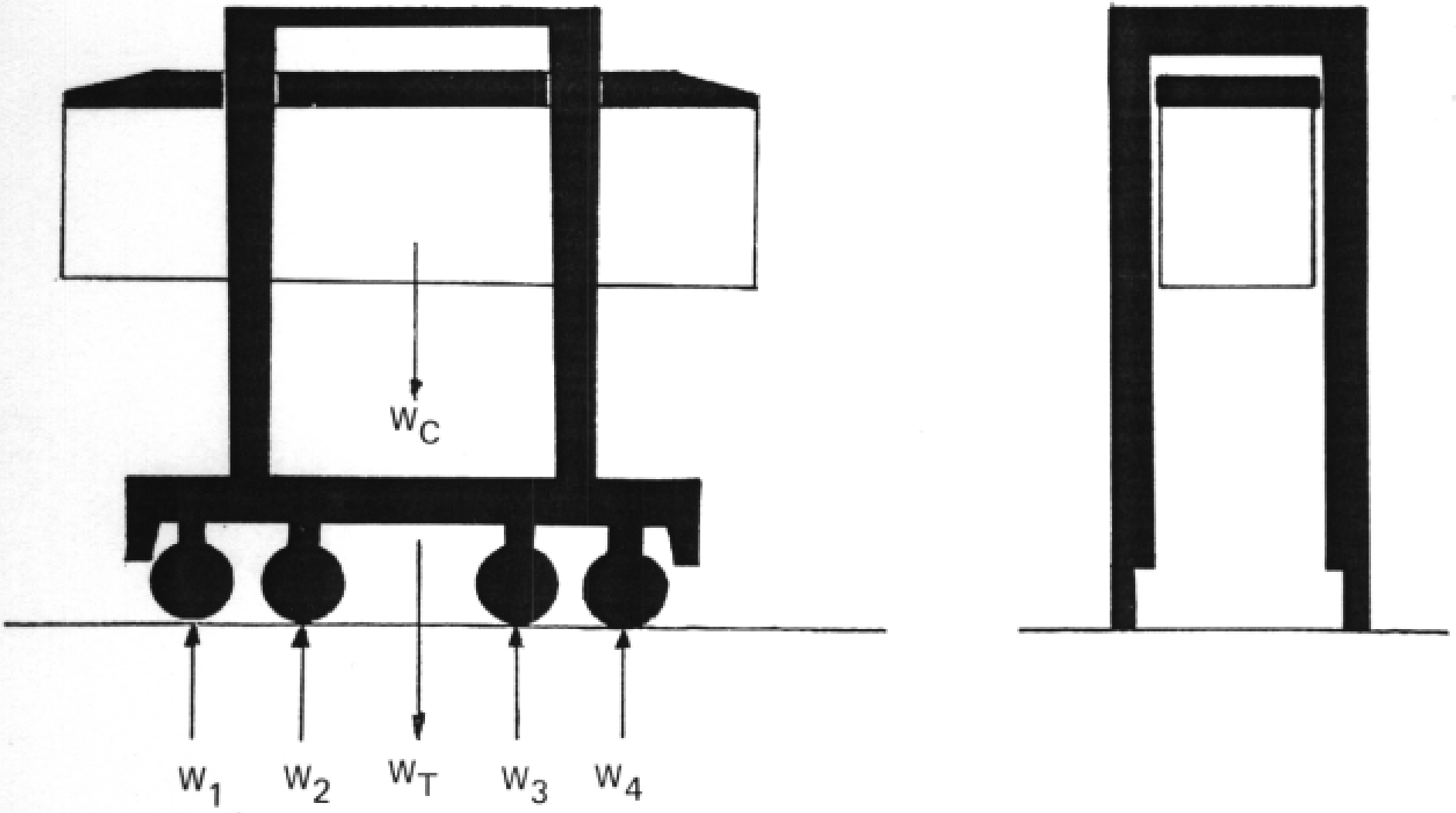
Characteristics:

Payload (Load Case 1): 0 Payload (Load Case 2): 35

Component No.	Tyre Pressure	Axle Load: (Load Case 1)	Axle Load: (Load Case 2)	Number of Wheels
1	0.90	31.78	84.51	4
2	0.90	22.15	5.70	2



Straddle Carrier



Straddle Carrier

Vehicle Models | Load Components and Locations

Type: Straddle Carrier Manufacturer: Kalmar Scope: All

ID	Title	Plot Label	Scope
KalmESC340fc	Kalmar ESC340 front cabin	Kalmar ESC340	Library
KalmESC340sc	Kalmar ESC340 side cabin	Kalmar ESC340	Library
KalmESC350	Kalmar ESC350 front cabin, twin lift	Kalmar ESC350	Library
KalmESC440	Kalmar ESC440 front cabin	Kalmar ESC440	Library
KalmESC450	Kalmar ESC450 front cabin, twin lift	Kalmar ESC450	Library

Straddle Carrier characteristics **conveniently specified in terms of** ***4 simple parameters*****…**

Kalmar ESC340 front cabin

Characteristics:

Number of Axle Rows:	4	Total Number of Wheels:	8
Tyre Pressure:	0.56	Unladen Weight:	62

Custom Payload Distribution

TITLE | MAX | Import

Spectrum | Spectrum Components | Wander

Two Forklift Models - each using Custom Payload Distribution

ID	Title	Movements	Graph Label
HysterH40C	Hyster H40.00E-16CH	1.00E+05	
HysterH48	Hyster H48.00E	5.00E+04	

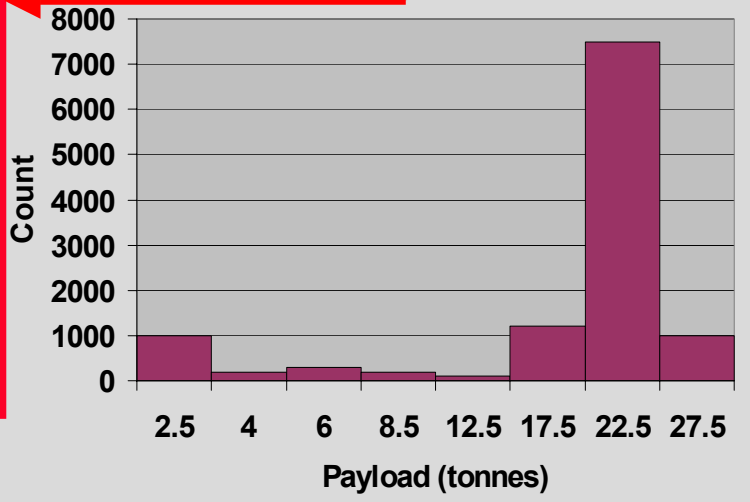
New | Delete

Payload Distribution:

Distribution Type: Custom

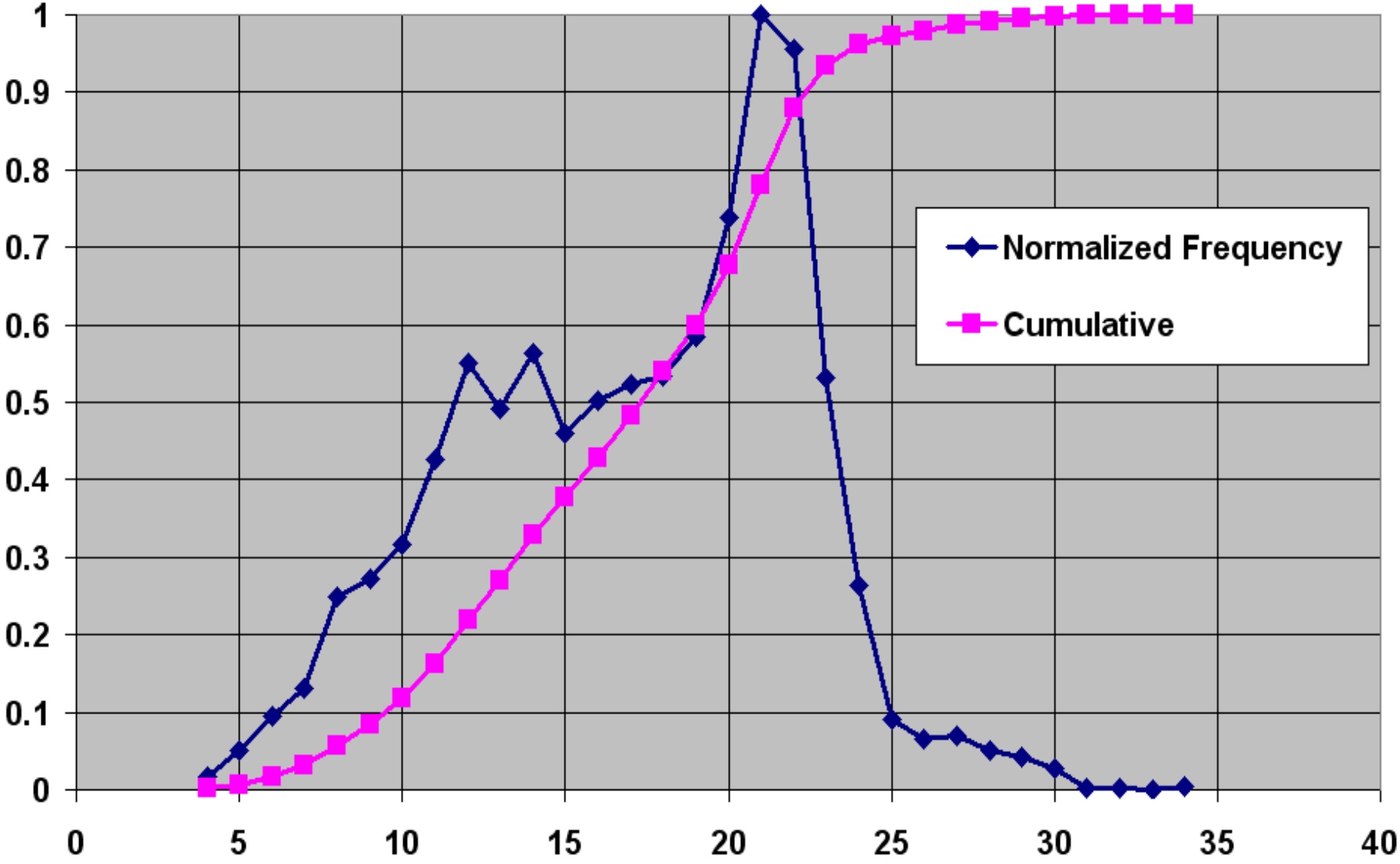
Payload	Count	Normalized Movements	Ac
2.50	1000	0.087	
4.00	200	0.017	
6.00	300	0.026	
8.50	200	0.017	
12.50	100	0.009	
17.50	1200	0.104	

New



Standard Container Weight Distribution

e.g. British Ports Association (1996) - 40 ft containers



Standard Payload Distribution

TITLE | $\sum d_i$ | MAX | Import | Export

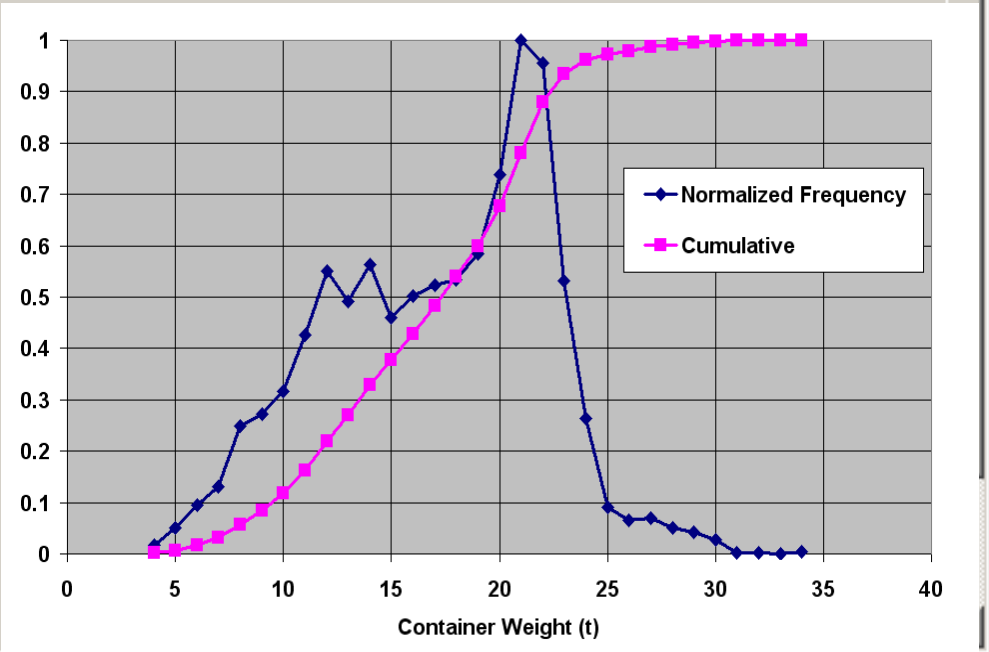
Payload Distributions | Distribution Details

e.g. British Ports Association (1996) - 40 ft containers

British Ports Association Guide 1996 - 100% x 20ft

	Payload	Count	Normalized Movements
▶	2.00	0.46	0.005
	3.00	1.49	0.015
	4.00	2.95	0.029
	5.00	3.96	0.040
	6.00	3.94	0.039
	7.00	3.97	0.040
	8.00	3.72	0.037
	9.00	3.41	0.034
	10.00	3.66	0.037
	11.00	4.04	0.040
	12.00	4.50	0.045
	13.00	4.41	0.044
	14.00	4.67	0.047
	15.00	5.63	0.056
	16.00	6.13	0.061
	17.00	6.21	0.062
	18.00	6.46	0.065
	19.00	7.58	0.076
	20.00	9.19	0.092
	21.00	6.72	0.067
	22.00	4.08	0.041

Can be used in multiple Traffic Spectrums



New

Delete

Lateral Vehicle Wander

- A critical design parameter
- A normal distribution is assumed
- Standard Deviation of wander distribution can vary with vehicle type

Dynamic Load Factors

- Dynamic Load Factors used by the British Ports Association Design Guide
- Simple way to account for effects of dynamic loading from:
  - cornering, accelerating, braking and surface uneveness.
- These simple multipliers are applied to the design loads
- Can vary with each axle
- HIPAVE lets you use your own values

The pavement system...

