

# USING WIM AND FWD DATA TO EVALUATE THE IMPACT OF LOAD RESTRICTIONS ON PAVEMENTS

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# PRESENTATION OUTLINE

- Objective
- Context
- Traffic
  - ESAL evaluation system
  - Reduction of ESAL and load restrictions
- Pavement damage and load restrictions
- Conclusion

# OBJECTIVE

- Operation of WIM weighing stations:
  - ESALs of heavy traffic on the road network
  - Seasonal effects of heavy traffic
- Seasonal damage measured by Falling Weight Deflectometer (FWD) testing
- Impact of load restrictions on pavements

# CONTEXT

- Road network
- Trucking
- Regulation

# ROAD NETWORK

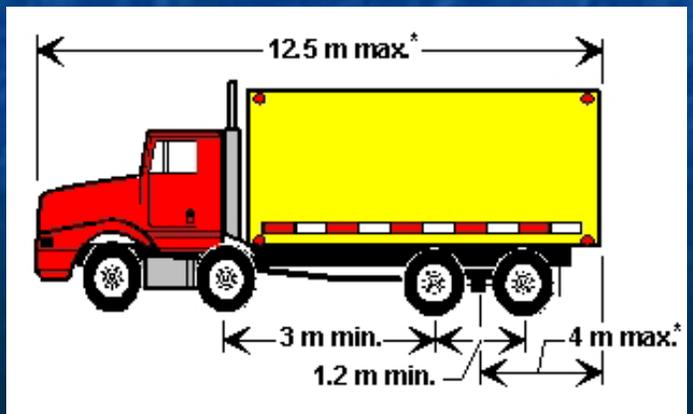
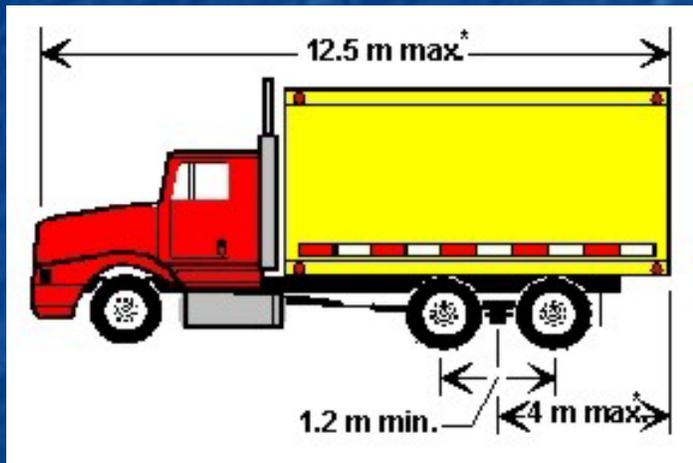
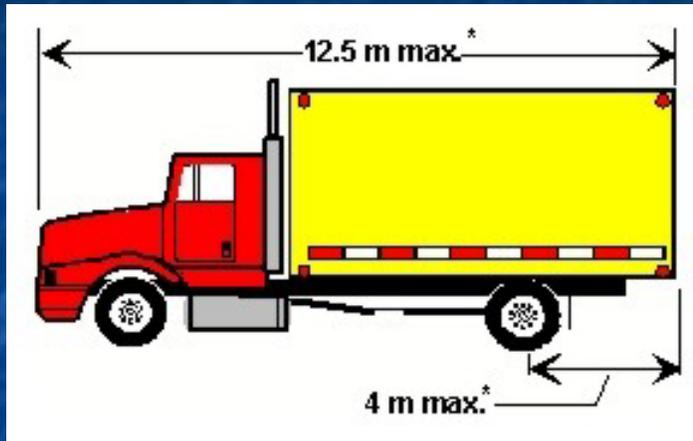
- Superior network composed of 4 classes:
  - autoroutes
  - national highways
  - regional highways
  - collector roads
- Length of 28,000 km in 2-lane equivalent

# TRUCKING

- Fleet: 104,000 units in 1997
- Average distance travelled/ HV: 53,000 km
- Average gros weight/ HV : 23,000 kg

