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dgac
STAC

CONTRIBUTION OF VISCOELASTICITY IN THE DYNAMIC SIMULATION OF HWD TESTS FOR FLEXIBLE PAVEMENT ASSESSMENT

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STS N°

Outline of the presentation

- Background
  - Principle of pavement testing using HWD
  - STAC's advanced dynamic analysis method

- Refinements of the method: introduction of viscoelasticity in bituminous materials
  - Modelling and resolution
  - Operational implementation

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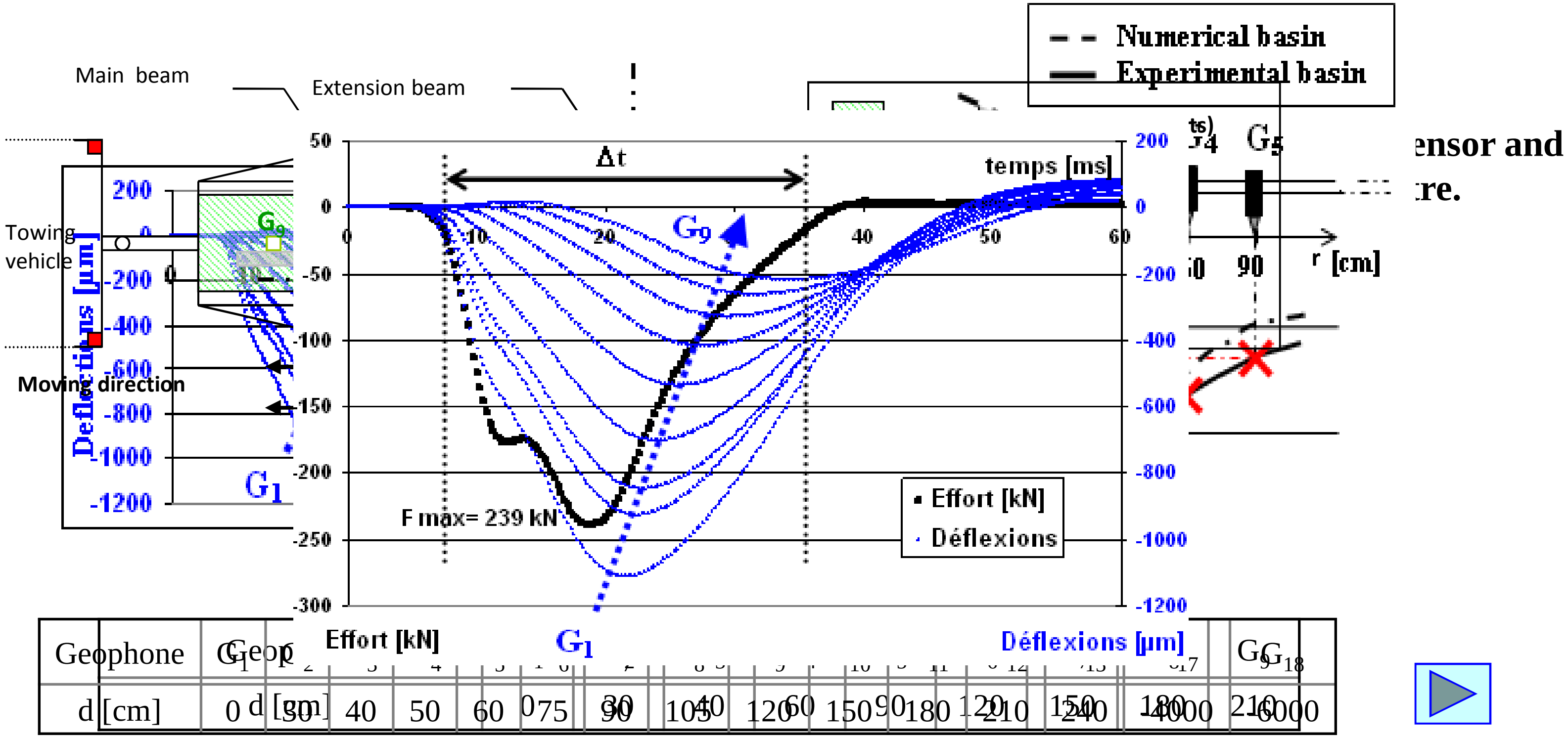
Principle of HWD



HWD principle

- A three step process

➢ 1 - Backcalculation

➡ of the parameters of the chosen mechanical pavement modeling

➢ 2 - Critical stresses/strains calculation under real traffic

➡ linked to the rational design method

➢ 3 - Pavement residual life and/or pavement bearing capacity (Single wheel load or PCN) determination

➡ development of rational PCN; cannot be disconnected to thoughts about rational ACN (ICAO/PSG matter)

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STAC's dynamical method

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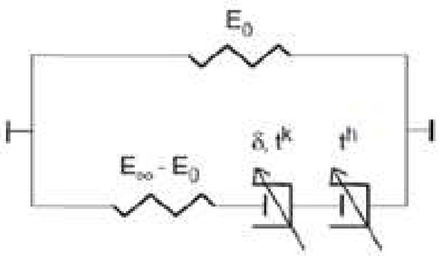
Viscoelasticity consideration

