Geotechnical infrastructure – cutting, embankments, landslides and engineered fills.

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Problem – investigating slope failure.

- Slope failures in infrastructure UK and Ireland
- Changing climate conditions – UKCP09

- Ageing infrastructure
- Lack of understanding of the mechanisms of progressive failure

Evesham, floods caused major damage across the south of England (July 2007).

Wicklow, slip causes closure of the Dublin to Rosslare railway line (Nov 2009).

Victorian railway embankments over soft foundations maintaining and stabilising tracks

A joint project sponsored by NIR

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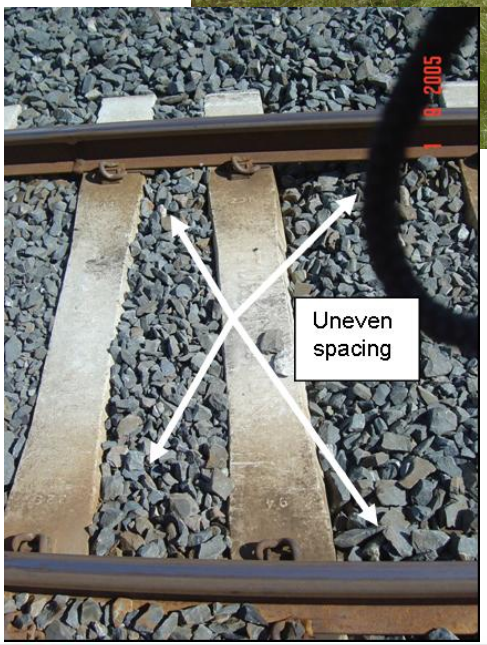
Description of Problem



Problems

- Dynamic movement of the embankment has restricted speed of trains from 90 mph reduced to 60 mph
- Increased maintenance from sleeper movement