# REGULATION

## LOAD LIMITS



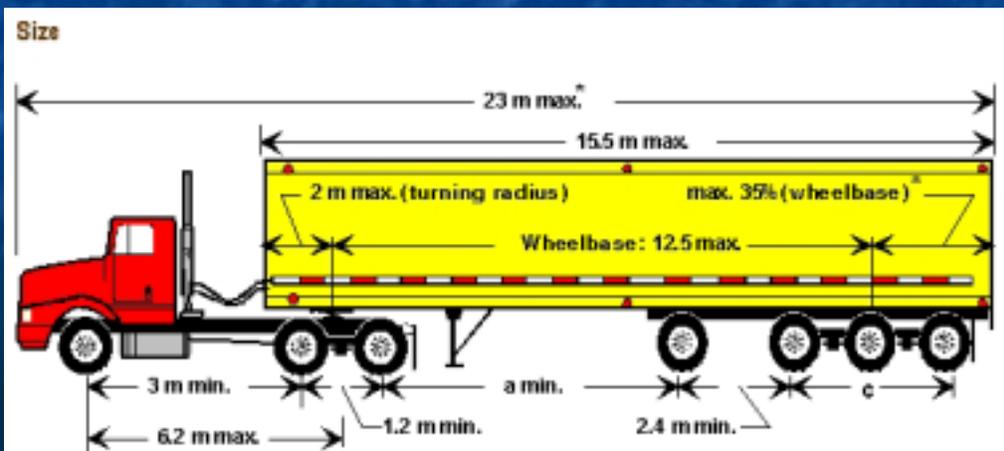
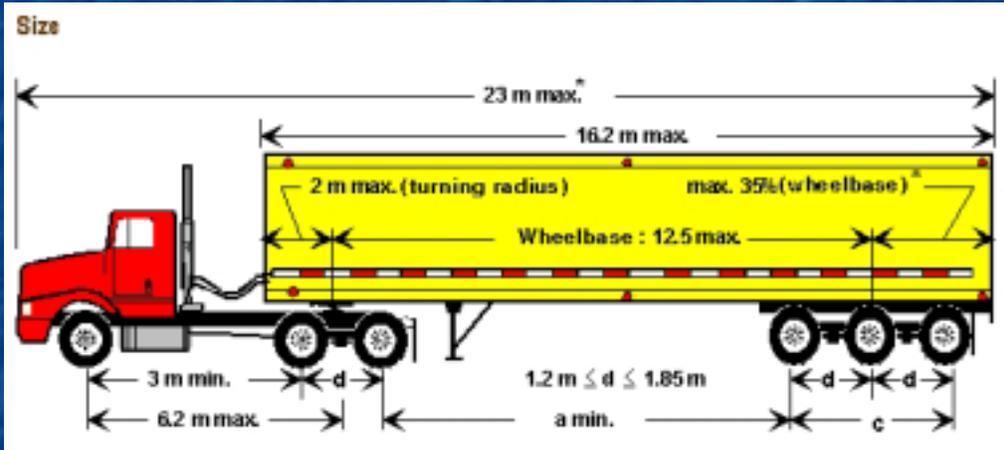
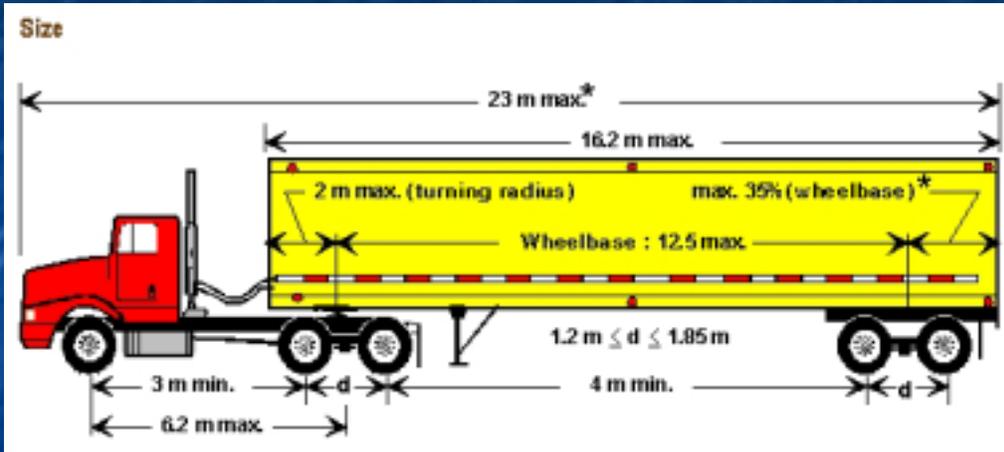
Périod	Gross vehicle weight
Normal	17 250 kg
Thaw	15 250 kg

Périod	Gross vehicle weight
Normal	25 250 kg
Thaw	22 750 kg

Périod	Gross vehicle weight
Normal	32 000 kg
Thaw	29 500 kg

# REGULATION

## LOAD LIMITS



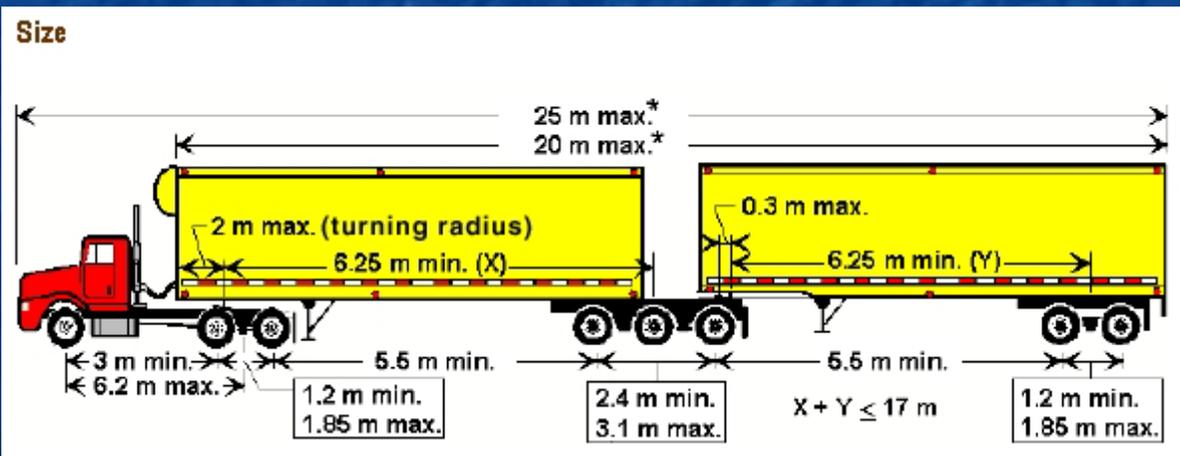
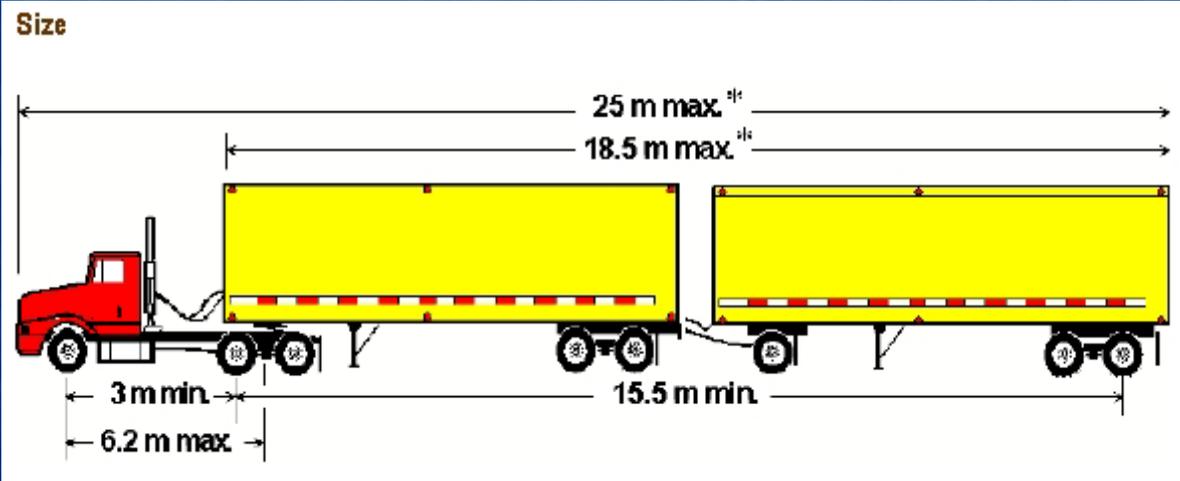
Périod	Gross vehicle weight
Normal	41 500 kg
Thaw	36 500 kg

