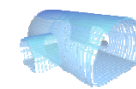
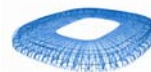


# Traffic Loads on Bridges

## Influence Line Method and Load Stepping Method

Karl Burgmann, Traffic Loads on Bridges



# AGENDA

## SOFiLOAD-V

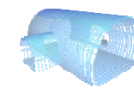
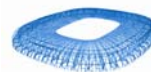
Live loads / train loading for bridges

## MAXIMA

Superposition of train loads at distinct positions

## ELLA

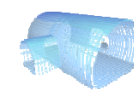
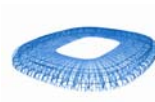
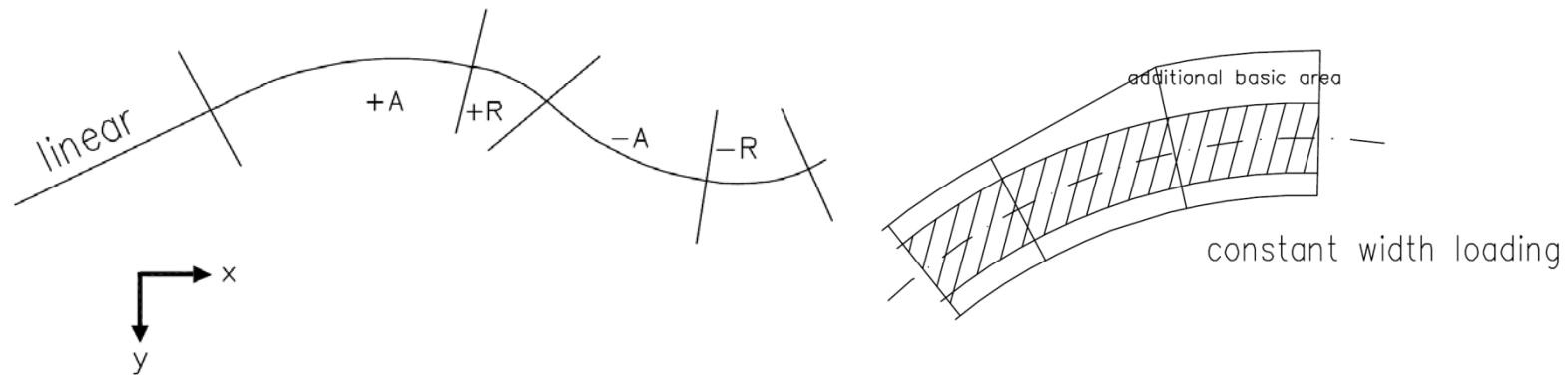
Extended Live Load Analysis with influence lines and surfaces



# SOFiLOAD-V

## Load Trains for Highway and Railway Bridges

- Base of the moving load process is an AXIS: record ,GAX'
- Alignment elements: straight, circular or clothoid segments
- up to nine separate lanes: 'LANE'
- effective length for dynamic coefficients, extra width of the traffic area



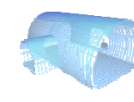
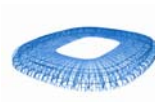
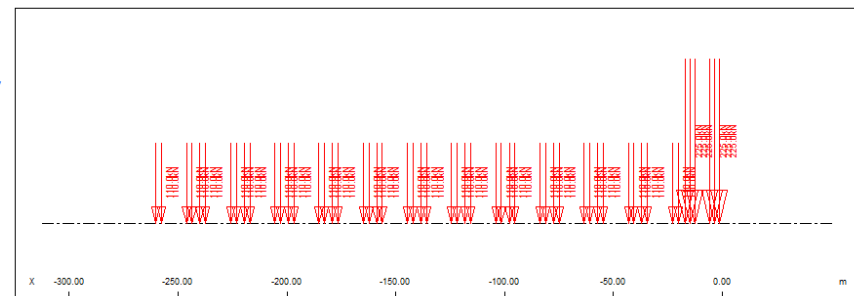
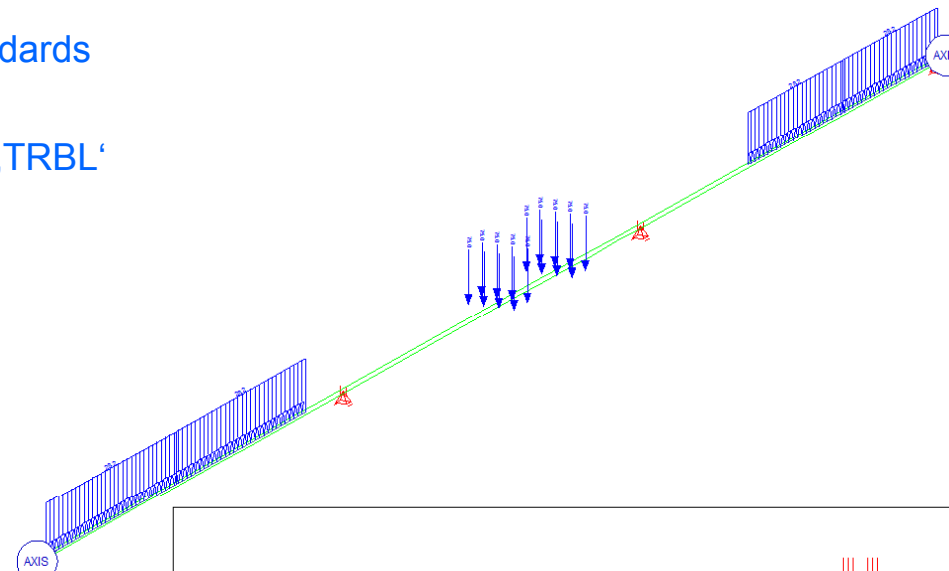
# SOFiLOAD-V

