Vibrations induites par le trafic ferroviaire : expérimentations, modélisations et isolation

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Plan de la présentation

I. Problématique

II. Expérimentations

   1. ***Mesures sur site***
   2. ***Essais à échelle réduite***
   3. ***Essais en laboratoire***

III. Modélisations

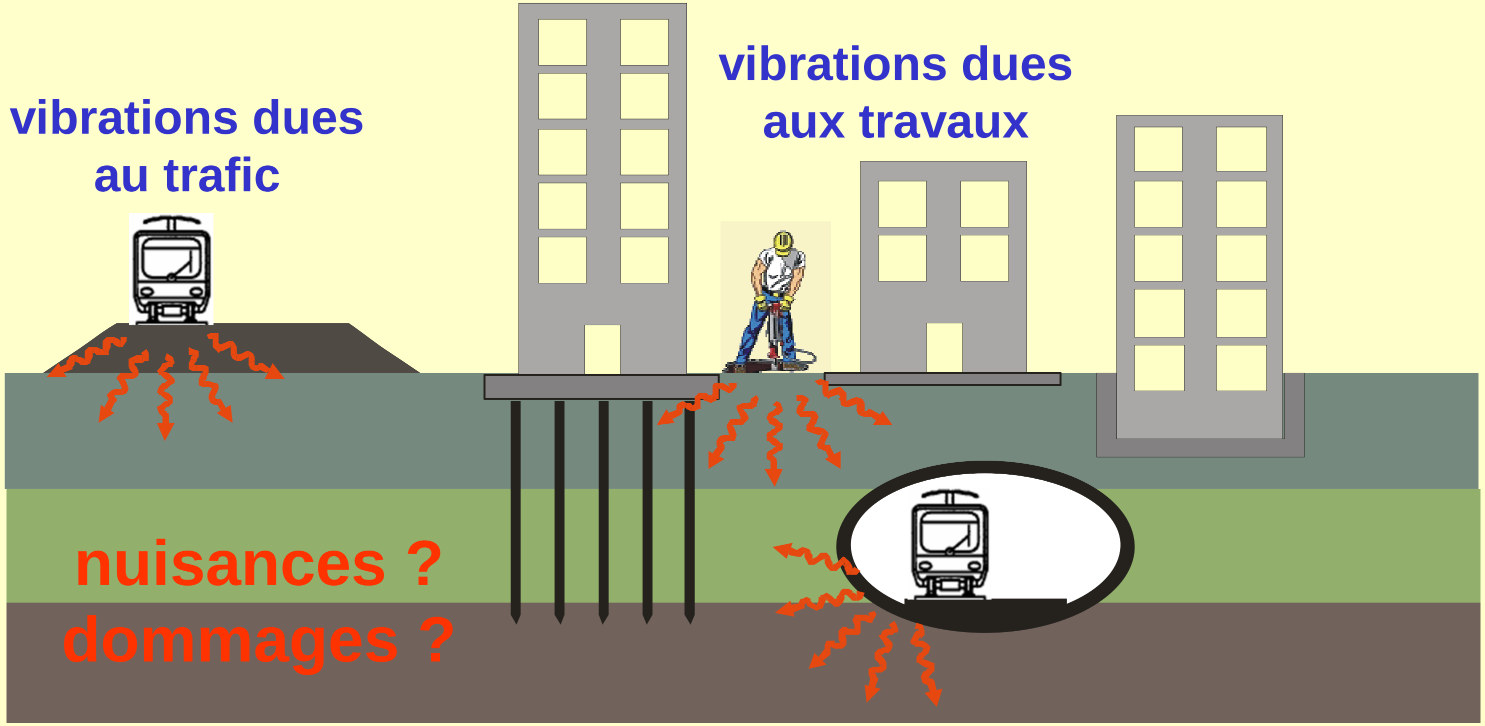
   1. ***Analyses théorique et numérique***
   2. ***Exemples (FEM, BEM…)***

IV. Isolation/mitigation

V. Conclusion

I/ Problématique

Problèmes vibratoires



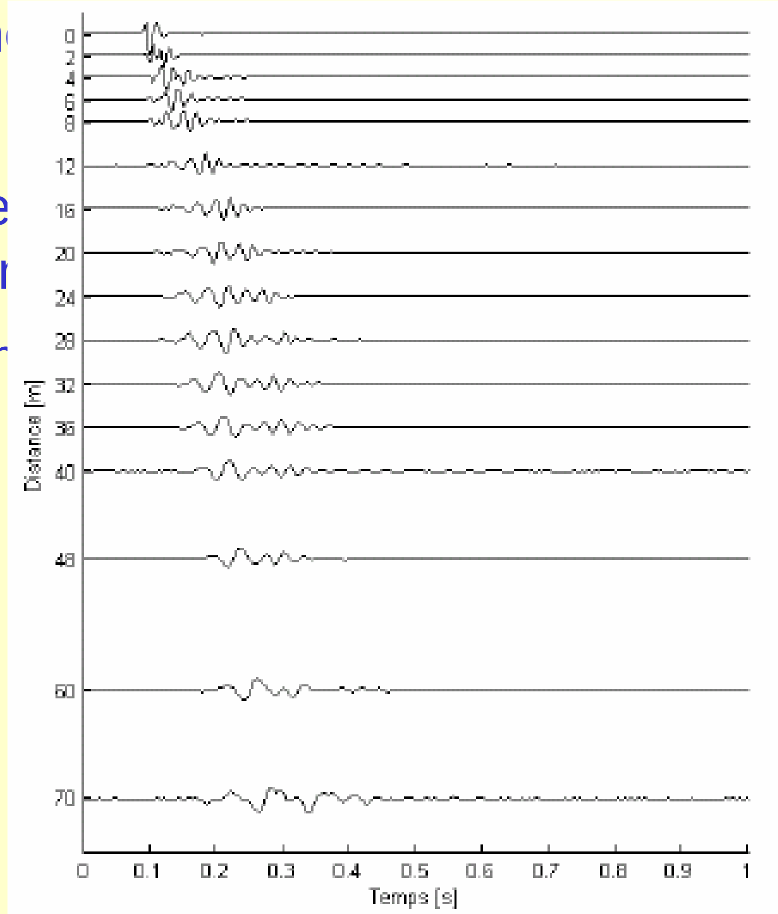
↔ sources ? propagation ? ISS ?