Périod	Gross vehicle weight
Normal	49 500 kg
Thaw	43 000 kg

Périod	Gross vehicle weight
Normal	55 500 kg
Thaw	51 000 kg

# REGULATION

## LOAD LIMITS



Périod	Gross vehicle weight
Normal	53 500 kg
Thaw	53 500 kg

Périod	Gross vehicle weight
Normal	62 500 kg
Thaw	58 500 kg

# TRAFFIC

- Traffic plan
  - équipement
- ESAL evaluation system

# TRAFFIC PLAN

## Equipement

- Network of counting and classification stations
  - 3,500 permanent and temporary stations
- weighing stations in operation: 10, approx.
- 1998-1999 data from four stations:
  - **Scott-Jonction, Donnacona, Batiscan, Champlain**

# ESAL EVALUATION SYSTEM

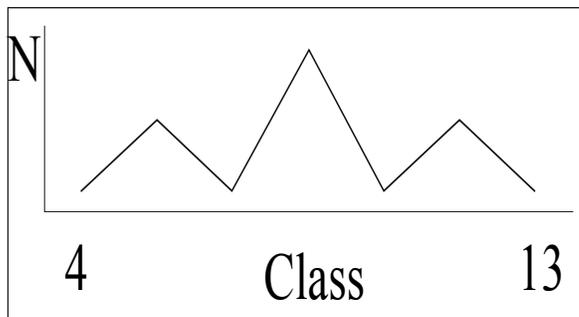
- Principle
- Description of the ESAL Evaluation System
- ESAL Reduction vs. Load Restriction Periods

# PRINCIPLE

- $ESAL = f(\text{number}, \text{mass}, \text{TF})$ 
  - TF: Truck Factor
- Action of HV according to three components
  - daily distribution or frequency of passage (N)
  - daily loading profile (Mass)
  - daily truck factor of HV according to its mass

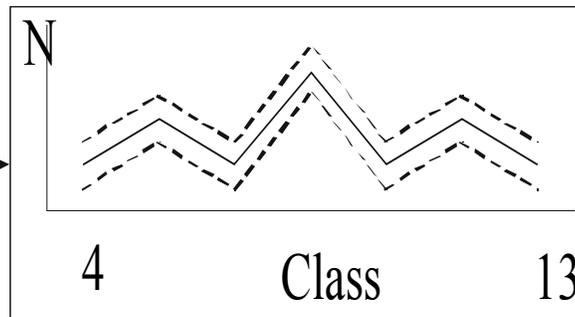
# DESCRIPTION OF ESAL EVALUATION SYSTEM

Distribution of HV classes on a site



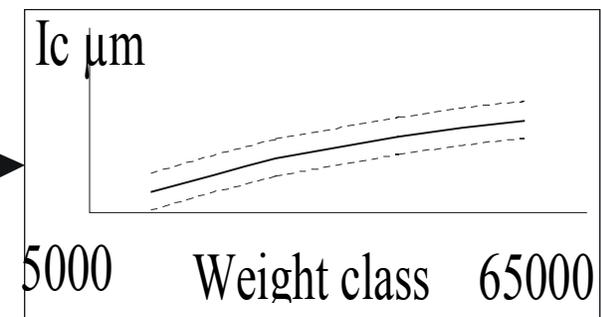
Graph 1

SHRP distribution model of HV classes on a site



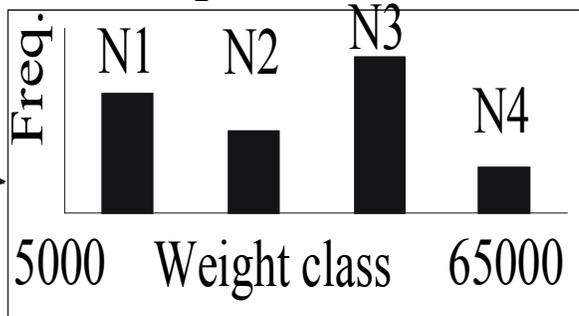
Graph 2

Associated loading profile (by weight class)



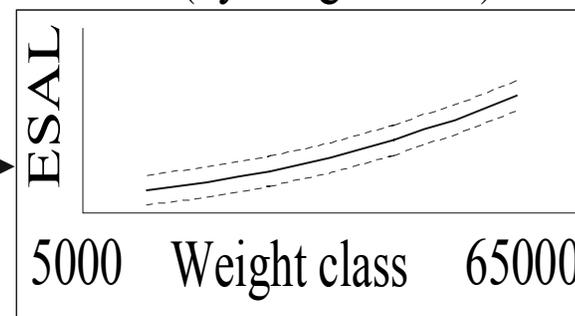
Graph 3

Frequency curve by weight class at a site



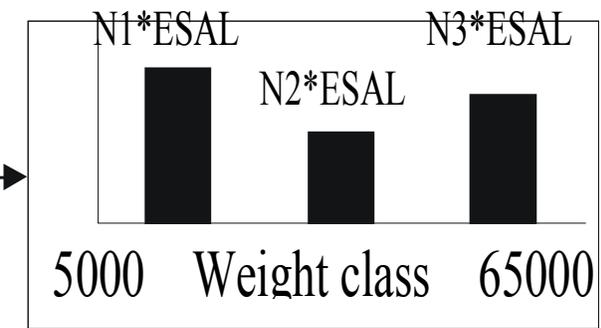
Graph 4

ESAL-Gross Weight Model (by weight class)