Goals

- Reduce dynamic movement and stabilize embankment.
- Increase train speed

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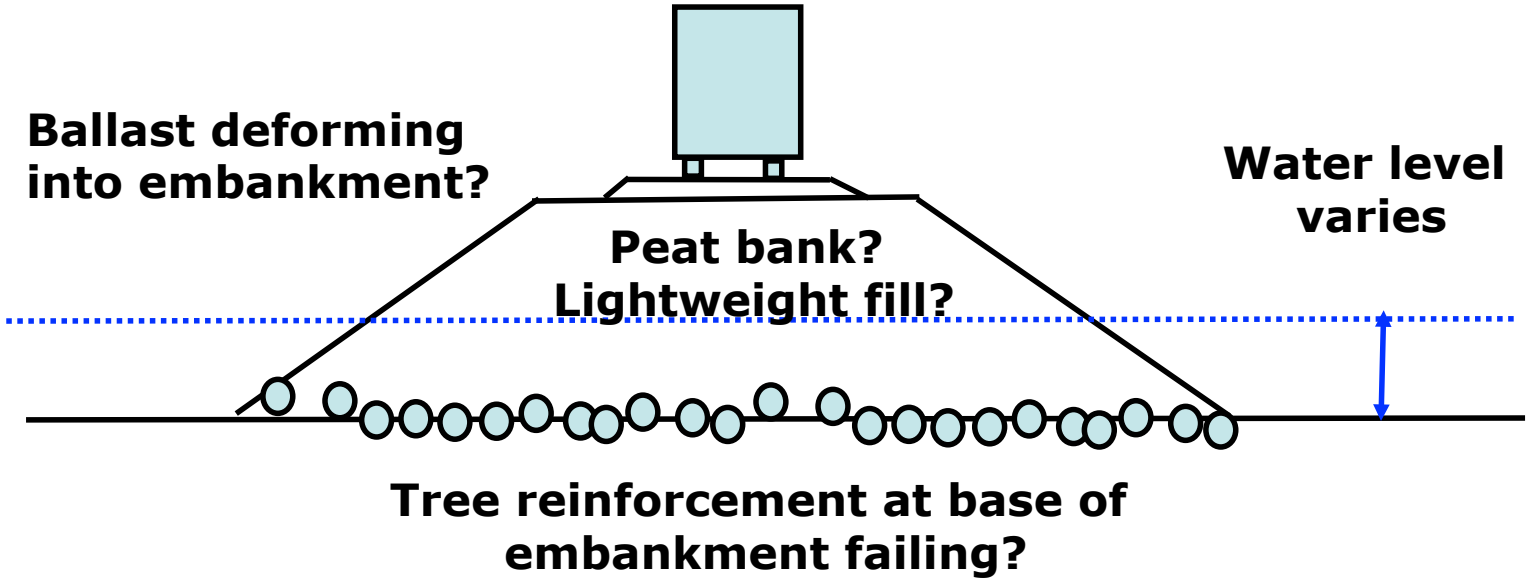
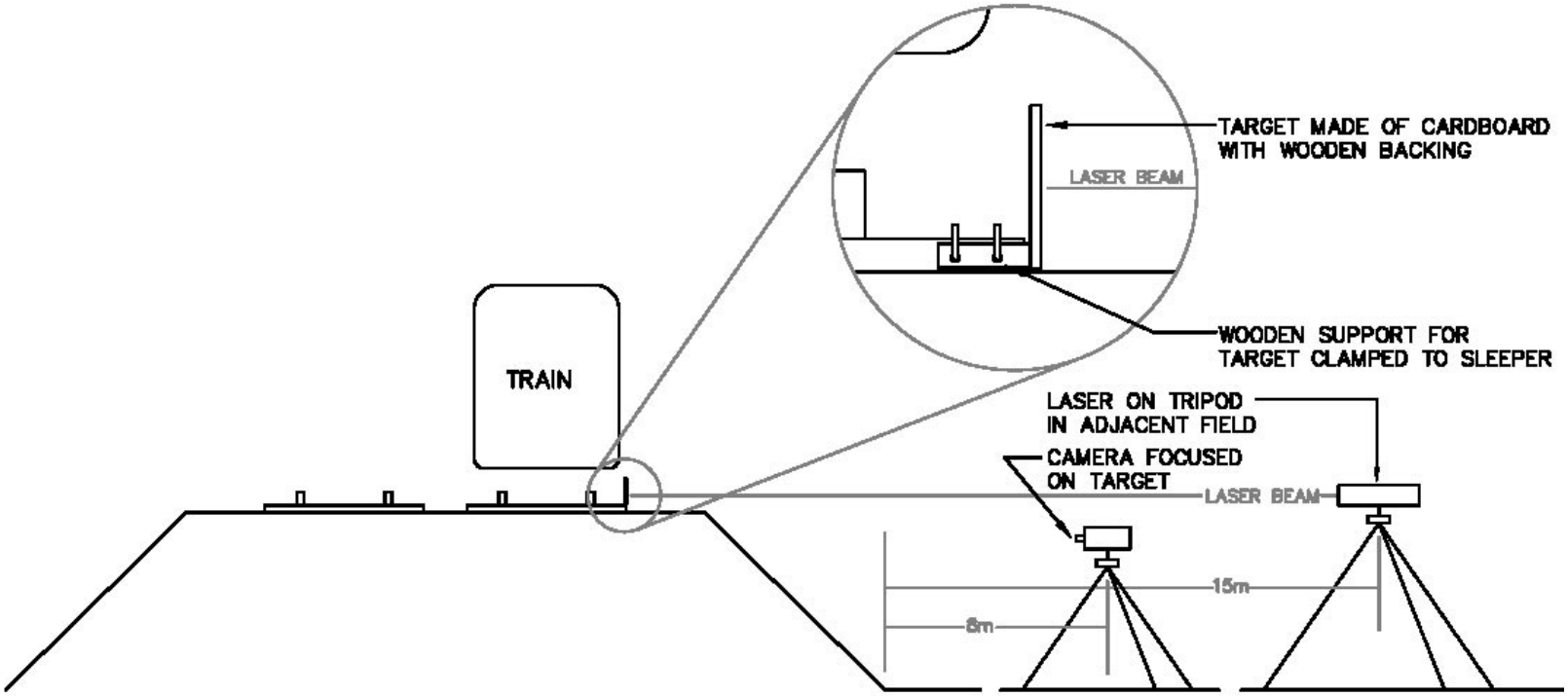
Description of Sites
Monitoring and modelling