- Huet & Sayegh rheological model [Sayegh,1965]



$$E^*(w) = E_0 + \frac{E_\infty - E_0}{1 + \delta(i\omega a(T))^{-k} + (i\omega a(T))^{-h}}$$

7 parameters → Backcalculation too complex

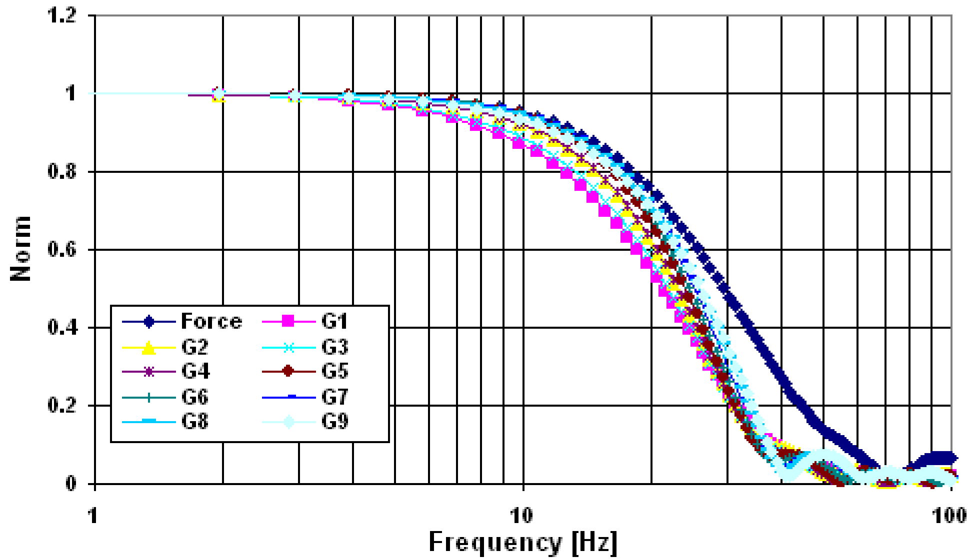
- Simplified Huet model

$$E^*(\omega) = \frac{E_\infty}{1 + A(i\omega)^{-\alpha}}$$

→ 3 parameters

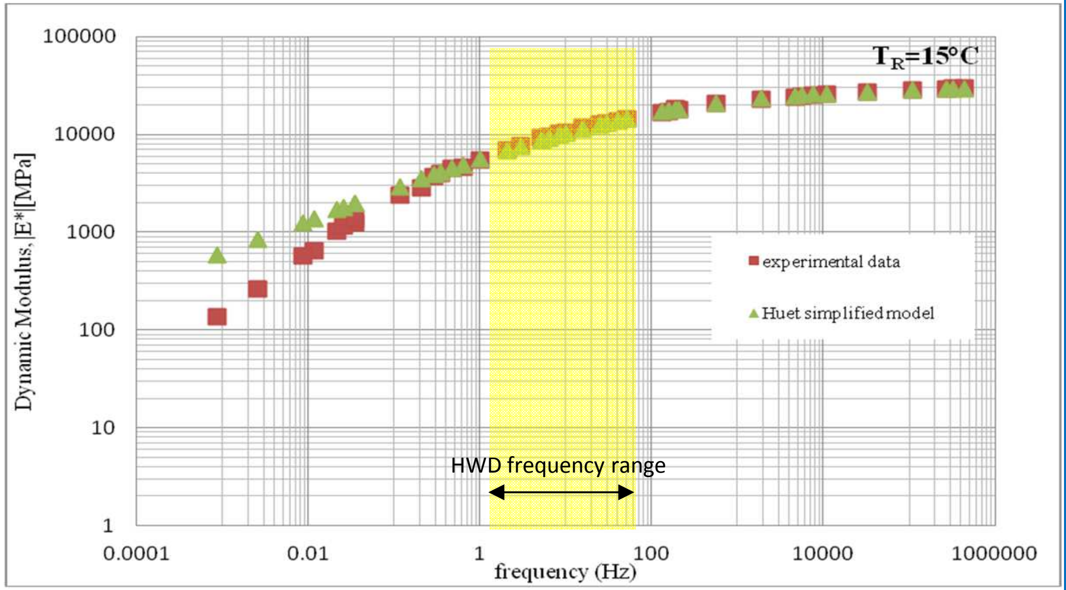
Viscoelasticity consideration

- Adjustment of the viscoelastic parameters
  - Using complex moduli results from laboratory tests performed on the STAC's instrumented test facility bituminous materials (BBA+GB)
  - Fitting on the HWD signal frequency range (1-80Hz)



Viscoelasticity consideration

- Fitting on the GB:



- Results:

Material	E_∞	A	α
BBA 0/10	30378	8,623	0,343
GB 0/14	31859	4,733	0,339

Numerical resolution

- In the frequency domain
- 1- FFT on the force signal

$$F(t) = F_0\, e^{i\omega t} \Rightarrow \tilde{F}(\omega) = \tilde{F}_r(\omega) + i\, \tilde{F}_i(\omega)$$

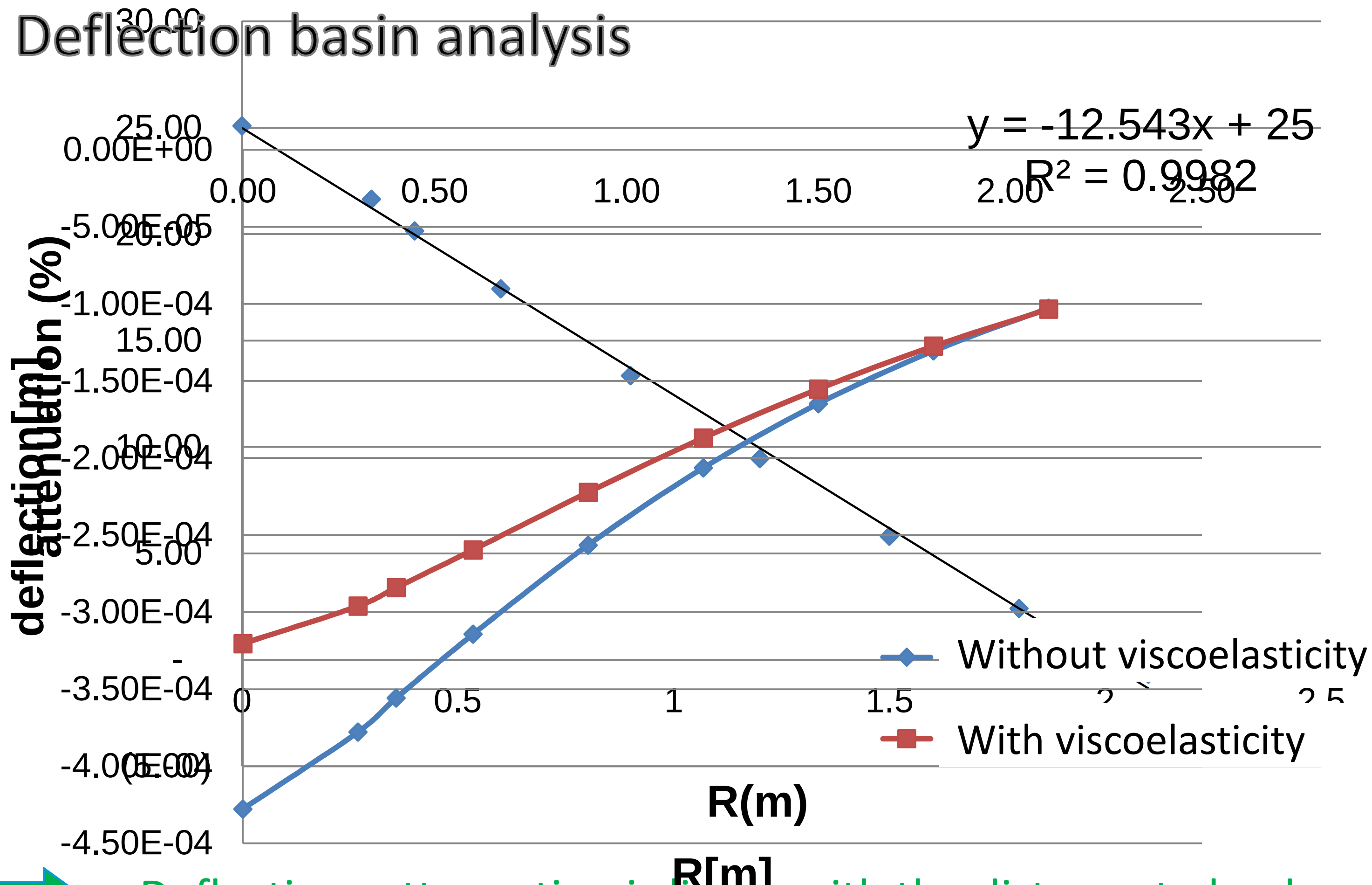
- 2- Resolution of the complex problem

$$\begin{bmatrix} K - \omega^2 M & \omega C \\ -\omega C & K - \omega^2 M \end{bmatrix} \begin{Bmatrix} \tilde{U}_r \\ \tilde{U}_i \end{Bmatrix} = \begin{Bmatrix} \tilde{F}_r \\ \tilde{F}_i \end{Bmatrix}$$

- 3- Inverse FFT to find time domain solution

Numerical resolution

- Deflection basin analysis



Deflections attenuation is linear with the distance to load center

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Implementation

- Viscoelastic direct calculation time-consuming
- Approximate method is advocated : define on the base of a sensibility study (as a function of material, temperature, layer thicknesses), corrections to be applied to deflections for the dynamical method to be used

Thank you for attention