(contact roue-rail, déformation voie)

II/ Expérimentations

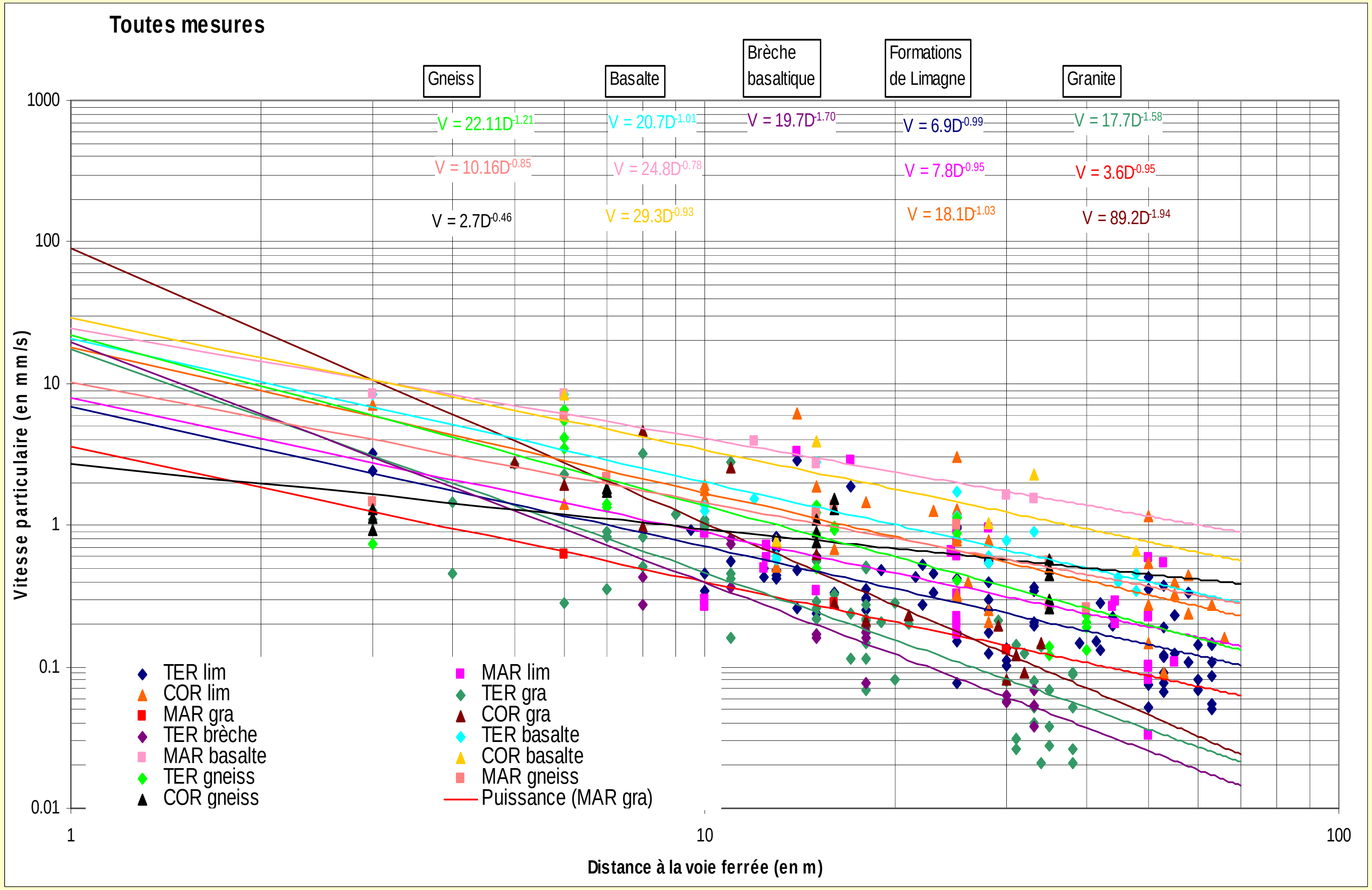
Essais sur site (1)

- Mesures de caractérisation du sol (méth
  - Excitation à 70 m de la voie (loin de
  - Socle = environ 300 kg, assemblage tiges enfoncées dans le sol sur 70 c
  - 2 approches : marteau et masse tom



donner au train des idées d'avance

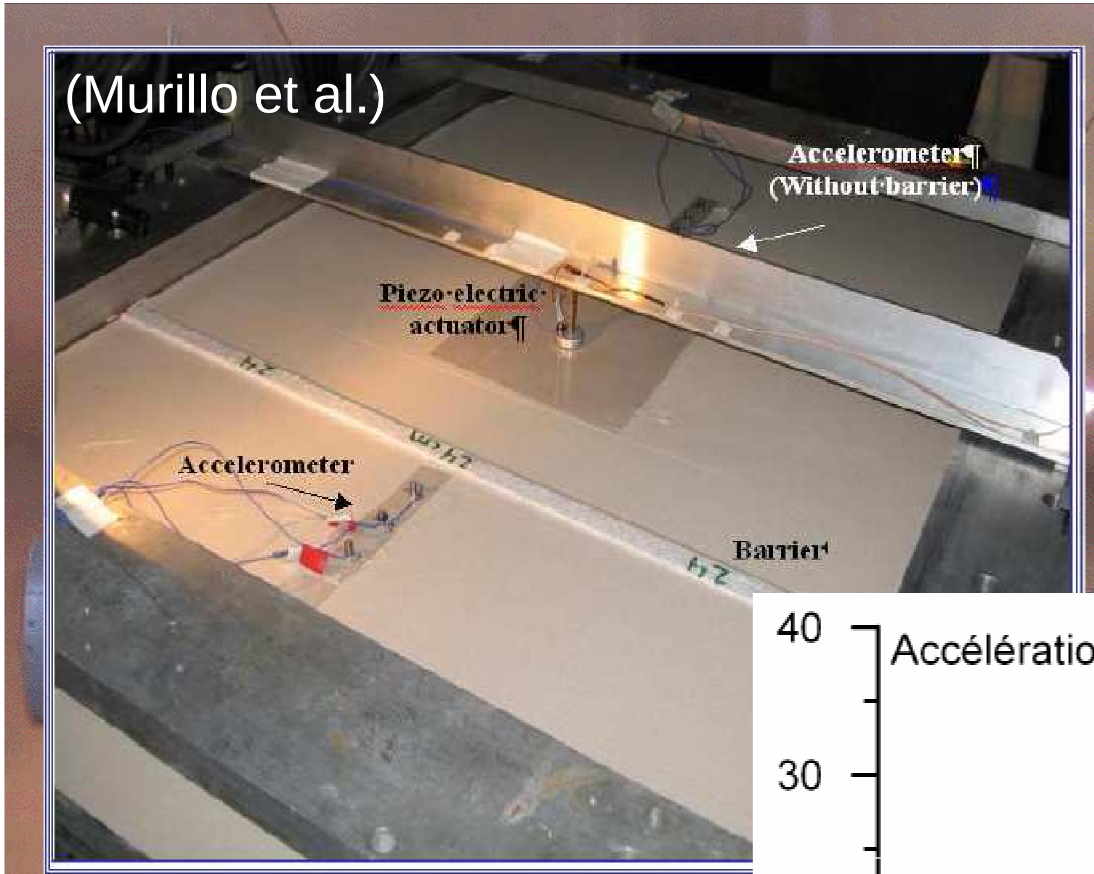
Essais sur site (2)