Embankments constructed using traditional techniques in 1850's used fascine or log rafts to support the embankment over the soft peat foundations

Preliminary arrangement for Remote Laser to measurement dynamic movement of rail



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Final arrangement using photo sensitive array for dynamic measurements – and auto data acquisition

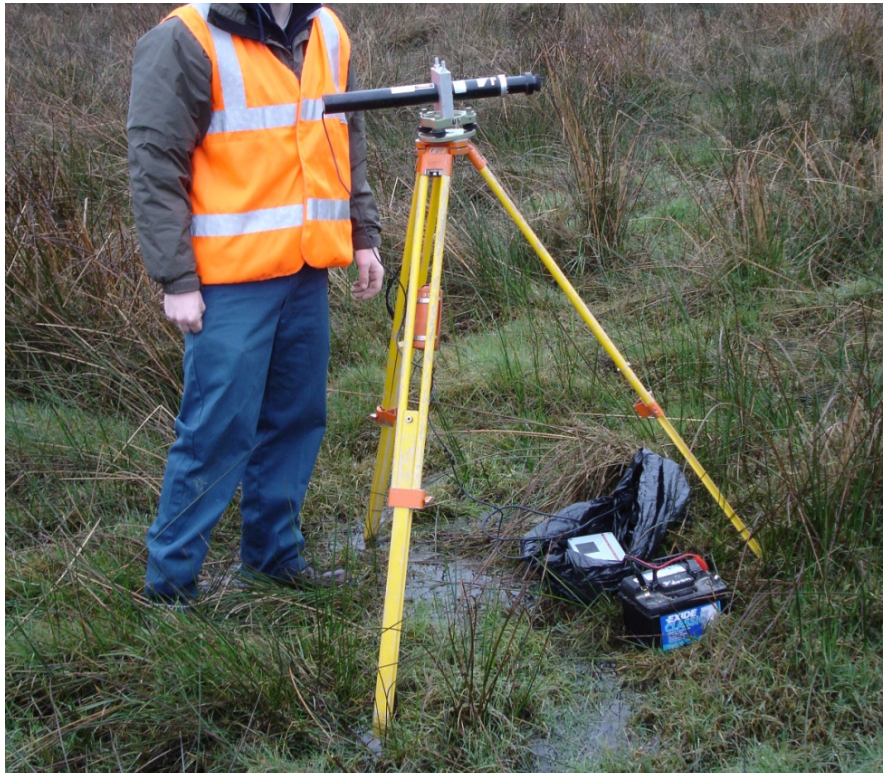

Photo-sensor Array

Laser on tripod

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Preliminary Dynamic Measurements

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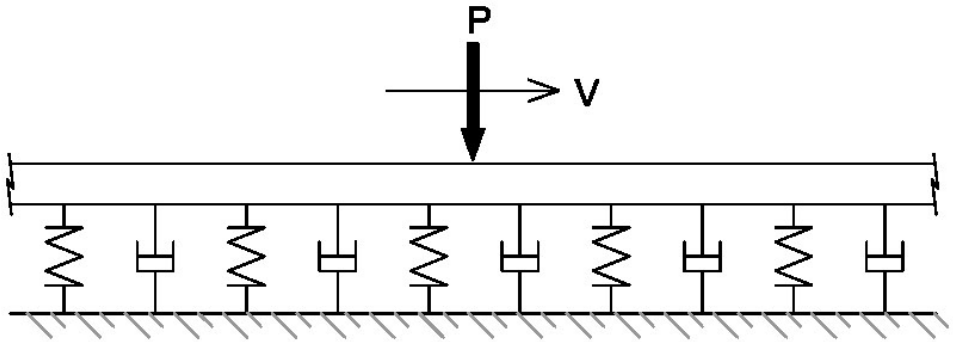
Numerical modelling (Winkler)