HIPAVE realistically models pavement response:

- any combination of layer thicknesses and elastic properties
- state of the art damage indicators

Typical layered pavement model

	Thickness (mm)	Modulus (MPa)	Poisson's Ratio
Asphalt	200	2800	0.4
Base Course/ Subbase Course	110	600	0.35
	150	600	0.35
	150	480	0.35
	150	240	0.35
	150	120	0.35
	150	60	0.35
Subgrade CBR = 3	Infinite	30	0.45

✓ anisotropic properties can be used

How damage models are defined

- A damage model relates pavement life to an indicator of damage such as subgrade compressive strain, etc.
- The models are of the form:

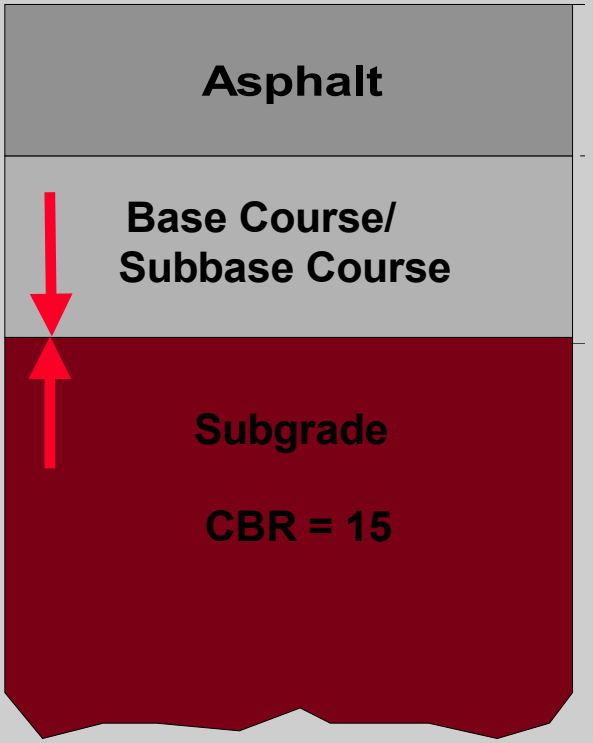
$$N = \left(\frac{k}{\varepsilon} \right)^{b}$$

where N is the predicted life
(repetitions to failure)
k is a material constant
b is the damage exponent
ε is the induced strain

You can choose damage indicators

Example:

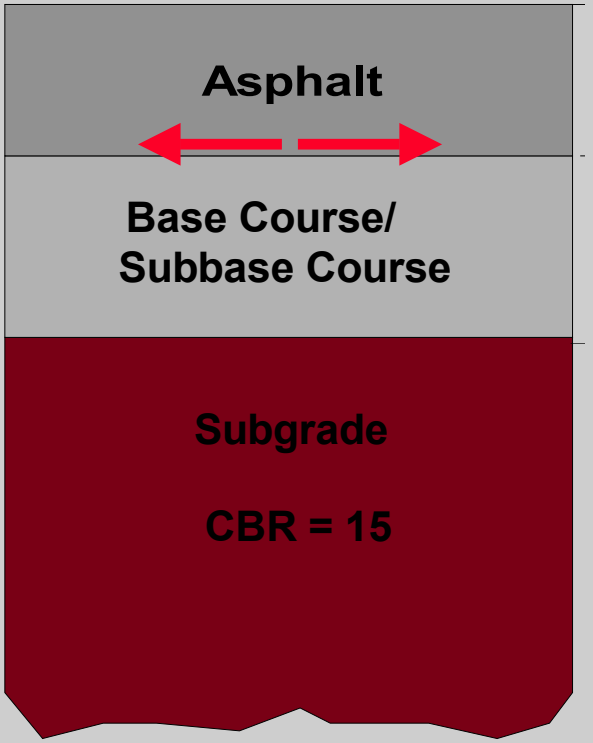
Vertical strain



You can choose damage indicators

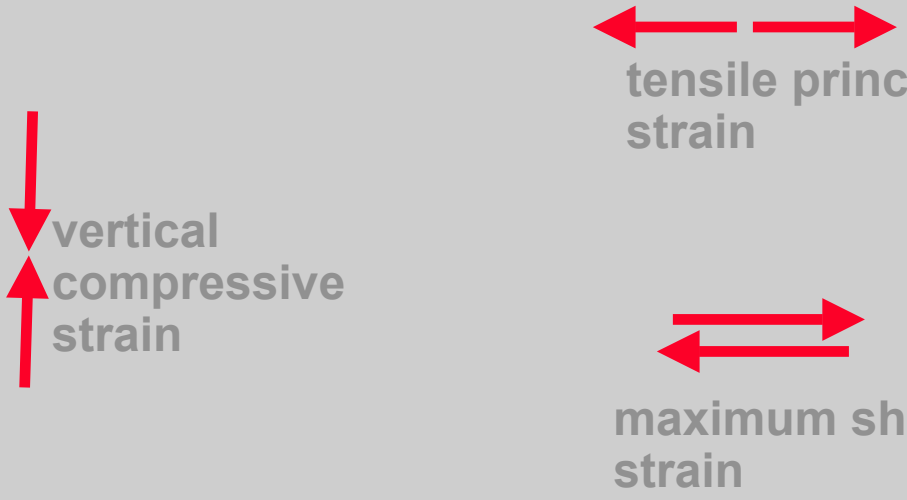
Example:

Tensile strain



HIPAVE handles all damage models

- you can define new models
- models can use any deflection, strain or stress component, e.g.:



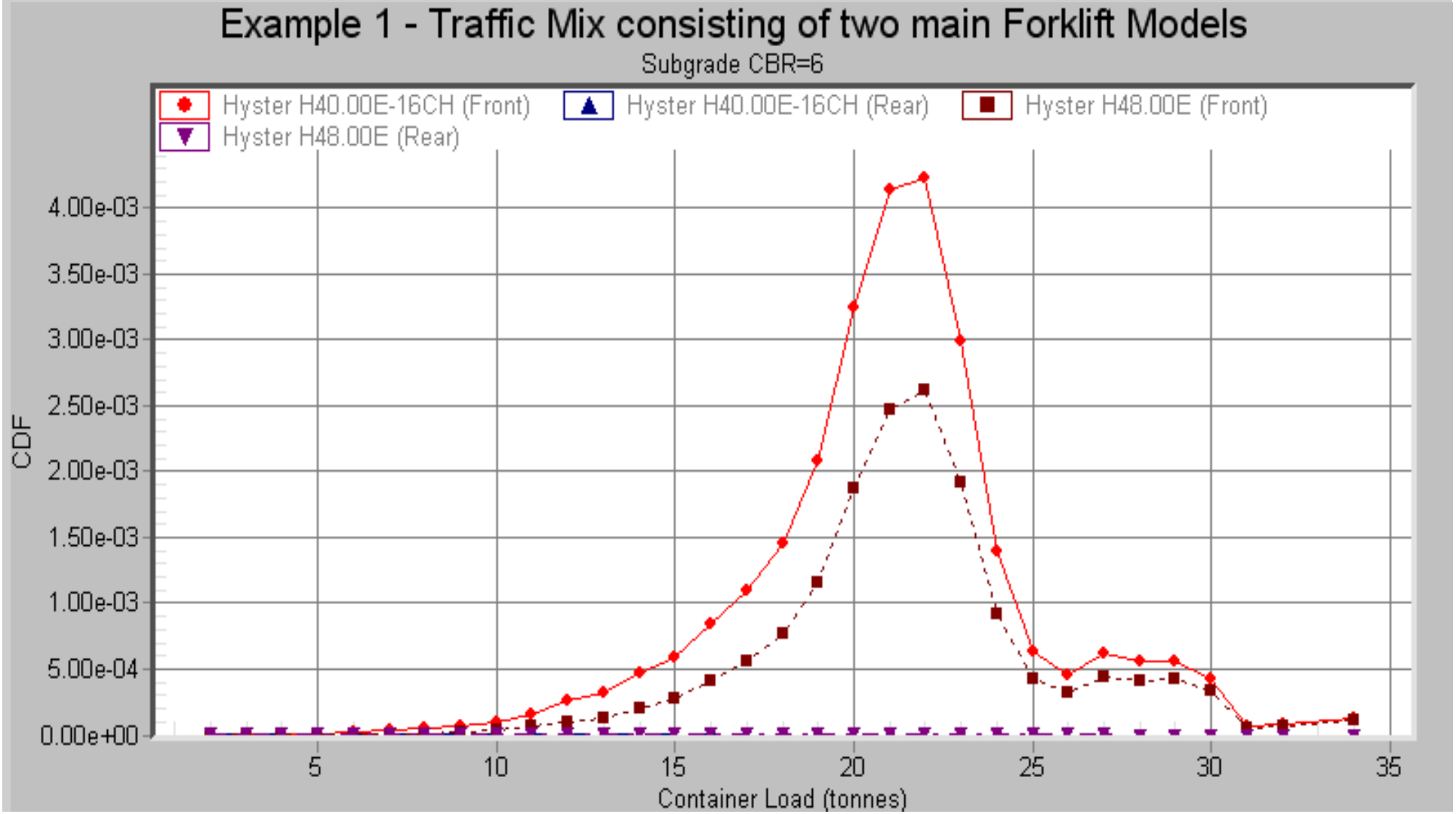
HIPAVE gives *fast* results:

- Once parameters are defined, typical runs take only seconds on Pentium PCs
- Even the most complex combinations of vehicles and the most complicated pavement structures take seconds, not hours!

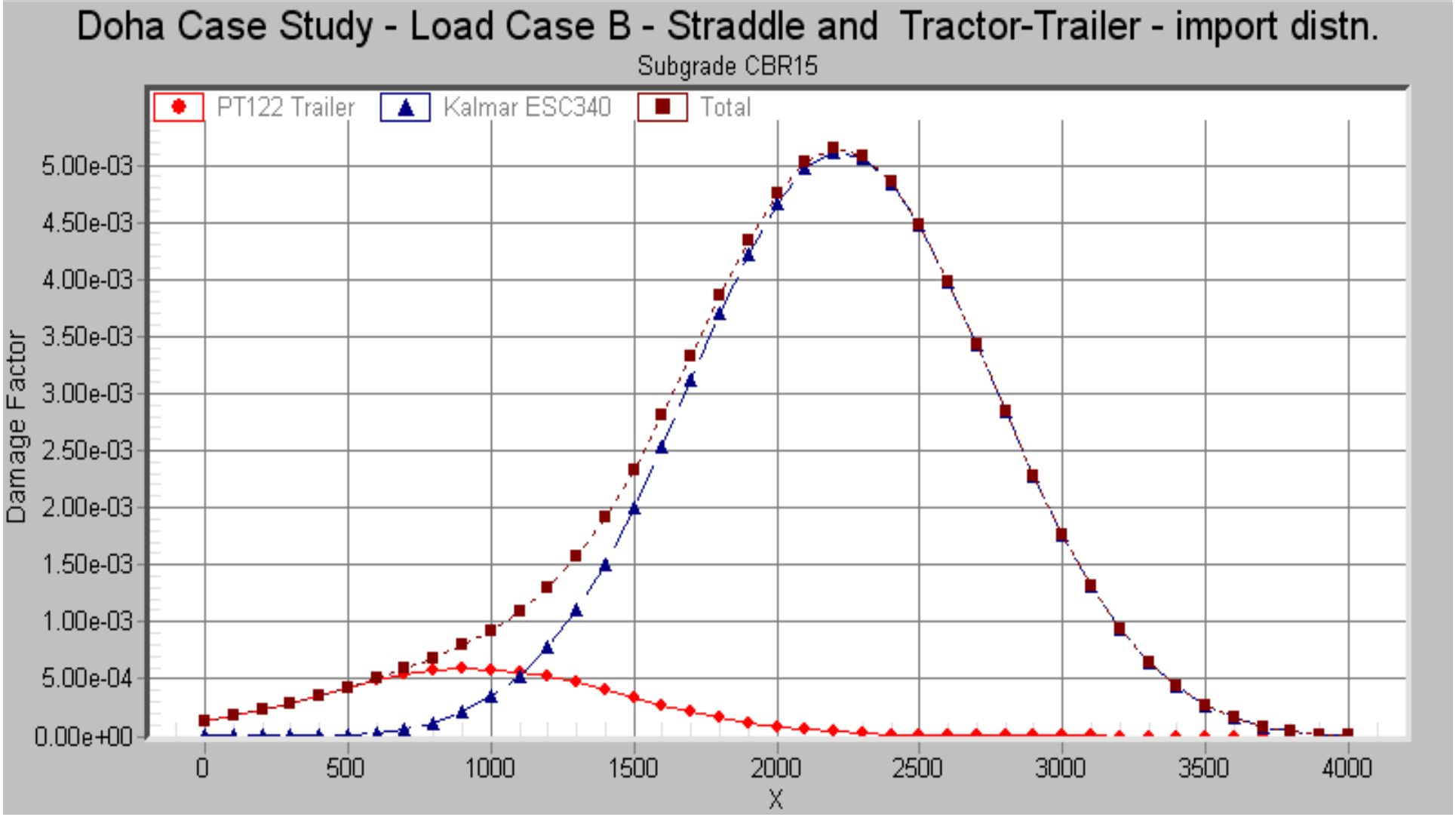
Results presentation

high quality plots can be output on any printer

Sample Damage Factor vs. Container Mass

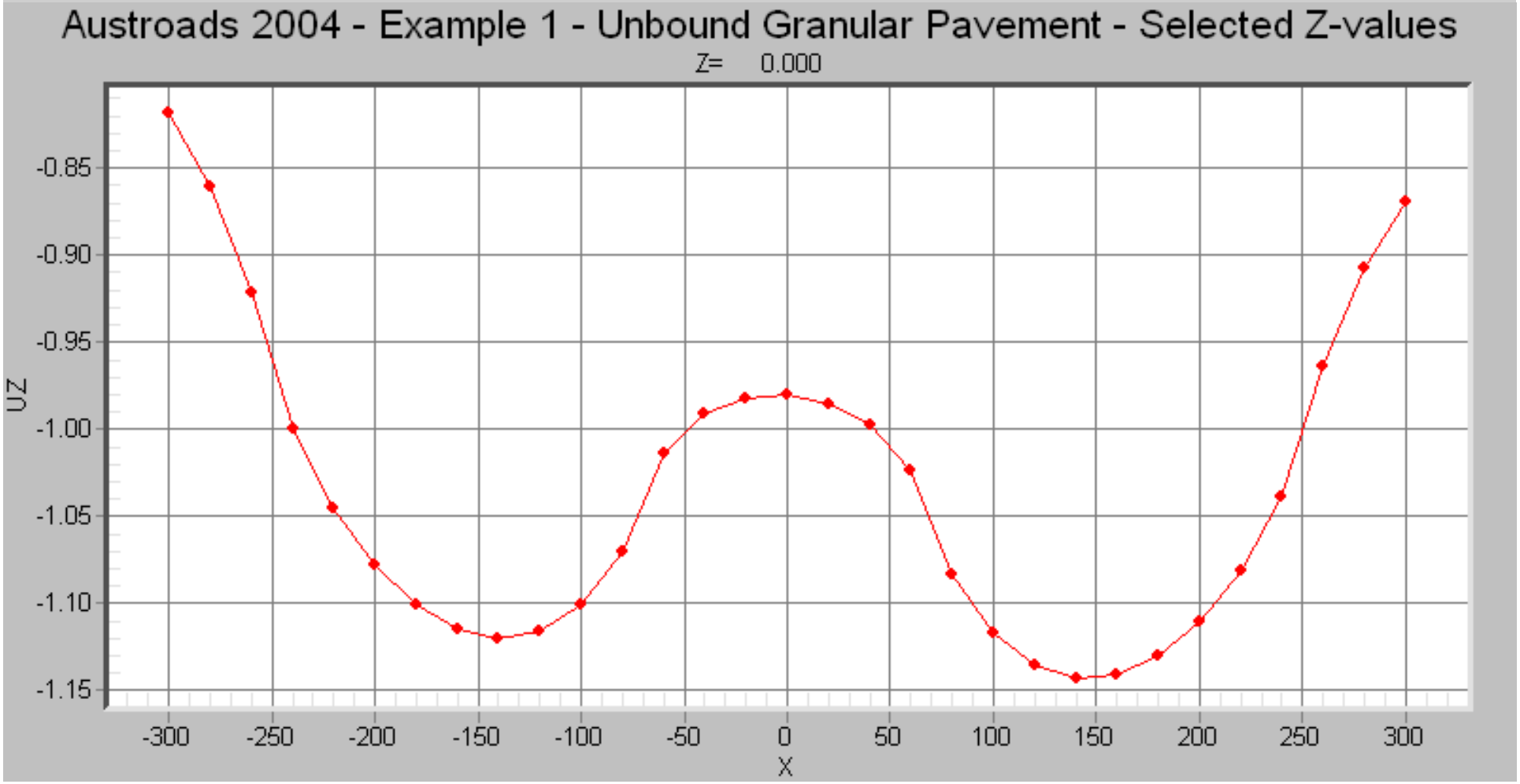