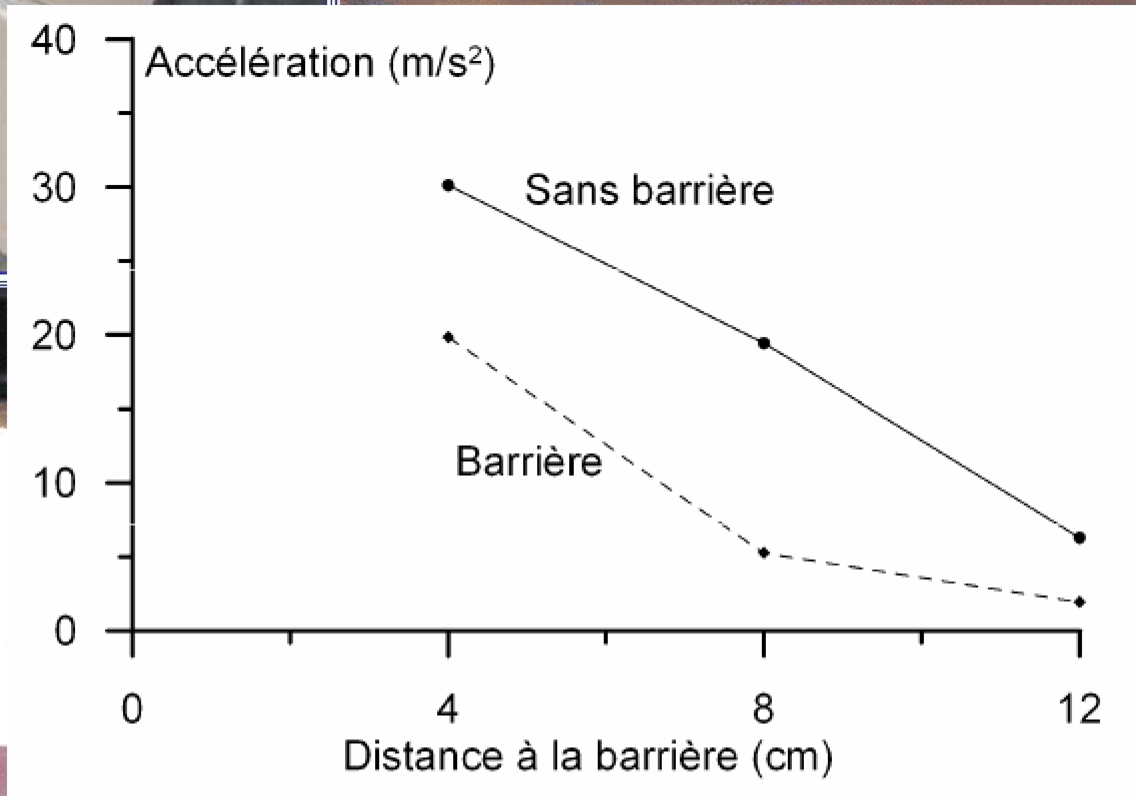


Auvergne (LRPC Clermont - Univ. Besançon)