Constitutive Model



Beam on visco-elastic foundation

$$EI\frac{\partial^4 y}{\partial x^4}+\rho A\frac{\partial^2 y}{\partial t^2}+c\frac{\partial y}{\partial t}+ky=P\delta(x,t)$$

Approximate solution taken from Frýba (1972)

Modelling Methodology

- EI and ρA terms calculated from embankment construction (using 2 methods)
- k term adjusted to 'fit' magnitude modelled displacement to measured displacements.
- Elastic modulus extracted from model properties

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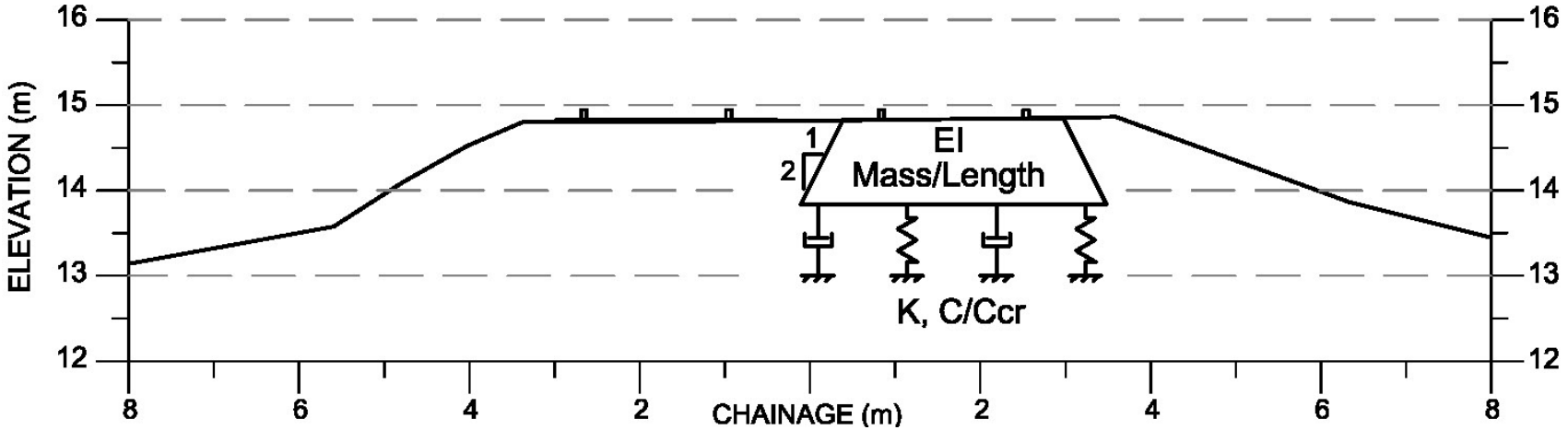
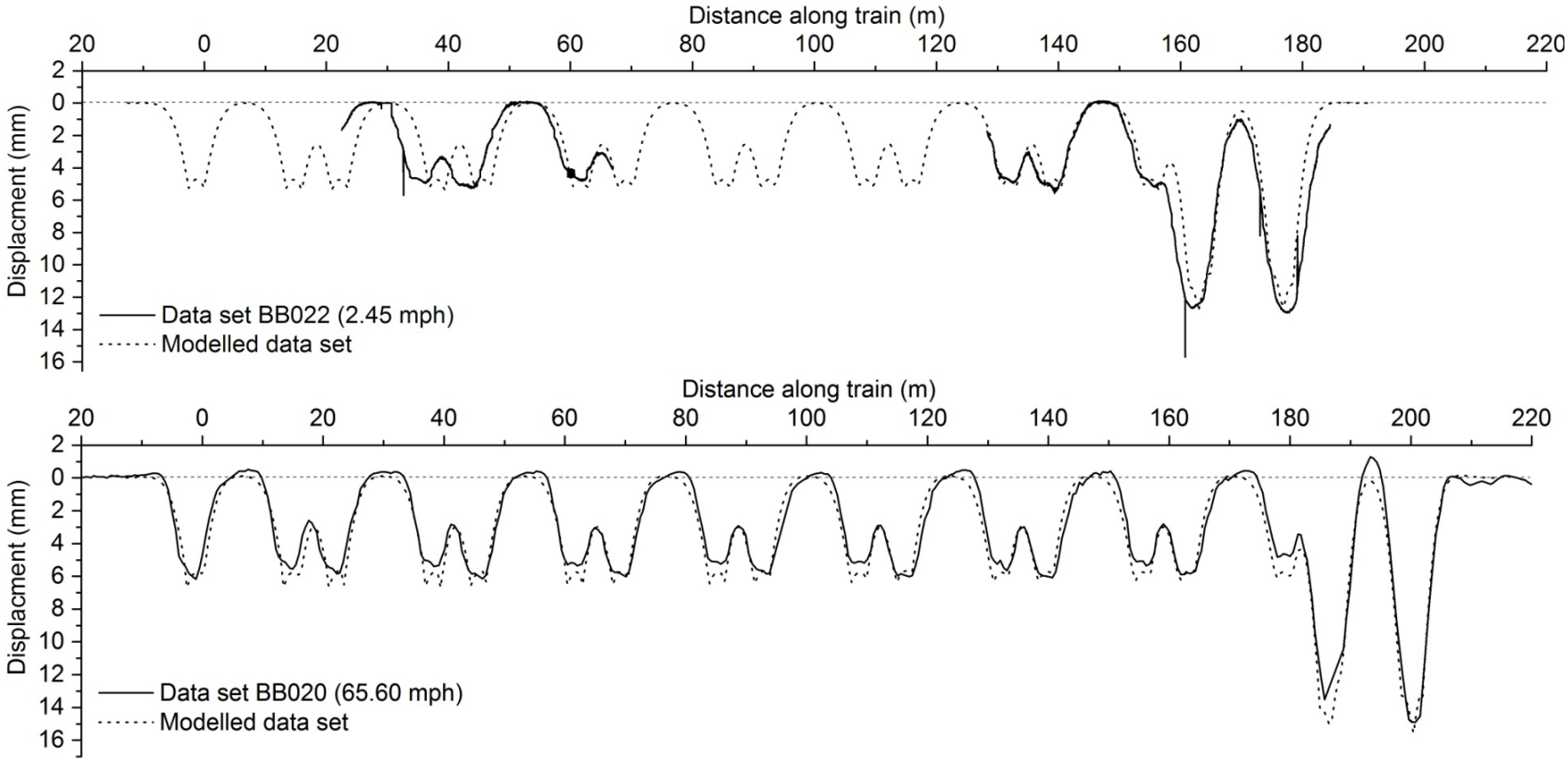
Numerical modelling

Selection of Material Properties



- Beam Element modelled as the Rail, Sleepers and Ballast.
- Visco-Elastic foundation modelled as the poor embankment fill and soft sub-grade.
- EI=80.17 MNm2, ρA=7394kg/m → k=4.28 MPa