Graph 5

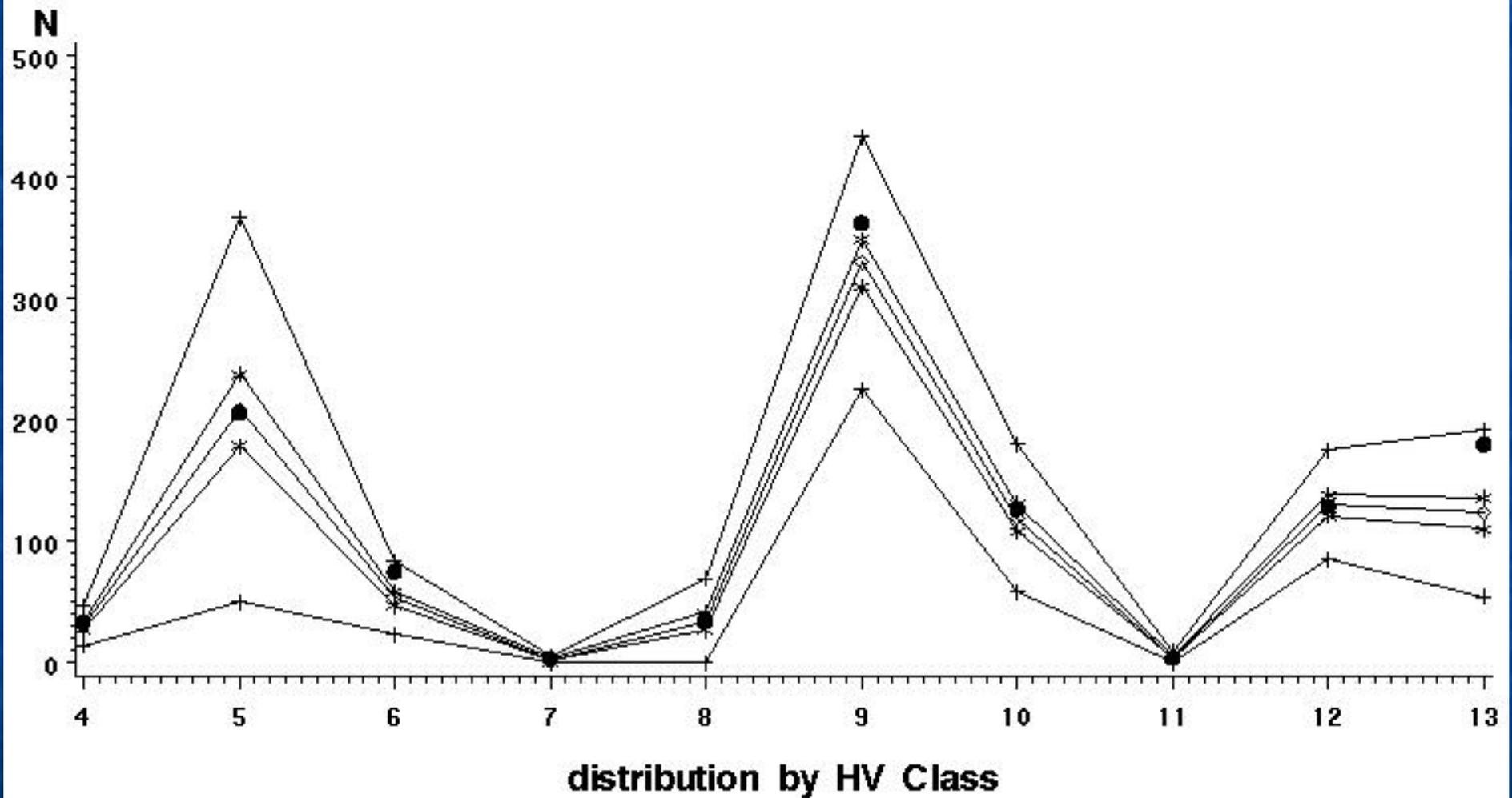
ESALs at a site



Graph 6

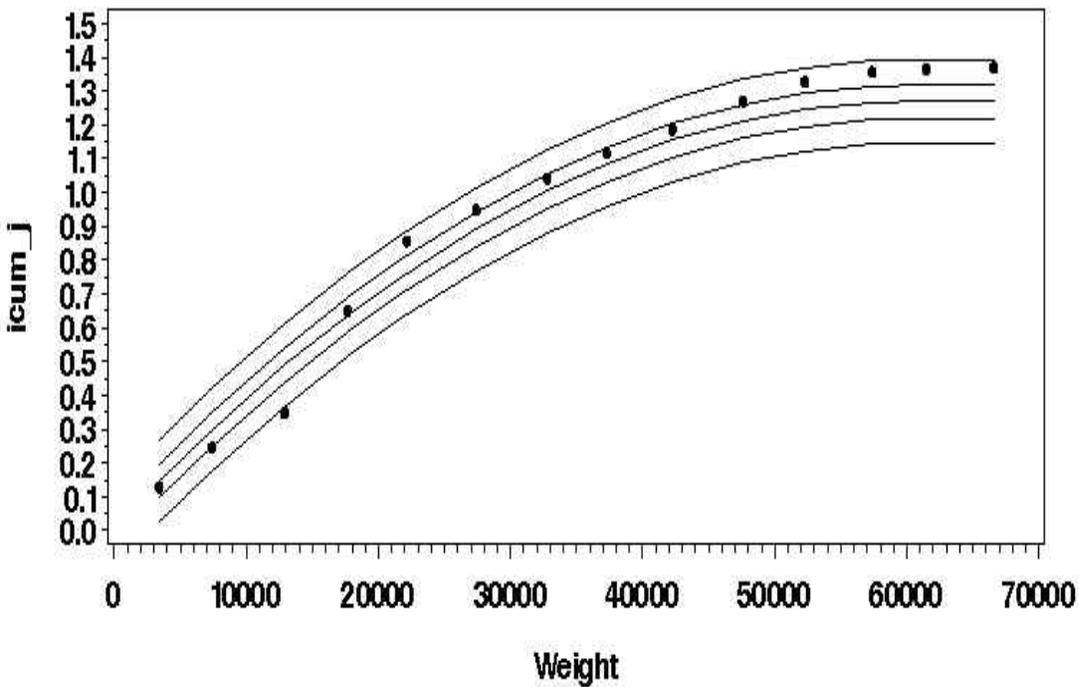
# DISTRIBUTION BY HV CLASS

Champlain lane= 1, on 1998 5 26 , day no. no.3



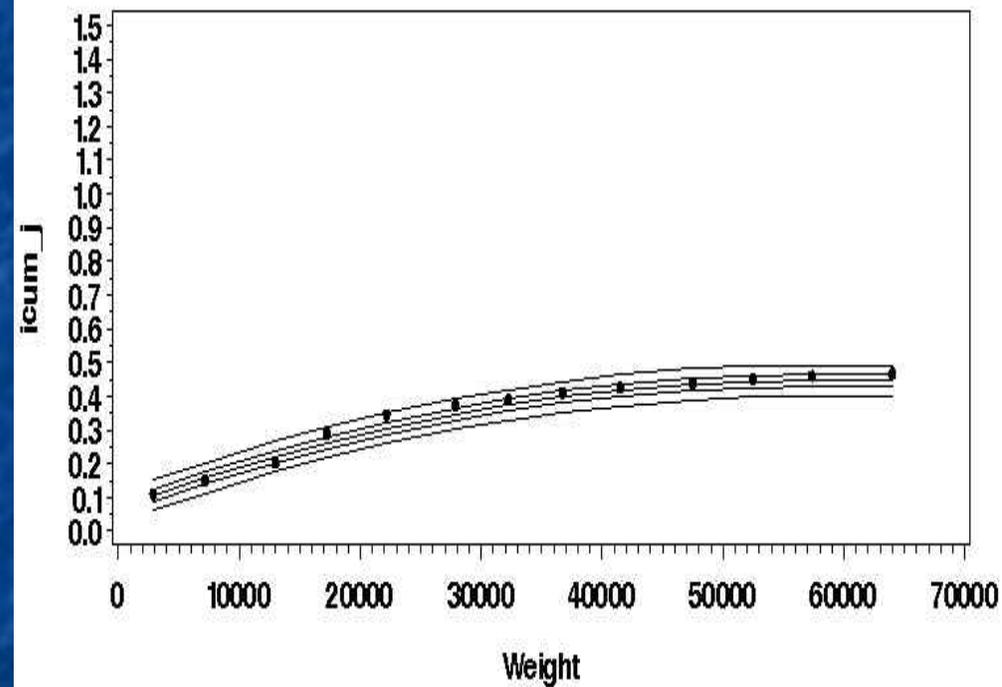
# LOADING PROFILE

Weight distribution: Champlain



Lane= 1 date : Tuesday, May 5, 1998