Library for Load Trains of different standards

Load train definition 'TRAI'

Explicit loading of a load train: ',TRPL', ',TRBL'

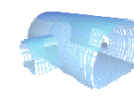
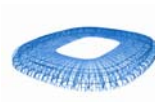
- Vertical loading UDL
- Vertical loading KEL
- Loading on spare areas
- Brake load
- Wind loading
- Centrifugal load
- explicit impact coefficient for bending and shear
- Lane width
- Speed of Load Train



# Problem?

## Finding out the most unfavourable load position:

- An approach can be the generation of numerous load cases with the train loads at distinct positions and search for the maximum with the superposition tool MAXIMA.
- Another one is to establish the influence lines for the forces and moments of all or selected locations within the structure, these influence lines may be evaluated with the load trains.
- Last but not least a transient analysis of the load coursing the structure with the program DYNA is possible.



# Best Solution?

Depends on the system and the loading.

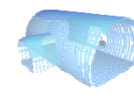
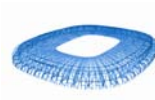
- Load is not bound to the lane in transverse direction,
- or having independent wheels increase the number of needed load cases.

## Discrete load positions

- Vast number of single LC's
- Combination of directions of action might be equivocal
- Engineering mind is actually essential

## Influence Lines and Surfaces

- Black-Box! checks ?
- Nearly unlimited automatism's for the evaluation
- Results from different actions

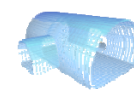
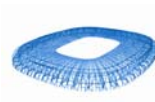


# MAXIMA: Superposition of Load cases

## Proceeding in the Superposition Tool:

- Definition of the geometry-Axis within SOFiLOAD
- Specification of the load train
- Generation of numerous Load cases with a Loop
- Analysis of the Load Cases
- Superposition of the created Load Steps

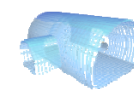
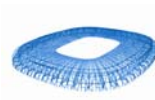
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# ELLA: Extended Live Load Analysis

Proceeding in the Analysis with influence-lines and surfaces:

- Determination of the stiffness matrix (Analysis of one LC, i.e. dlz)
- Definition of the geometry-Axis (within ELLA or SOFiLOAD)
- Division into straight or curved lanes of variable width (EC, EC-X, BS,...)
- Specification of the load train
- Establishing of the influence lines for the forces and moments
- Evaluation with the different load trains.
- Saving and evaluation cases
- Intermediate combination of evaluation cases