Essais en centrifugeuse

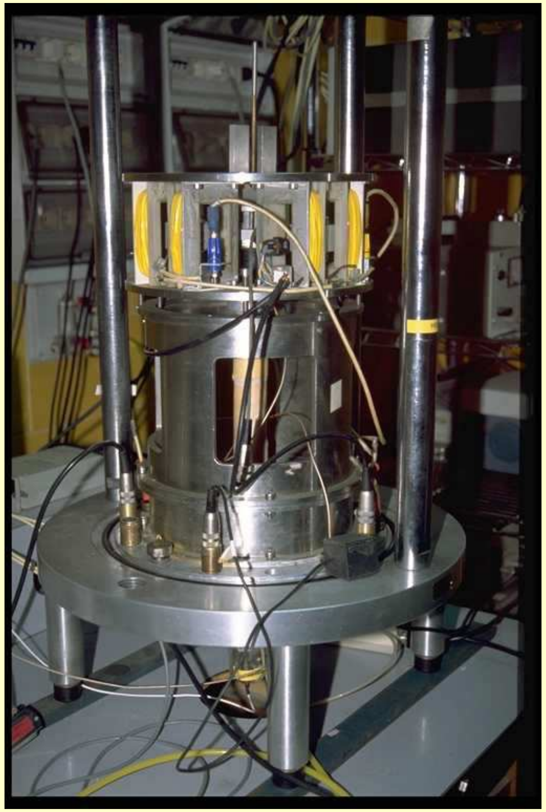
LCPC - Nantes

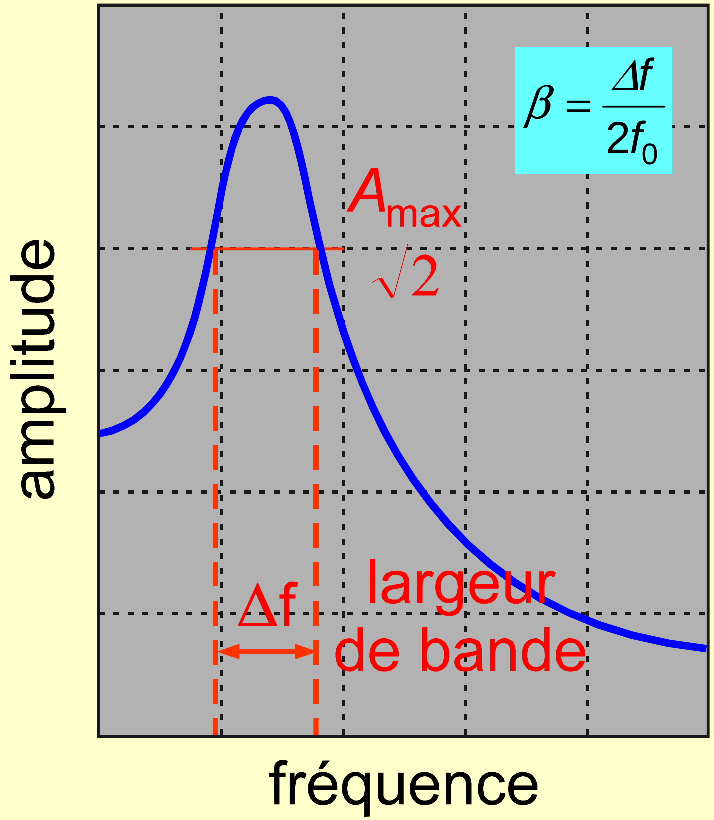




Caractérisation dynamique

- Colonne résonnante : module, amortissement

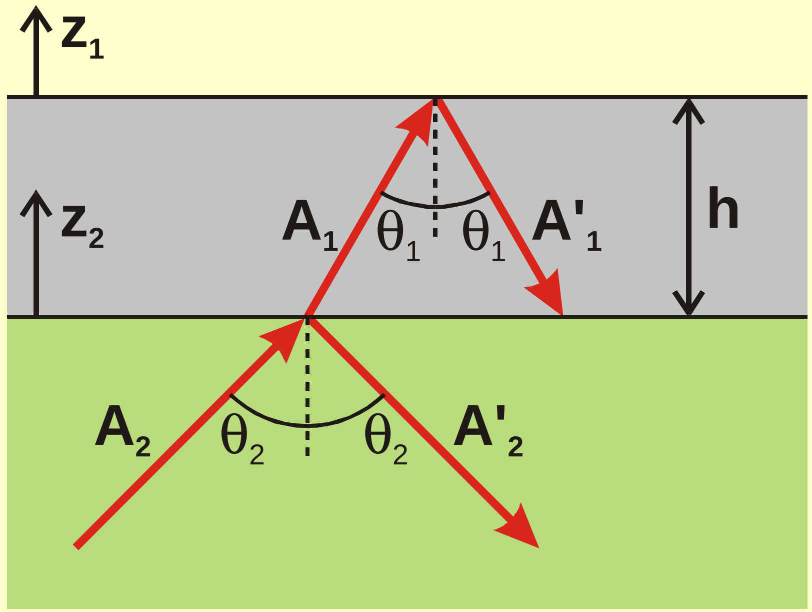


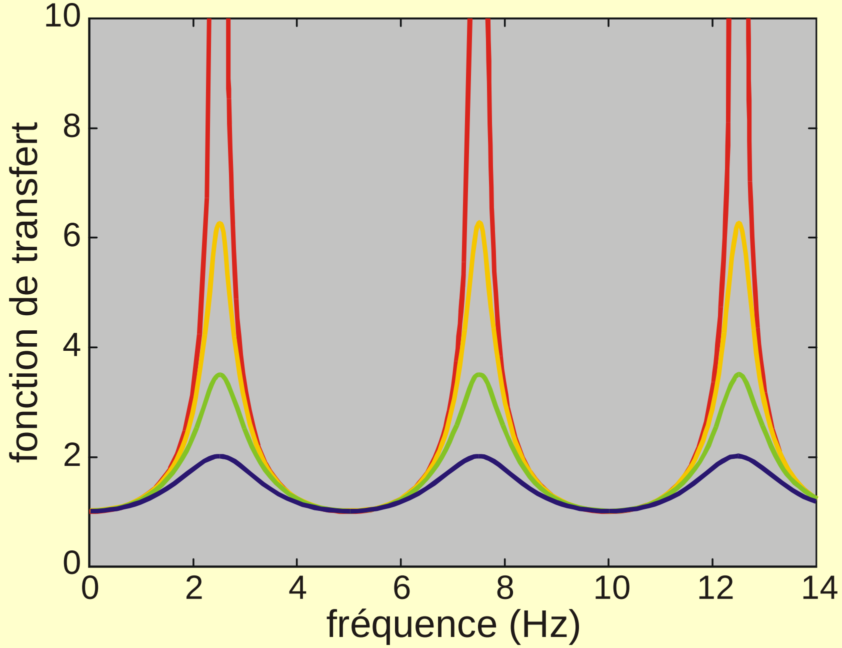


III/ Modélisations

Analyse simplifiée

- Couche élastique sur demi-espace élastique
- Onde sinusoïdale : solution analytique simple !
- Différents contrastes de vitesses : fonction de transfert





Modélisation numérique

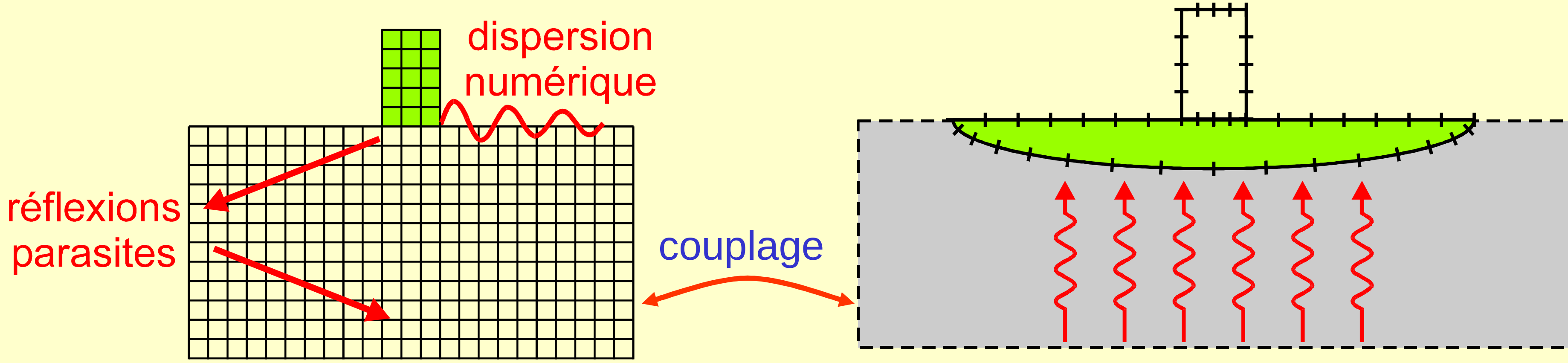
Éléments finis

- comportements complexes
- fortes hétérogénéités
- dispersion numérique
- réflexions parasites