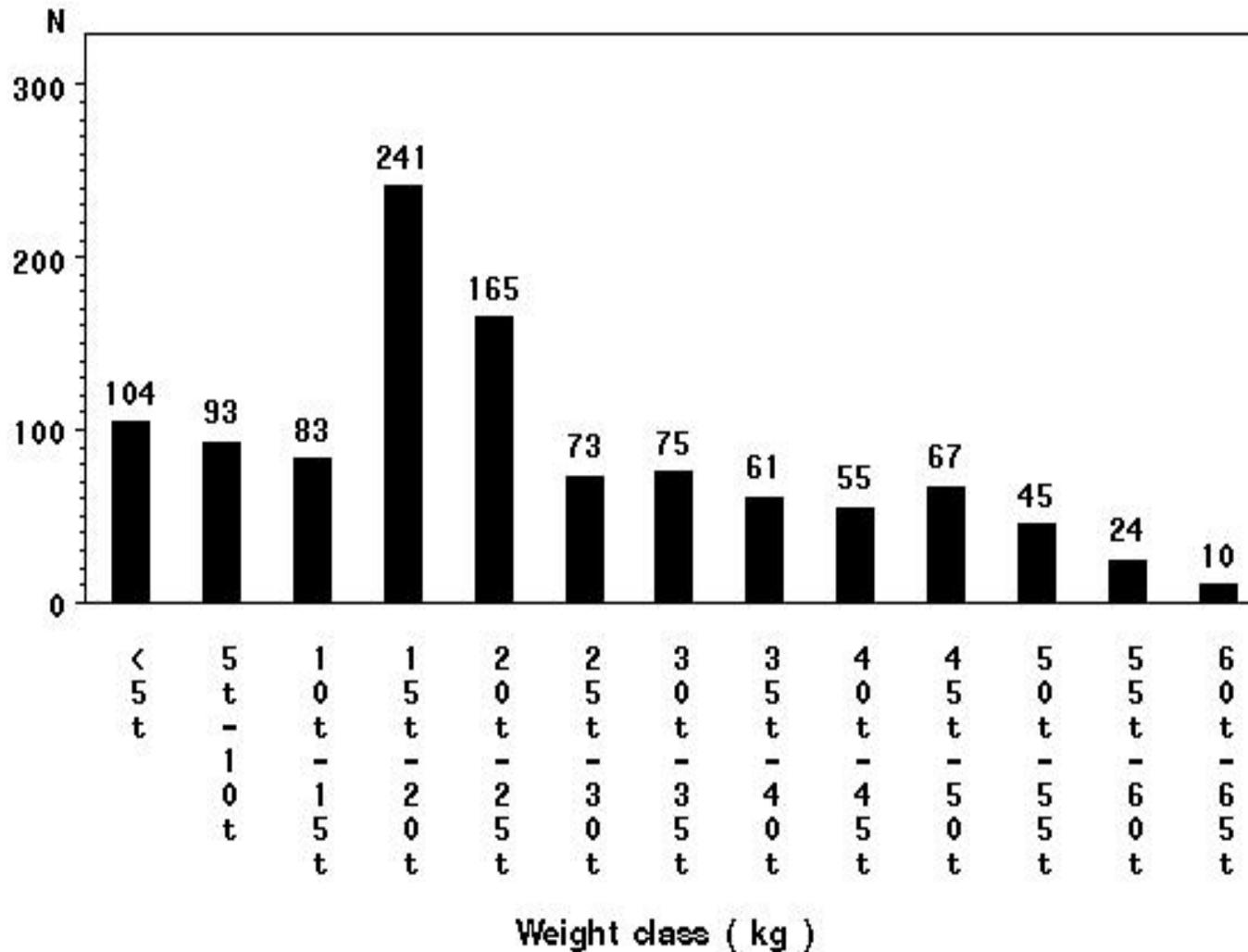
Weight distribution: Champlain



Lane= 1 date : Saturday, November 14, 1998

# FREQUENCY HISTOGRAM

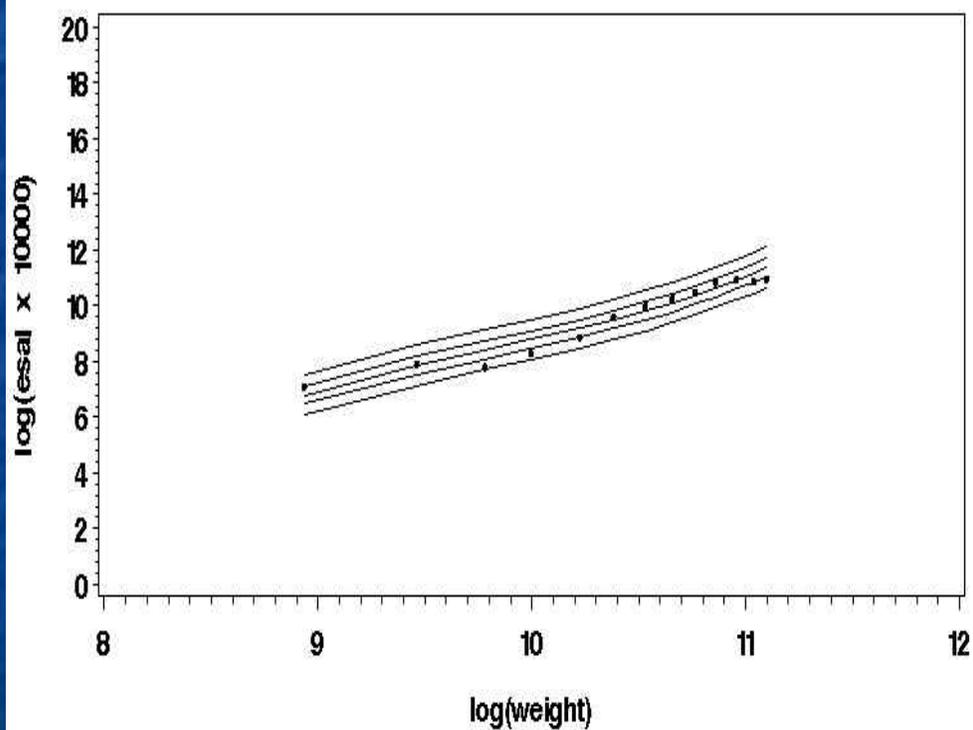
Champlain lane= 1 Tuesday May 5, 1998



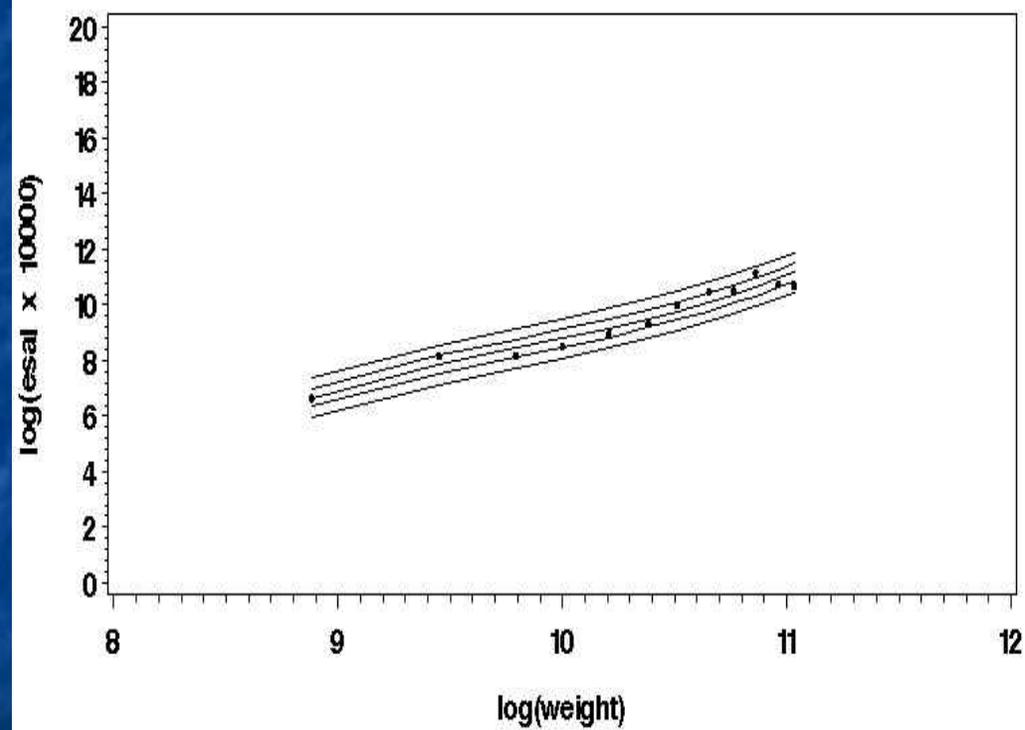
Frequency histogram