# ELLA: Extended Live Load Analysis

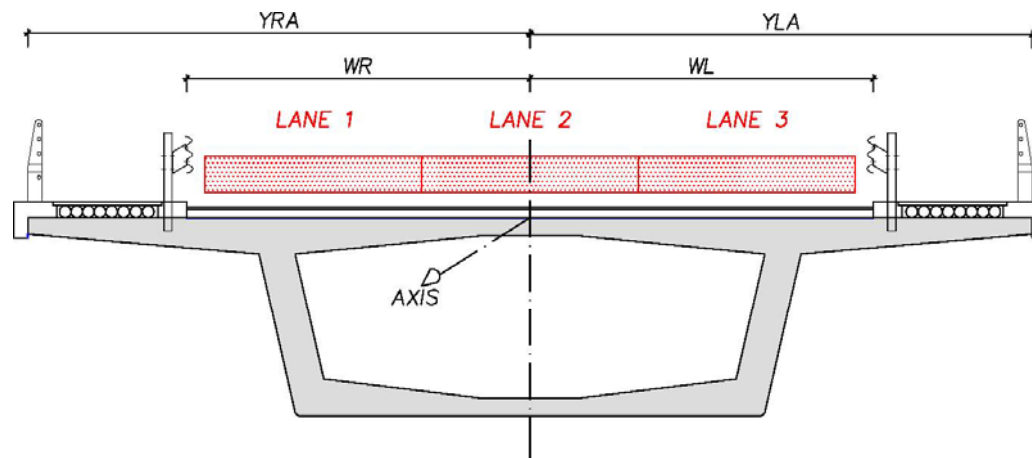
## Highway Bridges

$|w_r| - |w_l| =$  Width between curbs

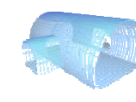
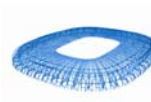
$y_{ra} - y_{la} =$  total width

Automatically Division into lanes according to EC, BS, AS ...

Effective length of region for impact coefficients and loaded length dependencies



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# ELLA: Extended Live Load Analysis

## Railway Bridges

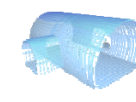
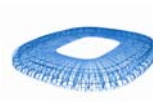
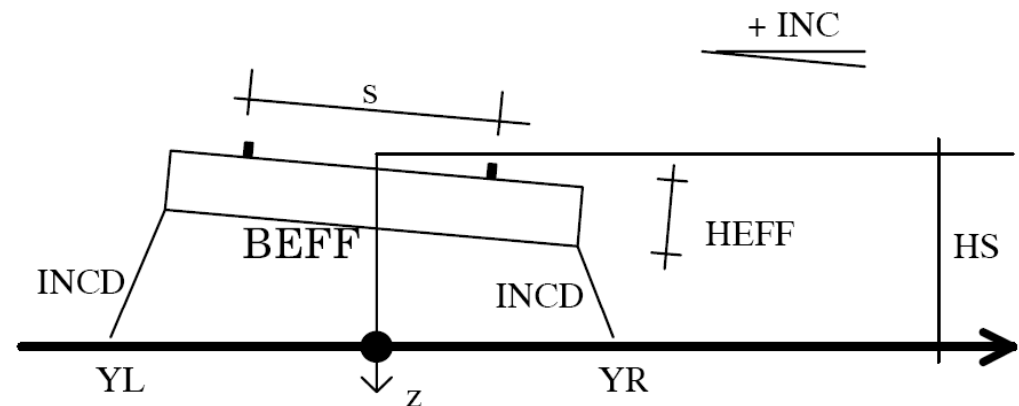
HS - Height of deck or rail above lane

INC - Cross fall

INCD - Spread angle for stresses

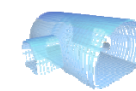
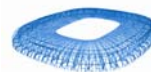
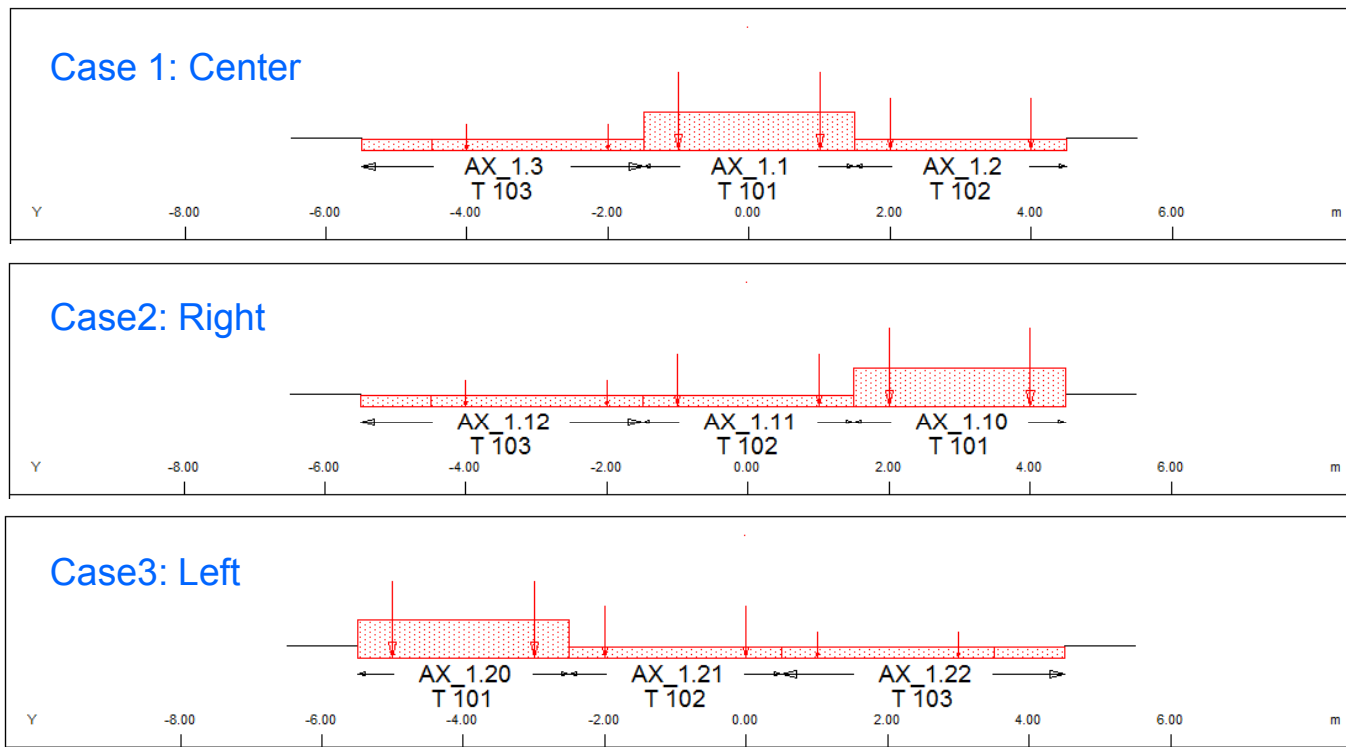
HEFF - Effective height of rail and sleeper /