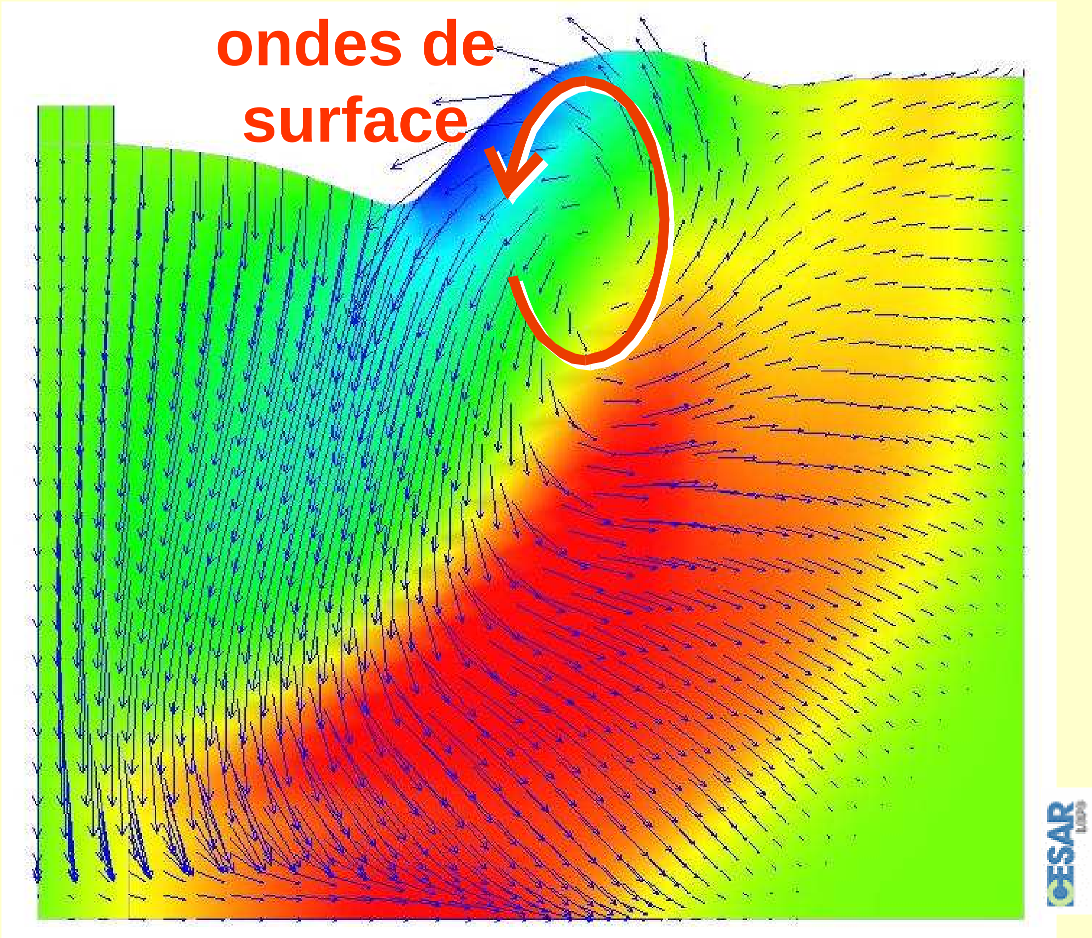
grands modèles

Éléments de frontière

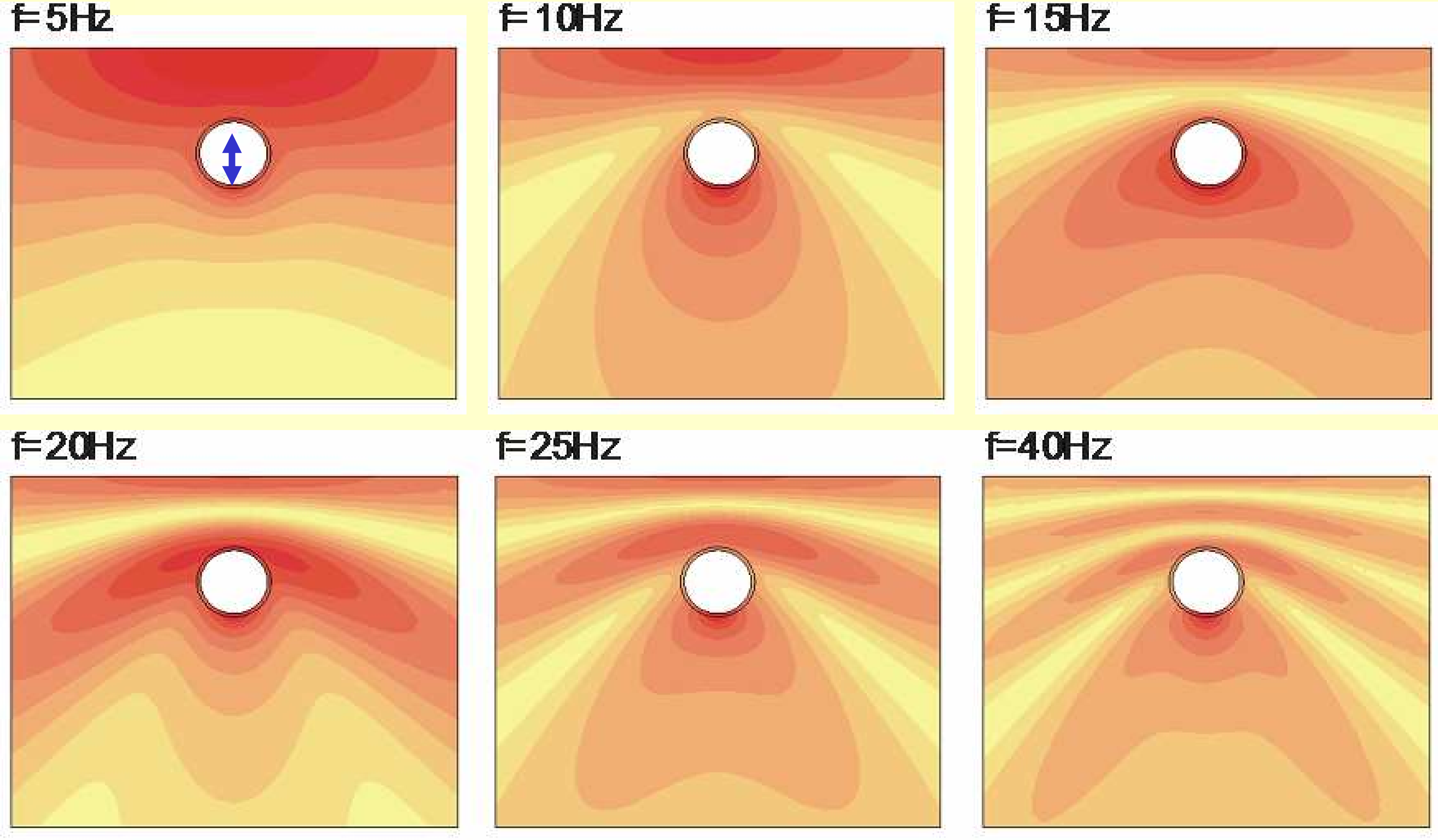
- comportements simples
- faibles hétérogénéités
- milieux (semi-) infinis
- modélisation des sollicitations dynamiques