Sample Damage Factor vs. Distance



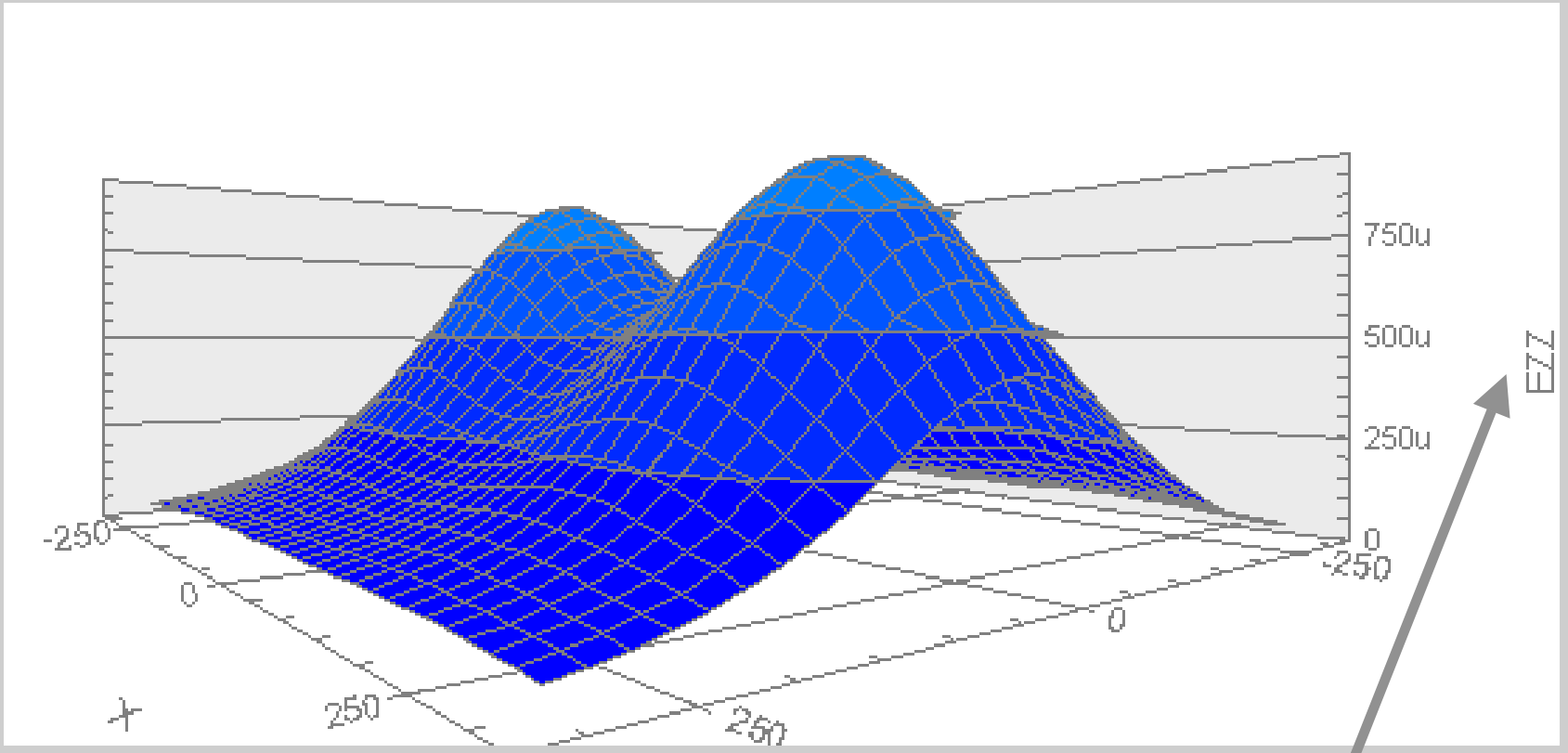
Results presentation

any deflection, strain or stress component,
e.g. surface displacements



Results presentation

any deflection, strain or stress component,
e.g. strain pulse under dual wheels

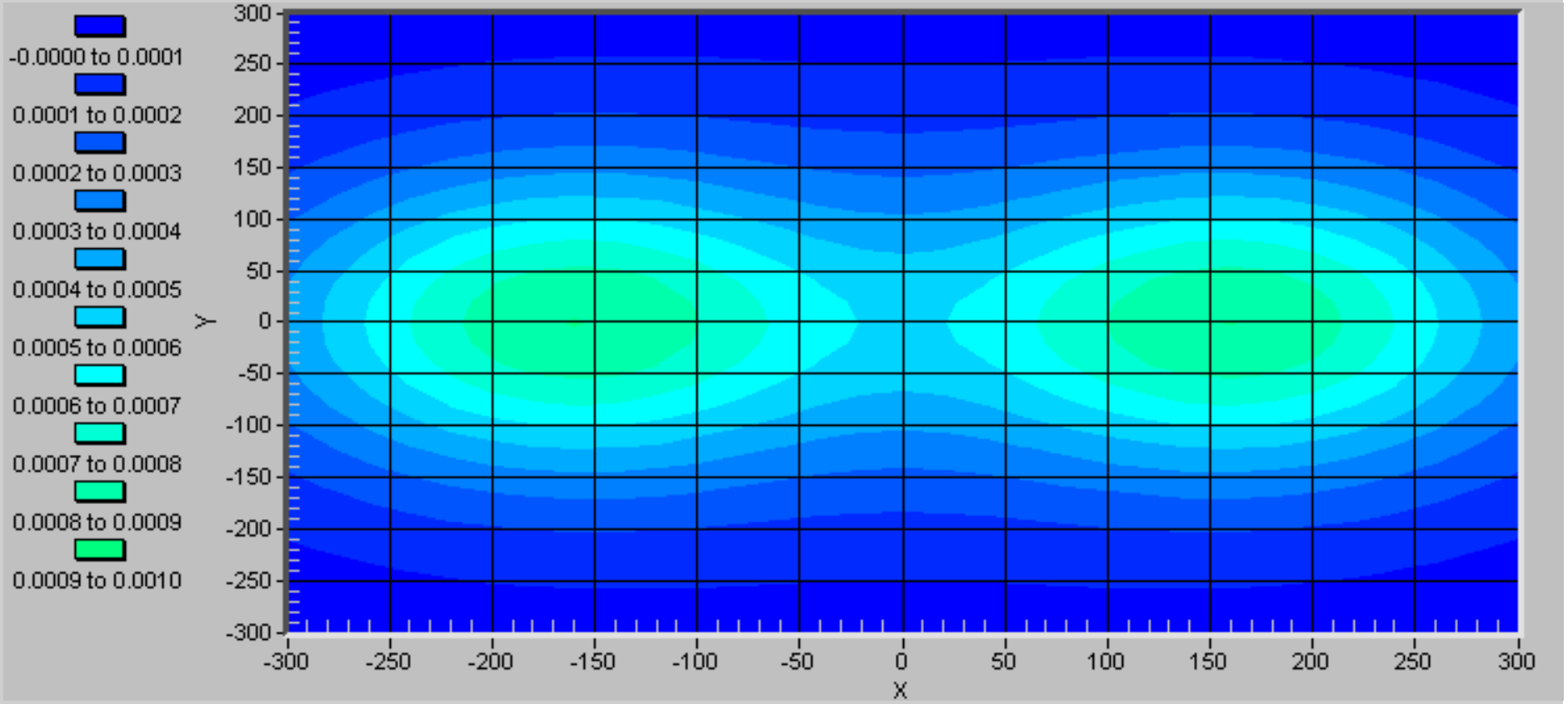


Vertical strain

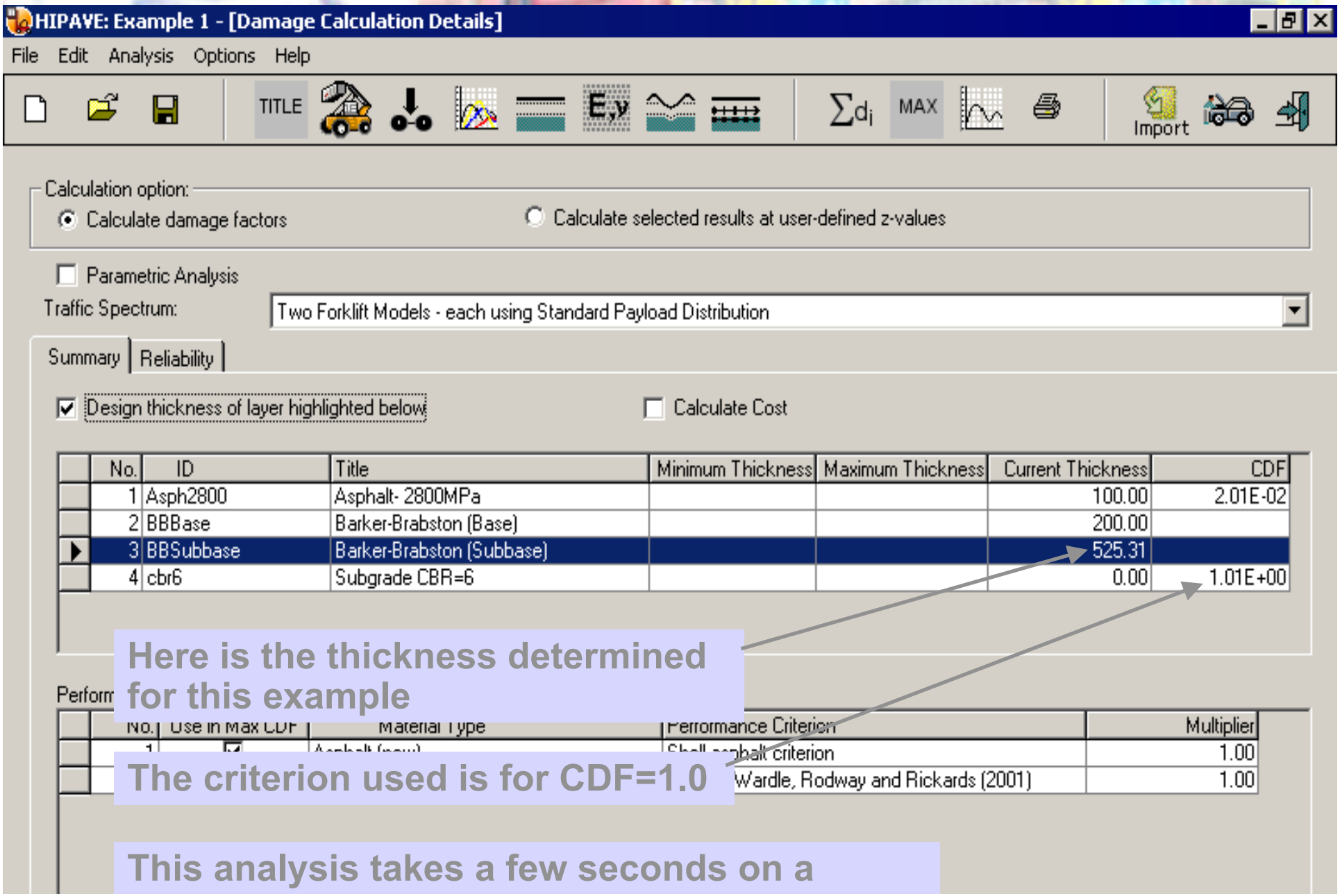
Results presentation