BEFF - Effective width of sleeper



# ELLA: Extended Live Load Analysis

Example: Automatically division into lanes according to EC

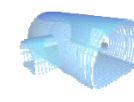
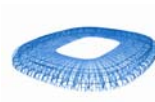


# ELLA: Extended Live Load Analysis

## Evaluation Case – Saving Case

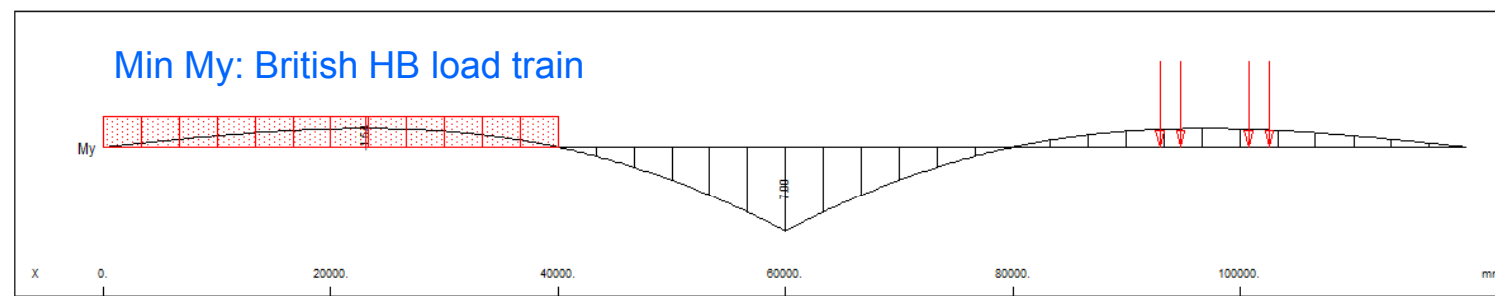
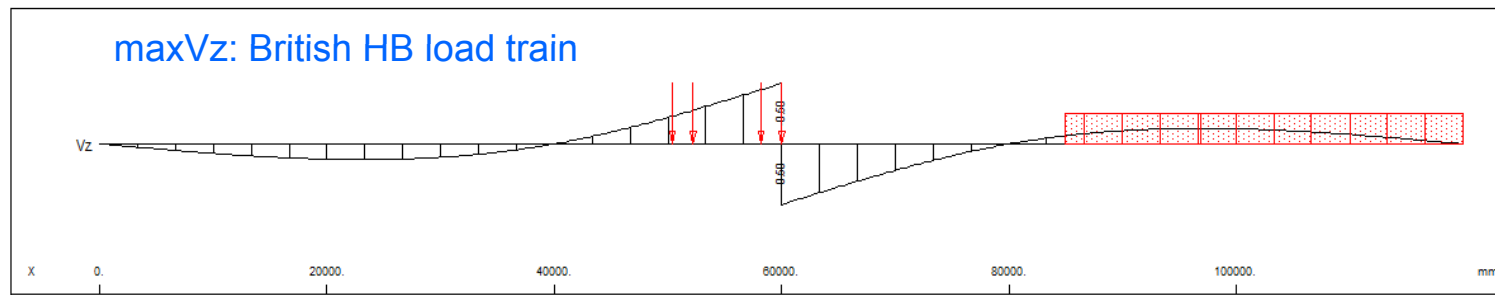
Evaluation options for load groups according to the EC1.