Exemple : éléments finis

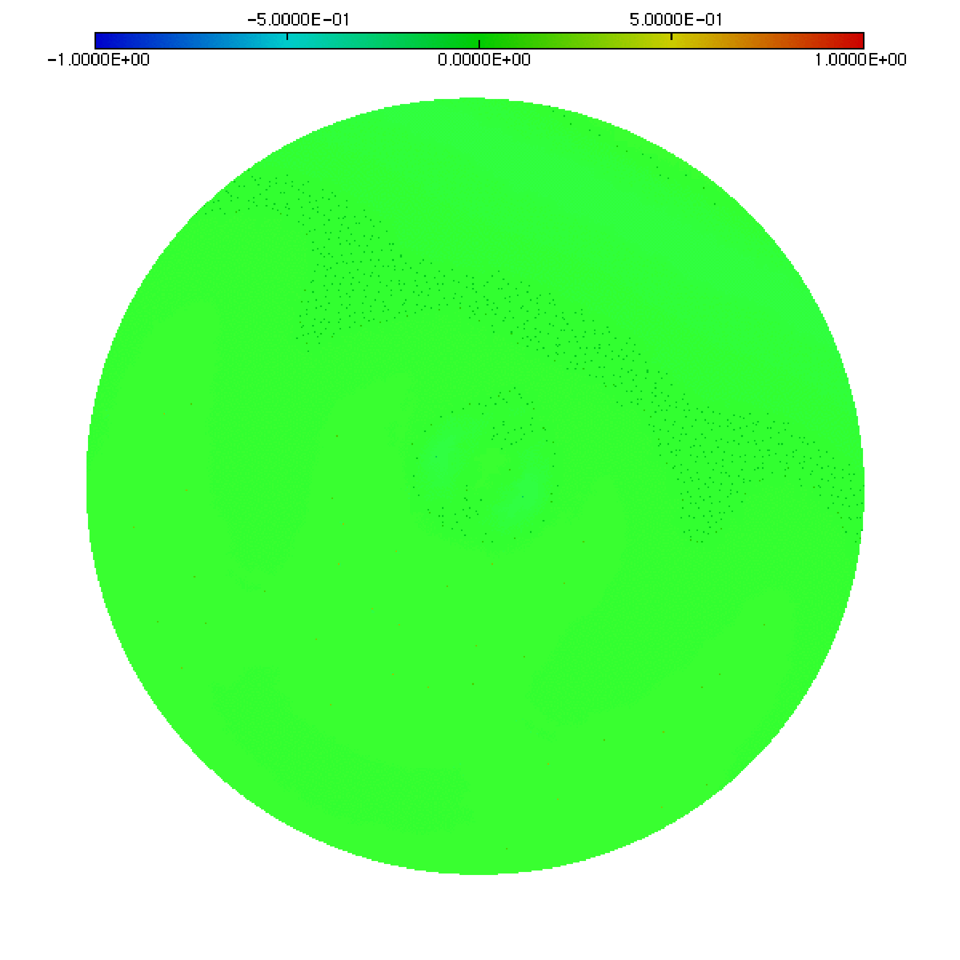


Exemple : élts de frontière



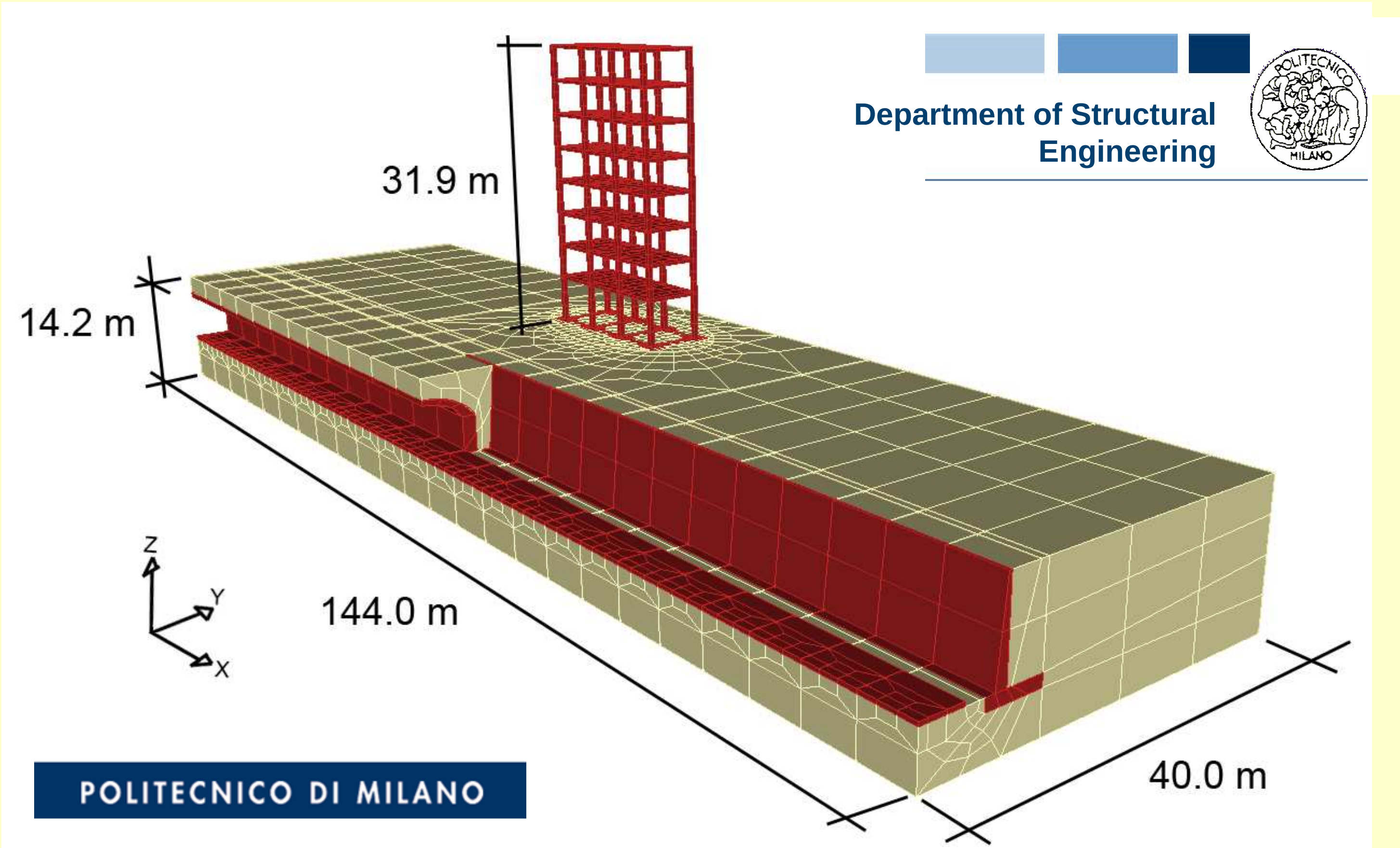
Exemple 3D : élts de frontière

- **Onde + Zone moins raide en surface**
- **Ondes piégées !**
- **Nouvelle méthode** : *"Multipôle rapide"* (LMS/LCPC)



(Chaillat, Bonnet, Semblat, CMAME, 2008)

Exemple 3D : élts "spectraux"

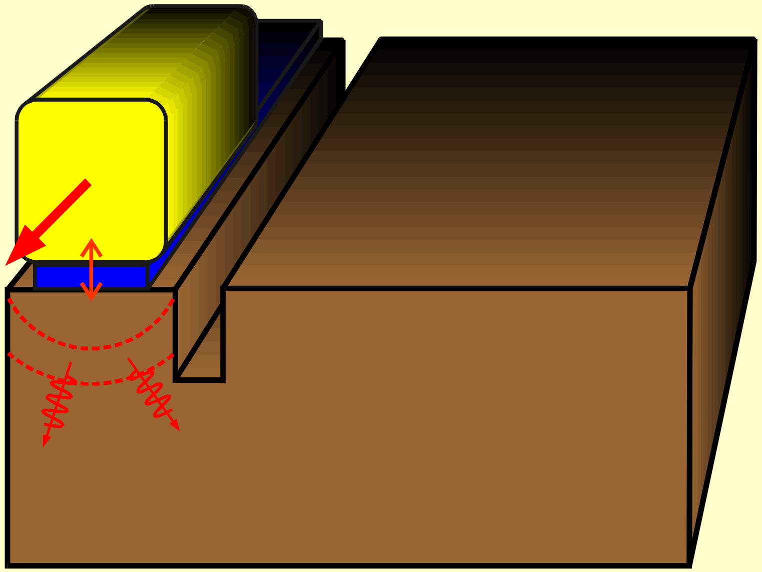


IV/ Isolation

Isolation vibratoire

Enjeu : limitation du niveau de vibration :

- à la source (émission),
- sur le trajet (propagation),
- dans les structures (récepteurs)