any deflection, strain or stress component,
e.g. strain pulse under dual wheels

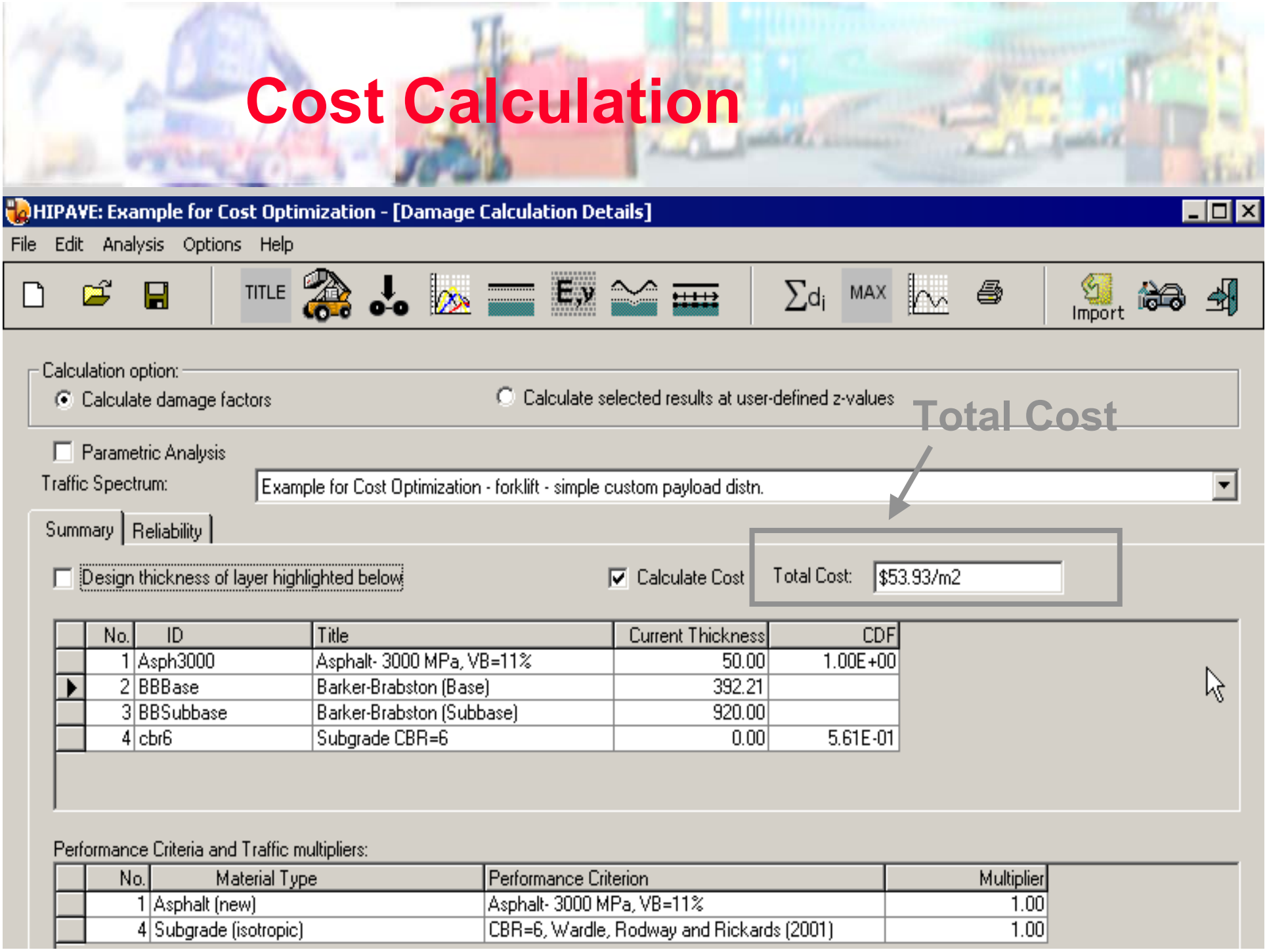
Vertical strain



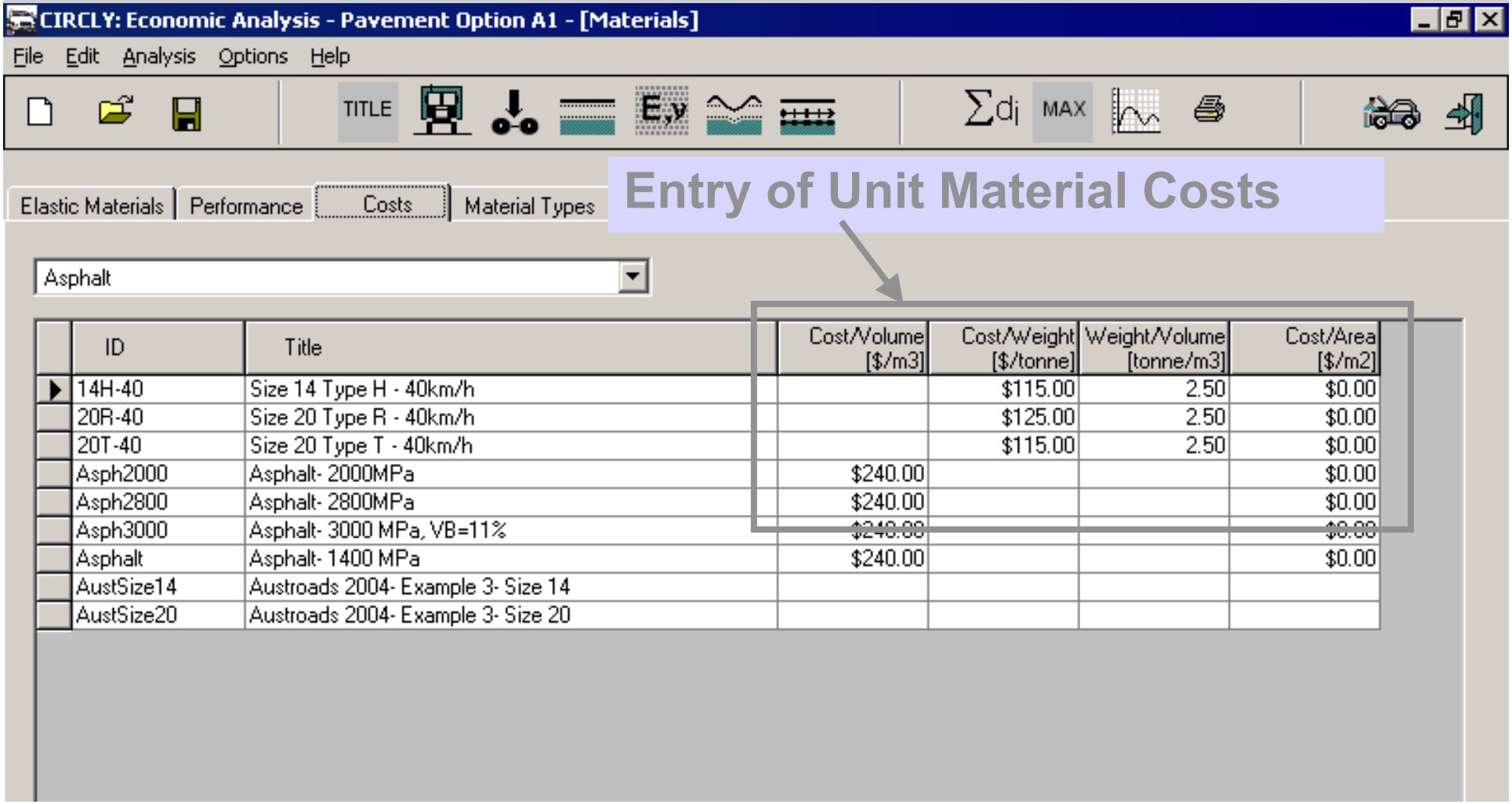
Automatic Thickness Design



Cost Calculation



Cost Calculation



ID	Title	Cost/Volume [$/m3]	Cost/Weight [$/tonne]	Weight/Volume [tonne/m3]	Cost/Area [$/m2]
14H-40	Size 14 Type H - 40km/h		$115.00	2.50	$0.00
20R-40	Size 20 Type R - 40km/h		$125.00	2.50	$0.00
20T-40	Size 20 Type T - 40km/h		$115.00	2.50	$0.00
Asph2000	Asphalt- 2000MPa	$240.00			$0.00
Asph2800	Asphalt- 2800MPa	$240.00			$0.00
Asph3000	Asphalt- 3000 MPa, VB=11%	$240.00			$0.00
Asphalt	Asphalt- 1400 MPa	$240.00			$0.00
AustSize14	Austroads 2004- Example 3- Size 14				
AustSize20	Austroads 2004- Example 3- Size 20				