# ESALS VS. GROSS WEIGHT

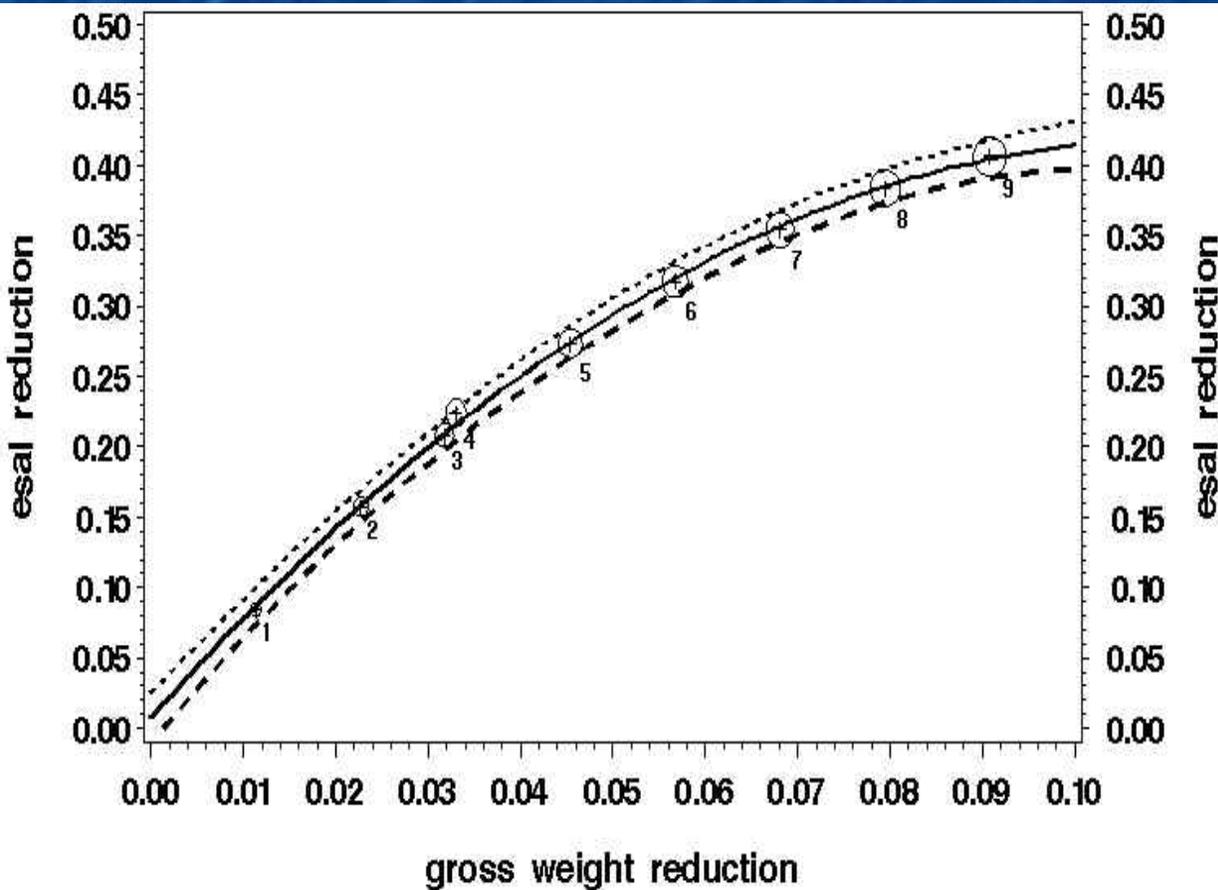
ESAL: Champlain Wednesday, August 26, 1998



ESAL: Champlain Saturday, August 22, 1998



# ESALs REDUCTION VS. LOAD RESTRICTION



$$\Delta \text{ESAL}_{\text{ST}} = \Delta_n + (1 - \Delta_n) \Delta_e$$

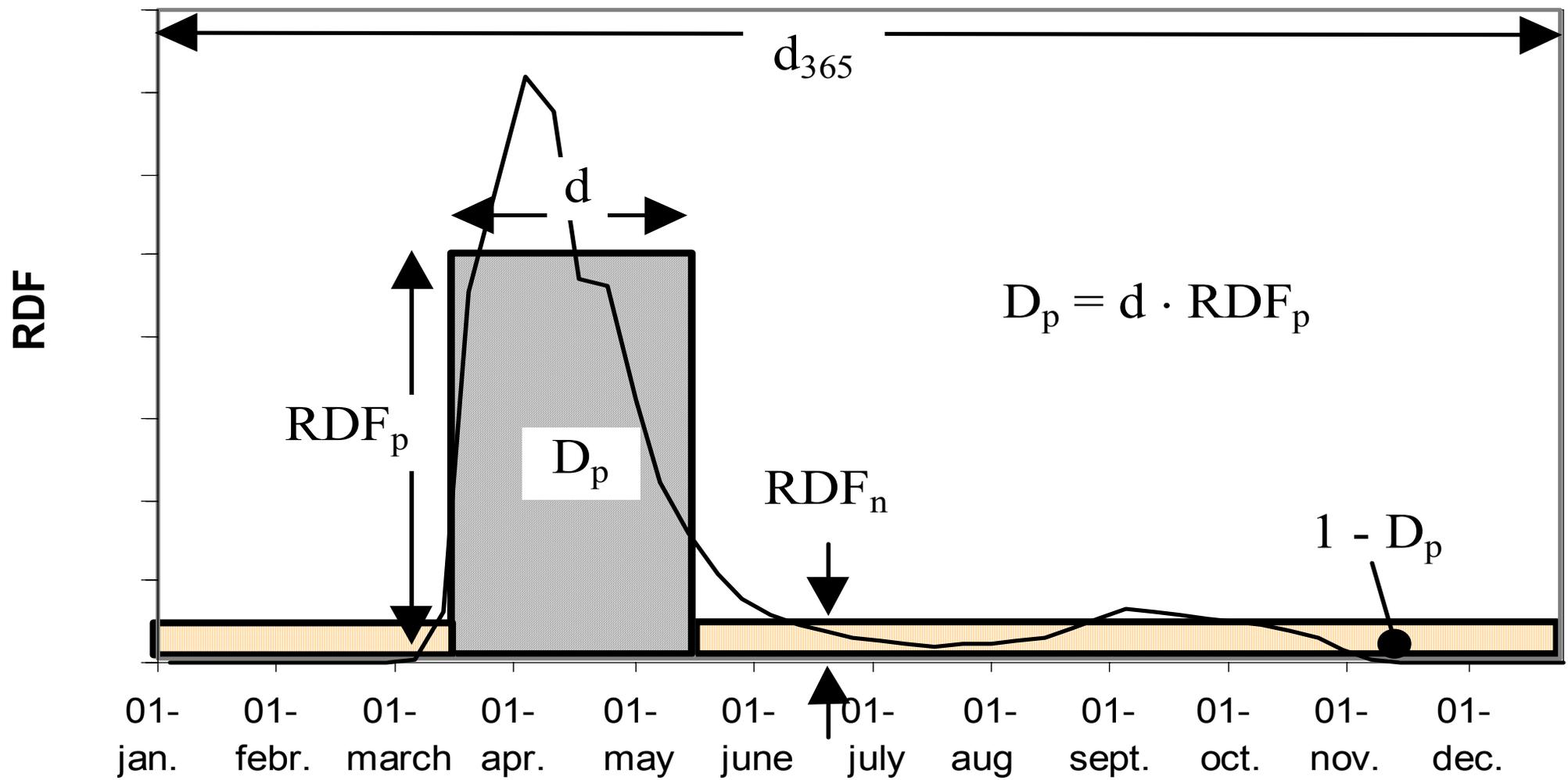
$\Delta \text{ESAL}_{\text{ST}} > 0$  : pavements are protected

$\Delta \text{ESAL}_{\text{ST}} = 0$  : no loss or gain in pavement performance

$\Delta \text{ESAL}_{\text{ST}} < 0$  : pavements are not protected

$$\Delta_e = 7.15 \times 10^{-3} + 7.41 \times \Delta_{\text{gw}} - 33.41 \times (\Delta_{\text{gw}})^2$$