- GR0 = Single vertical loads only
- GRU = only vertical distributed loads (UDL + Residual area)
- GRU0 = only vertical distributed loads within lane (UDL)
- GR1 = Vertical loads (gr1 in Table C1)
- GR2 = Horizontal loads (gr2 in Table C1)
- GR2N = nonfrequent variant of group 2
- GR2F = frequent variant of group 2
- GR2L = only longitudinal loads of group 2
- GR2T = only transverse loads of group 2
- GR20 = only horizontal loads of group 2
- GR6 = Loadings for exchange of supports (gr6 in Table C1)

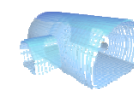
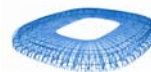


# ELLA: Extended Live Load Analysis

Example: Three-span Girder



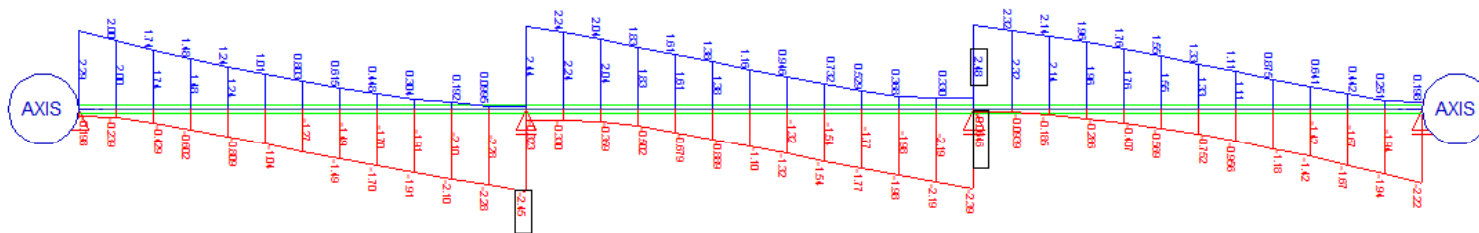
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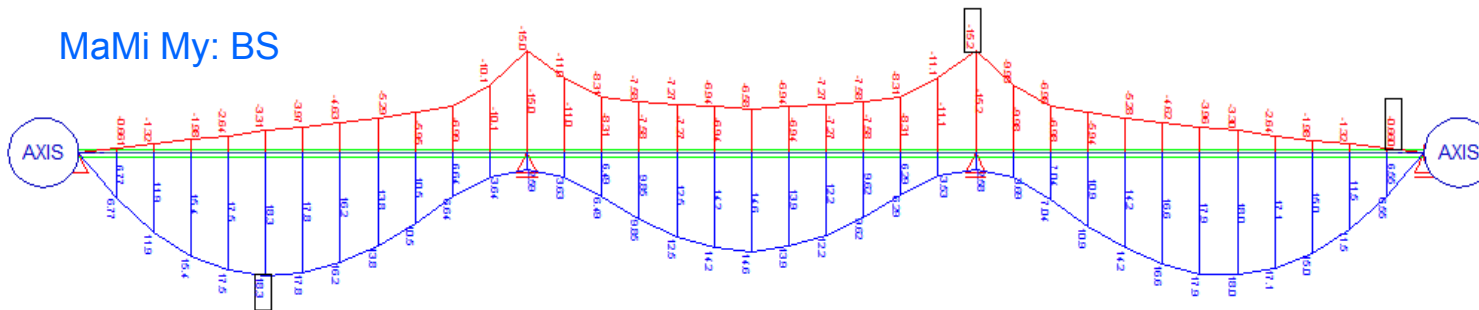
# ELLA: Extended Live Load Analysis

Example: Three-span Girder

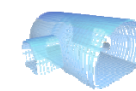
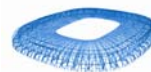
MaMi Vz: BS



MaMi My: BS



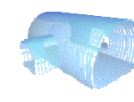
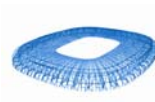
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# DYNA: Transient Analysis

## Proceeding in the Dynamic Analysis

- Definition of the load trains
- Define and convert masses
- Establishing of Eigenvalues and Eigenforms
- Consideration of the damping values in the system
- Specification of the time step
- Simulation of train passing



Thank you for your attention

Karl Burgmann, Traffic Loads on Bridges