Automatic Parametric Analysis

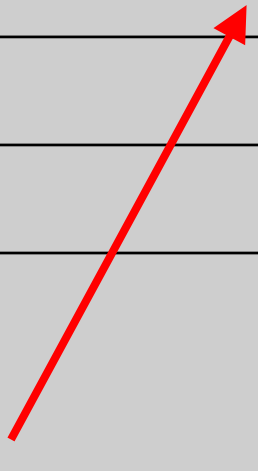
- Automatically loop through one or two thickness ranges
- Simultaneously design the thickness of another layer
- Lets you fine-tune layer thicknesses to minimize construction and maintenance costs

Cost Optimization Example

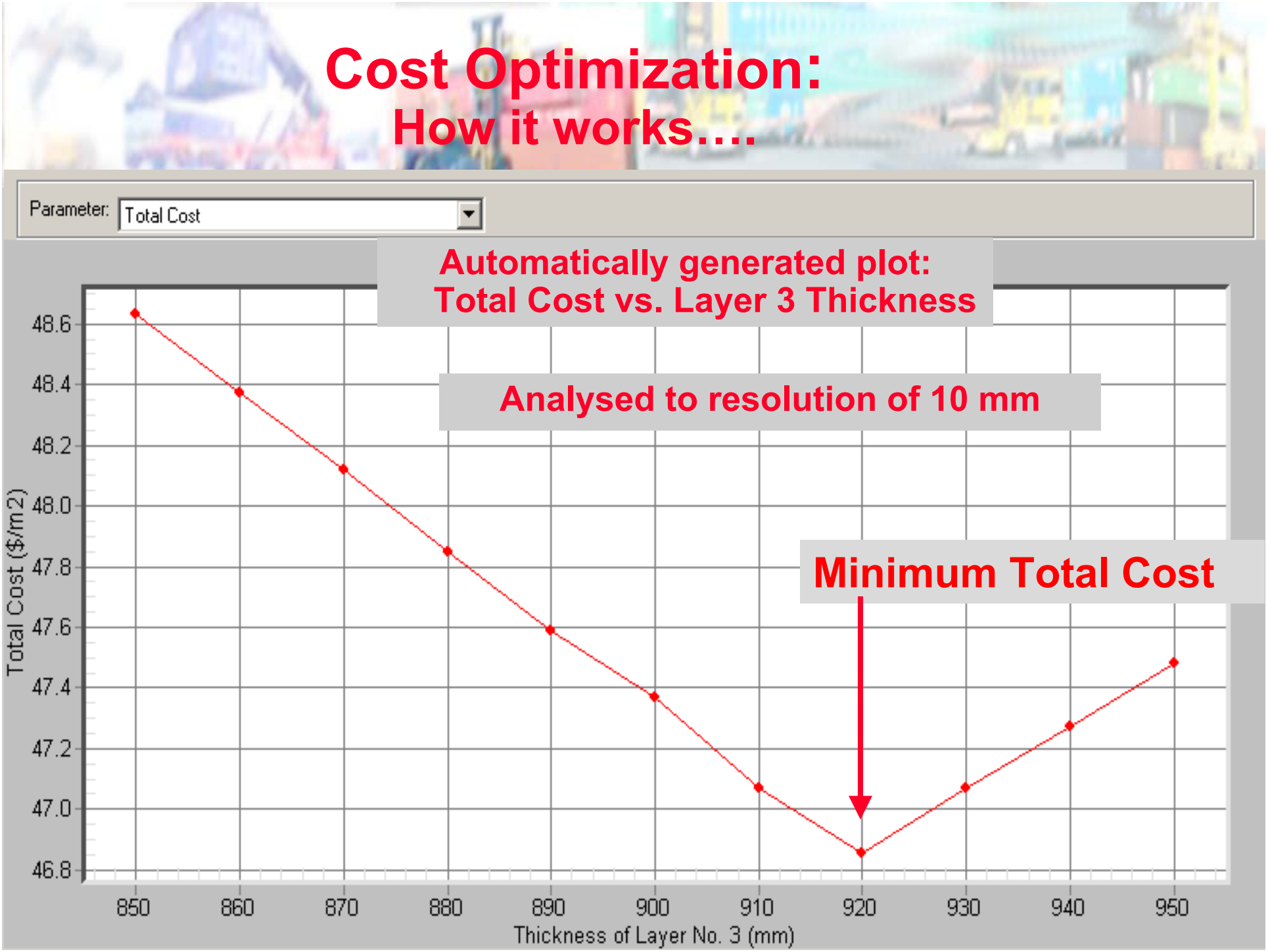
Thickness		Unit Cost
T_1 = 50 mm	Asphalt: Asphalt- 3000 MPa, VB=11%	$240 / m^3
T_2 = ?	Base	$60 / m^3
T_3 = ?	Sub-base	$20 / m^3
	Subgrade, CBR = 6	

Cost Optimization Case Study
Summary of Results

Layer 3 Thickness	Layer 2 Thickness	Max. CDF	Total Cost ($/m^2)
700	445	1.0	52.7
800	368	1.0	50.1
900	289	1.0	47.4
1000	275	1.0	48.5
1100	275	1.0	50.5



Cost Optimization:
How it works….



In summary.....

A complete design system.....

- models actual traffic spectrum
- models all design vehicle loads
- uses multi-layered pavement
- predicts pavement life with user-defined state-of-the-art damage models

HIPAVE - easy to use.....

- complete integrated system
- runs on IBM-compatible PCs
- rapid analysis
- ready-to-use databases for vehicle loading, pavement composition and damage models
- new parameters easily defined
- quality hard copies of results on any printer or plotter

How does HIPAVE differ from CIRCLY and APSDS?

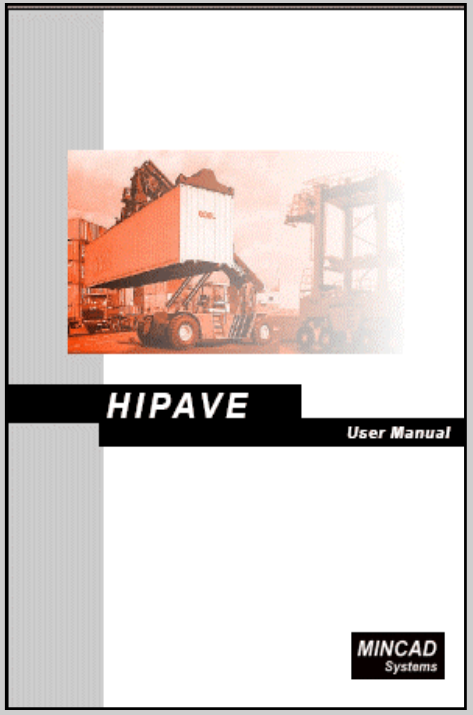
- a comparison of the features of our three pavement design packages….

Feature Comparison

	CIRCLY 5.0	APSDS 4.0	HIPAVE 5.0
Application Profile:	Road pavements-streets, roads, highways	Airport pavements	Container and intermodal terminal pavements
Key Core Features:	no wander	rigorous wander algorithm	rigorous wander algorithm
	parametric analysis		parametric analysis
	economic analysis		economic analysis
	support for 2004 Austroads Pavement Design Guide	Barker-Brabston heavy duty unbound materials	Barker-Brabston heavy duty unbound materials
			Standard Vehicle Library with automatic updates
			Automatic calculation of axle loads from vehicle geometry and container mass
			automatic treatment

New

Technical Support



- Comprehensive 105 page User Manual includes worked examples
- Users are notified of updates
- Latest version can be downloaded from website

HIPAVE

MINCAD Systems

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