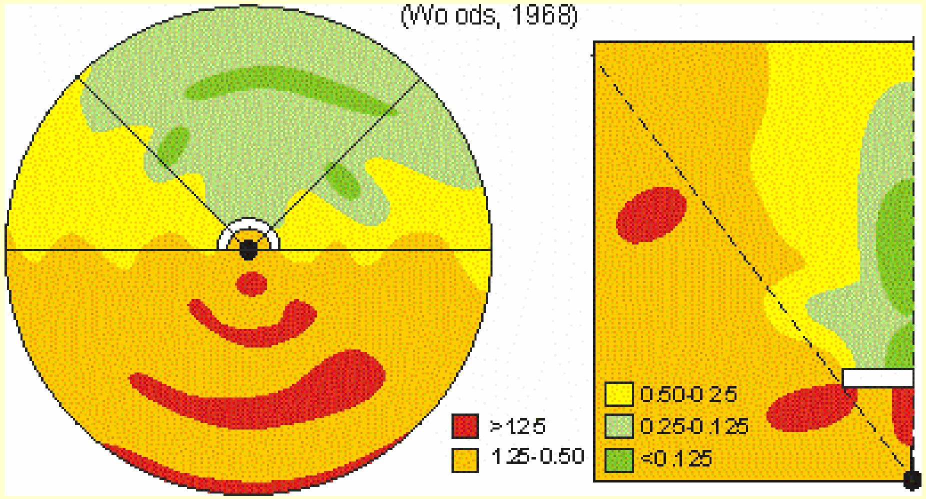


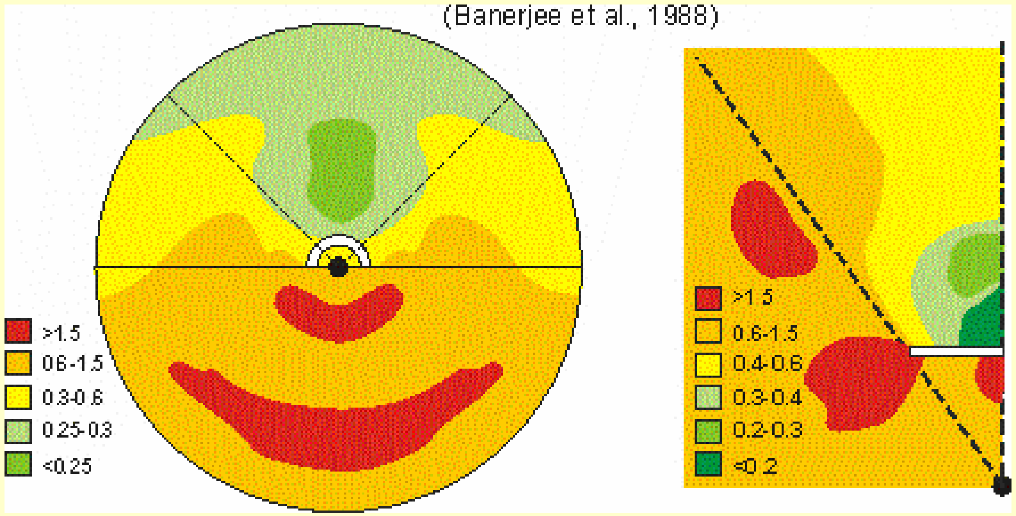
Techniques :

- couches absorbantes,
- écrans enterrés,
- masses ajoutées,
- …

Isolation : exemple 1

- Efficacité tranchées (facteur réduction d'amplitude)
- Comparaison expérimental (Woods, haut) et numérique (Banerjee, bas)