Numerical modelling



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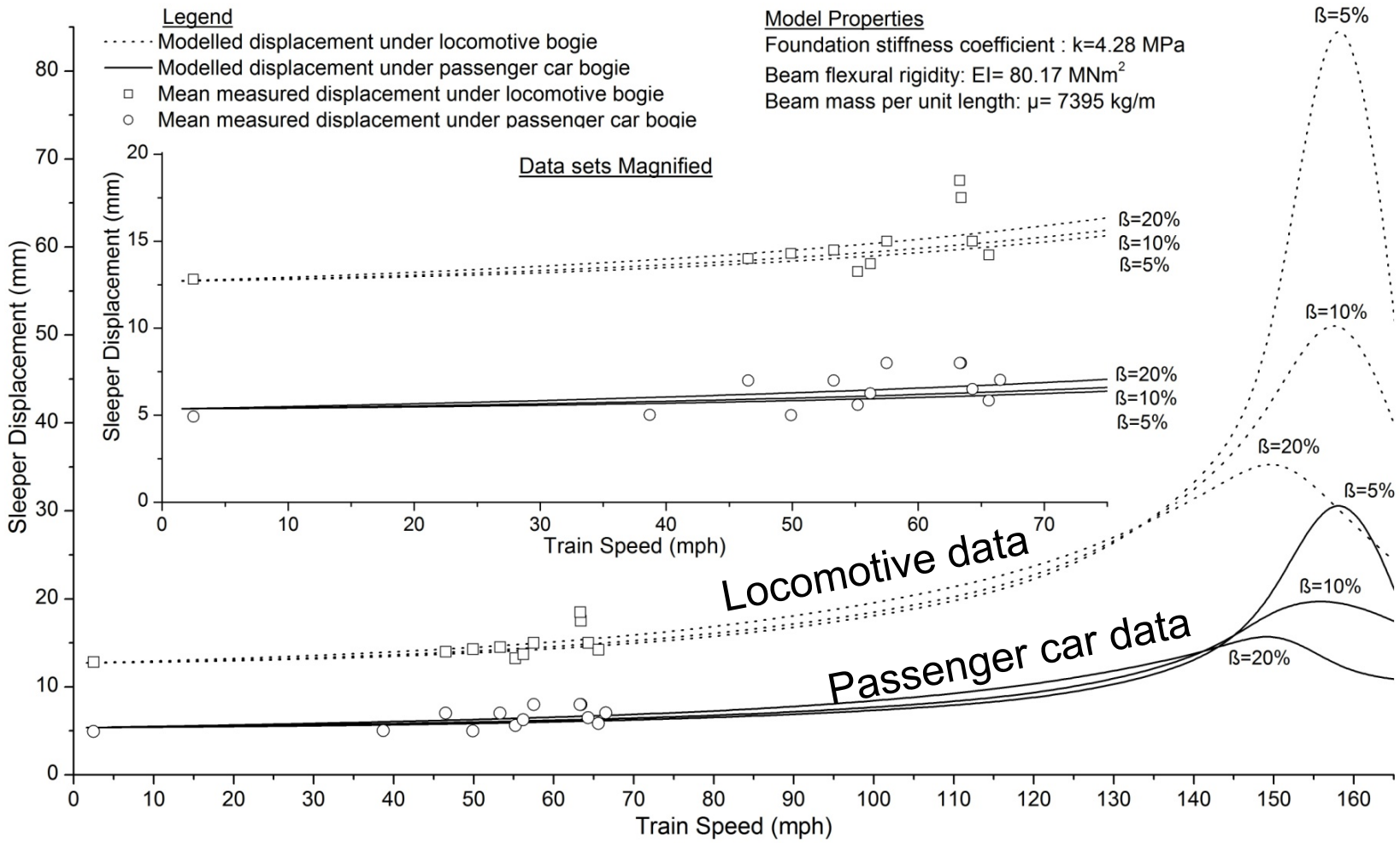
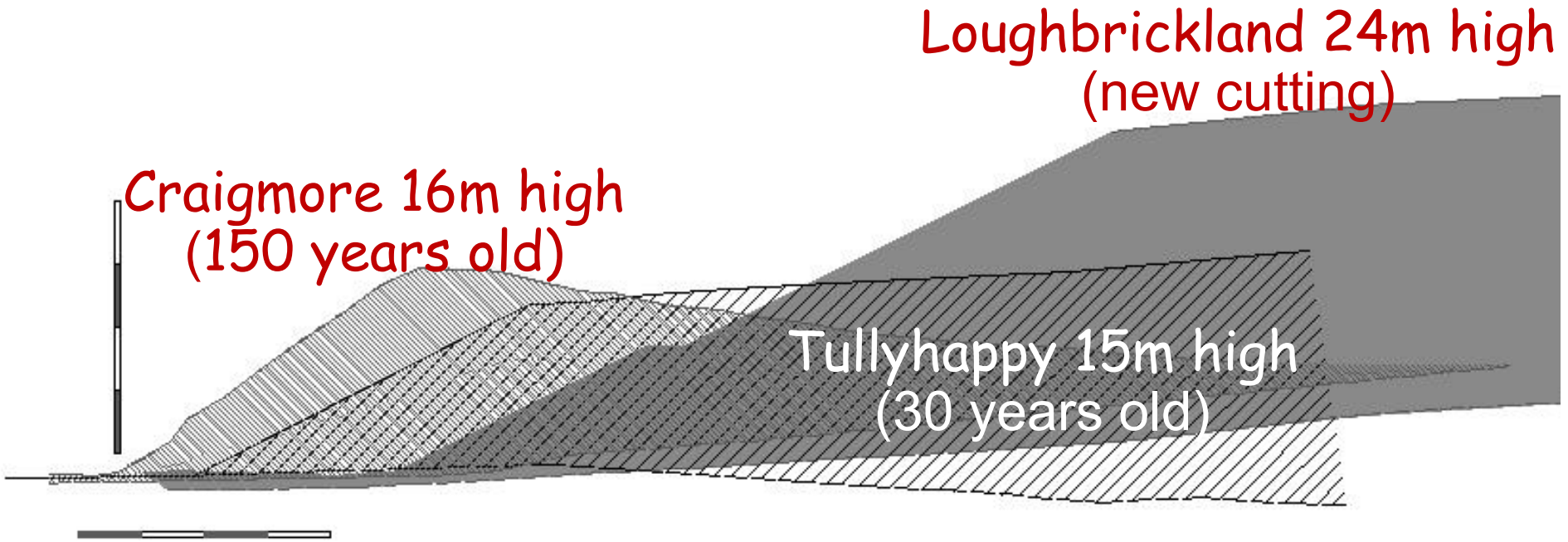
All measured data at various train speeds with modelled response