# PAVEMENT DAMAGE AND LOAD RESTRICTIONS



**$D_p$  ranges from 0,3 to 0,85**

# PAVEMENT DAMAGE AND LOAD RESTRICTIONS

## Pavement life adjustment ratio

$$R_1 = \frac{\text{Life for a given scenario (years)}}{\text{Life for a uniform annual traffic (years)}}$$

$$R_1 = 1 / (D_p (R_{\text{ESALs}} - 1) + 1)$$

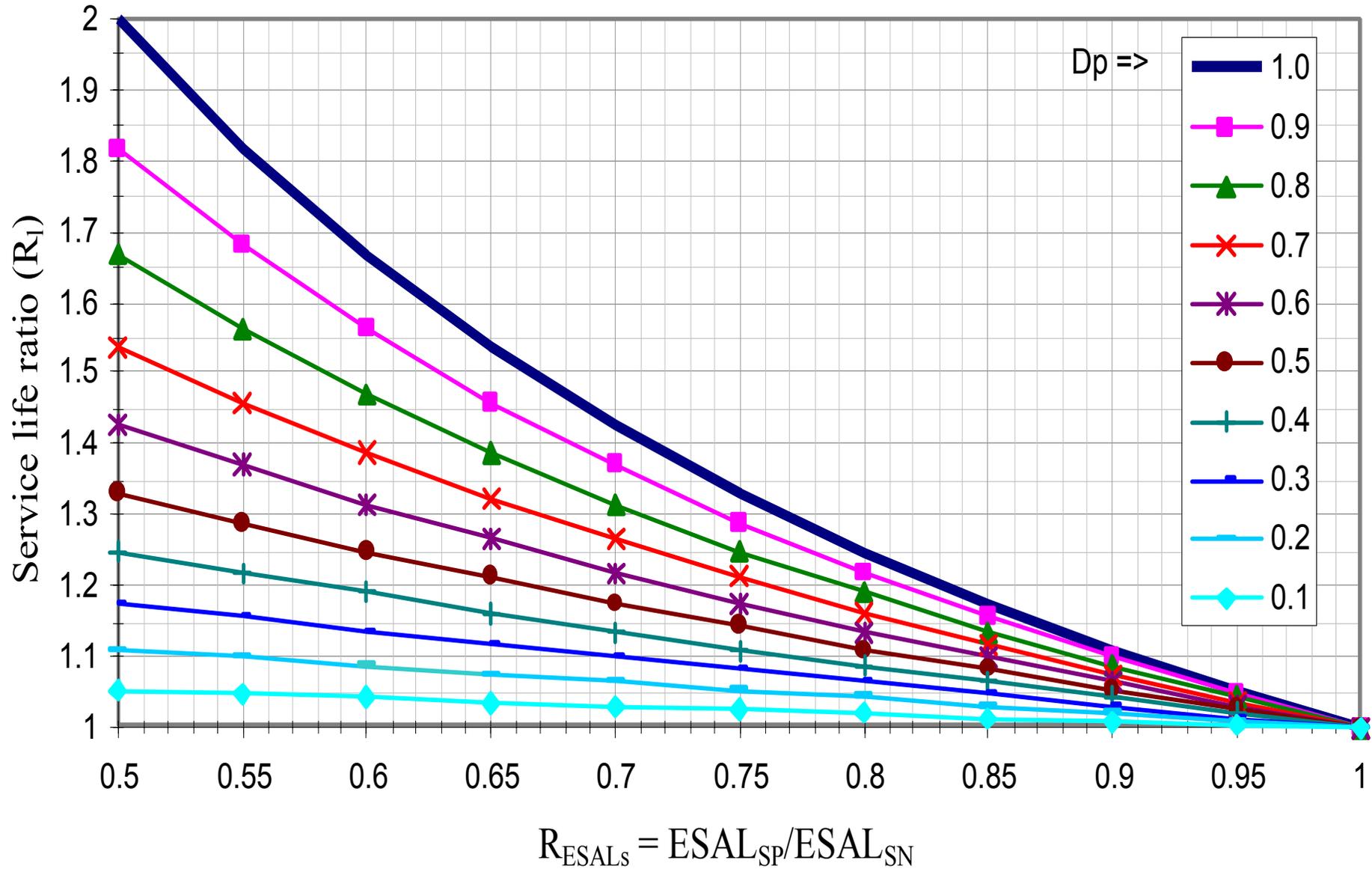
$R_{\text{ESALs}} = \text{ESAL}_{\text{sp}} / \text{ESAL}_{\text{sn}} = 1 - \Delta\text{ESAL}_{\text{ST}}$ : the ratio  
of daily ESALs during the load restriction  
to daily ESALs at other times

# PAVEMENT DAMAGE AND LOAD RESTRICTIONS

**Selected  $D_p$  and obtained  $R_1$   
by type of road**

	<b>AUTO</b>	<b>NAT</b>	<b>REG</b>	<b>COL</b>
<b><math>R_{ESAL\ SQ}</math></b>	<b>0.60</b>	<b>0.60</b>	<b>0.60</b>	<b>0.60</b>
<b><math>R_{ESAL\ WR}</math></b>	<b>0.715</b>	<b>0.715</b>	<b>0.715</b>	<b>0.715</b>
<b><math>D_p</math></b>	<b>0.30</b>	<b>0.48</b>	<b>0.69</b>	<b>0.76</b>
<b><math>R_1\ SQ</math></b>	<b>1.14</b>	<b>1.24</b>	<b>1.38</b>	<b>1.44</b>
<b><math>R_1\ WR</math></b>	<b>1.10</b>	<b>1.16</b>	<b>1.25</b>	<b>1.28</b>

# PAVEMENT DAMAGE AND LOAD RESTRICTIONS



# CONCLUSION

- Many modes of traffic loading carried by road network can be represented
- Seasonal effect on typical Truck Factor due to load restrictions is determined
- Generalised ESAL reduction equation allows to evaluate effectiveness of load restrictions on pavement service life

## FINALLY

Combination of WIM and FWD Data allowed to evaluate impact of load restrictions on pavement service life

**THANKS YOU**

**FOR**

**YOUR ATTENTION**