Managing geotechnical risk & improving infrastructure resilience; assessment/monitoring of landslides, cutting and embankments

3 road and rail cutting tills – Loughbrickland, Craigmore & Tullyhappy



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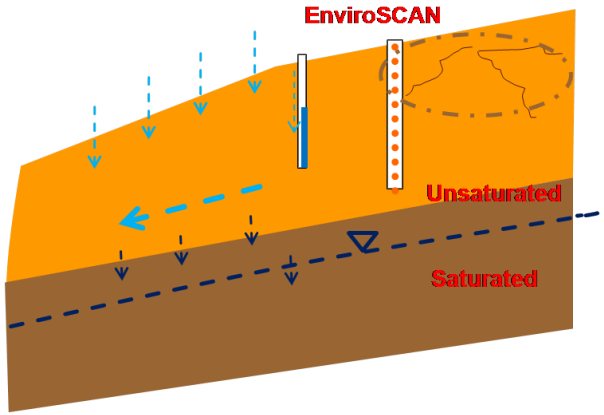
The near surface boundary is important – measuring moisture and water table (suctions from SWCC). We have used the Enviroscan –

Field Monitoring

1. Near surface moisture Content monitoring,(Θ, t) – EnviroSCAN / Diviner 2000
2. Near surface (shallow) water table monitoring(z, t)
3. Deep pore water pressure monitoring (h, t)



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Developing surface based monitoring systems for marine infrastructure: GPR, FOS, acoustic