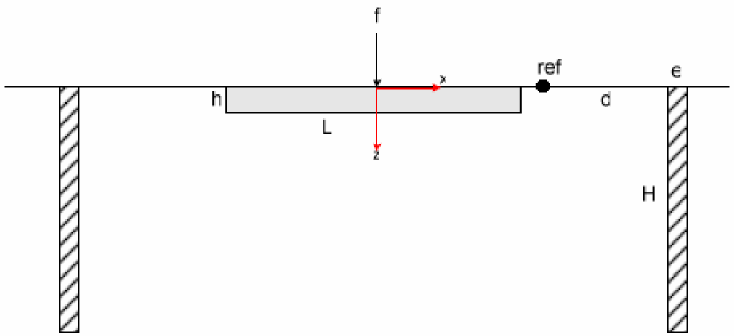




Isolation : exemple 2

Tests comparatifs avec RATP/CSTB

CONFIGURATION **B** : *Fondation simple + confinement*

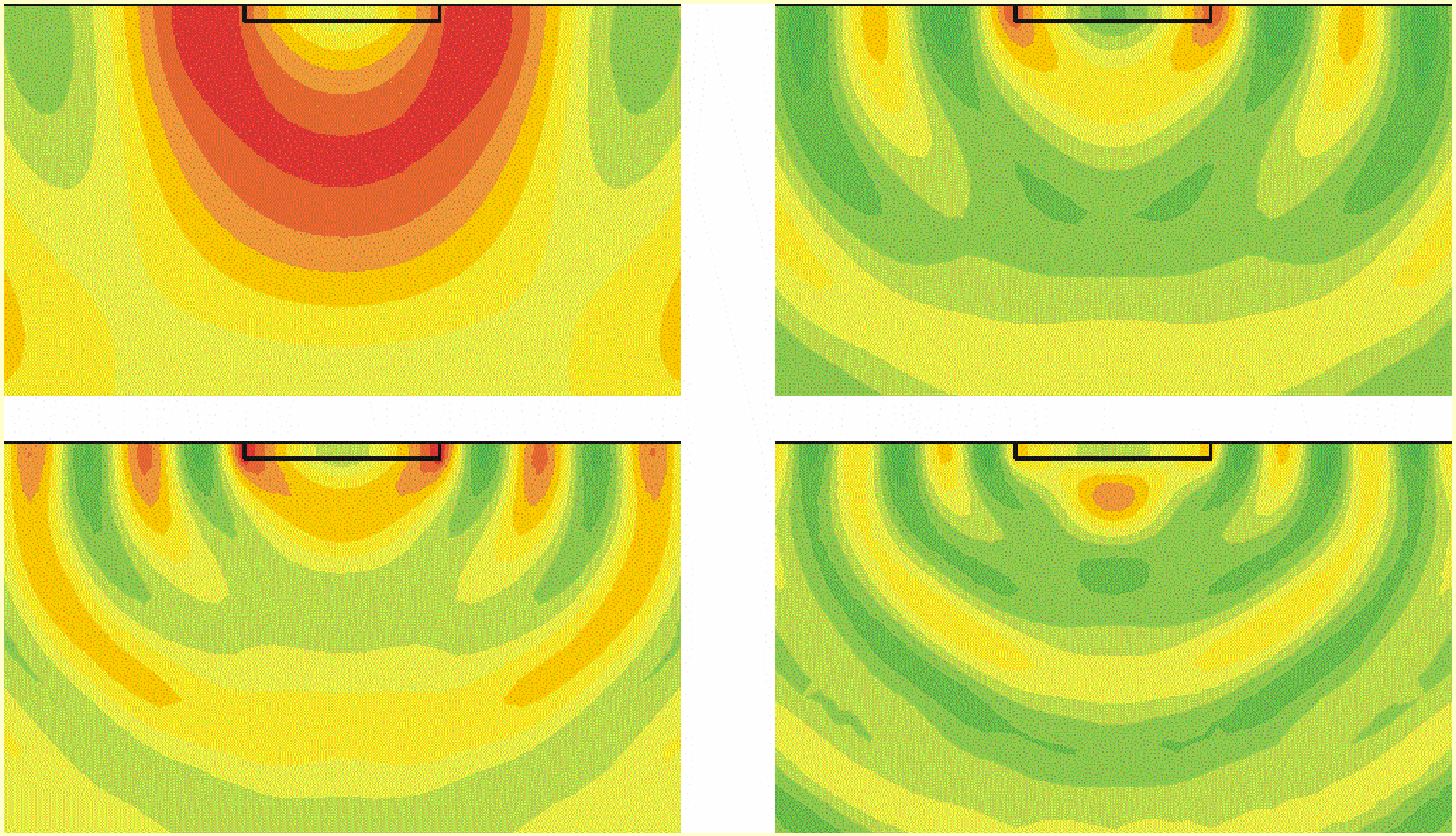


Dimensions

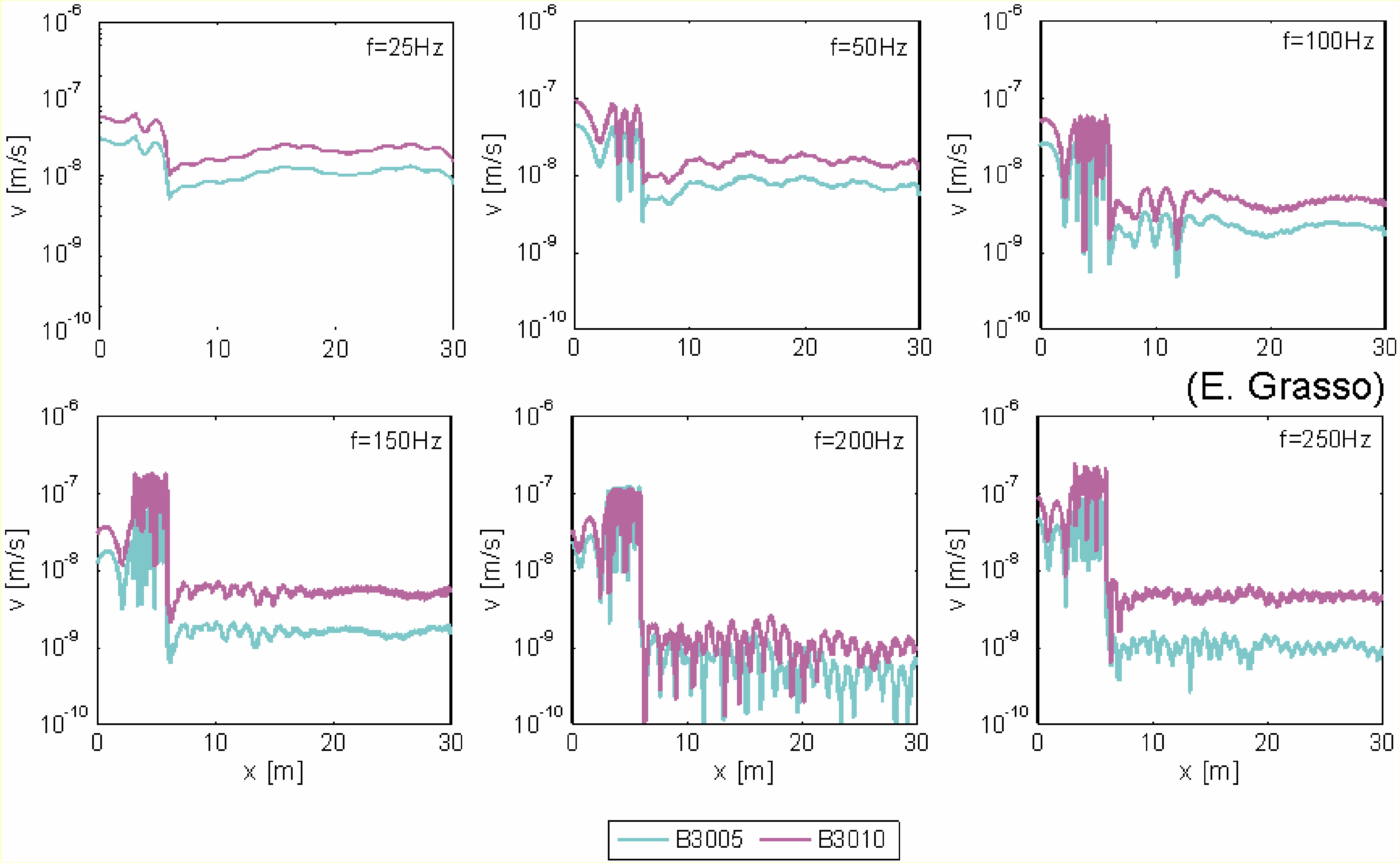
L	=	6	m
h	=	0,5	m
d	=	3	m
e	=	0,4	m
H	=	5	m

- Configurations types
- Modélisation numérique (2D/3D)
- Comparaisons méthodes
- Thèse RATP/CSTB (G. Coquel)

Isolation : simulations LCPC

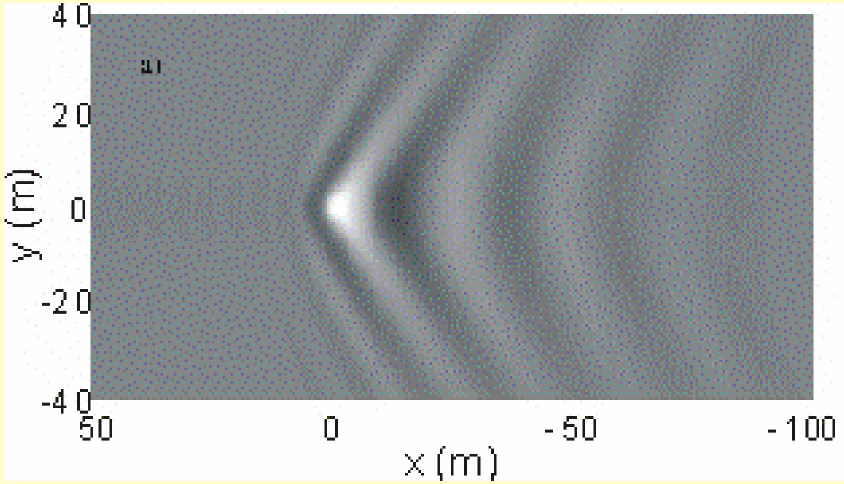


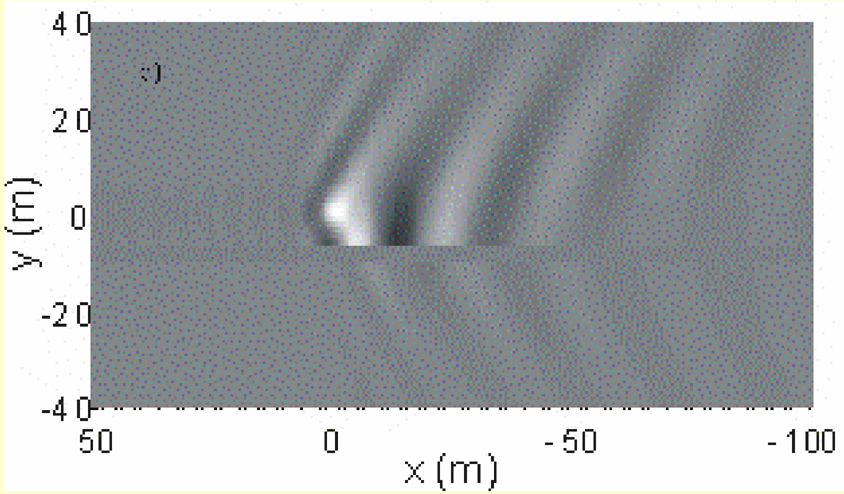
Isolation : simulations LCPC (2)



(E. Grasso)

Isolation : exemple 3



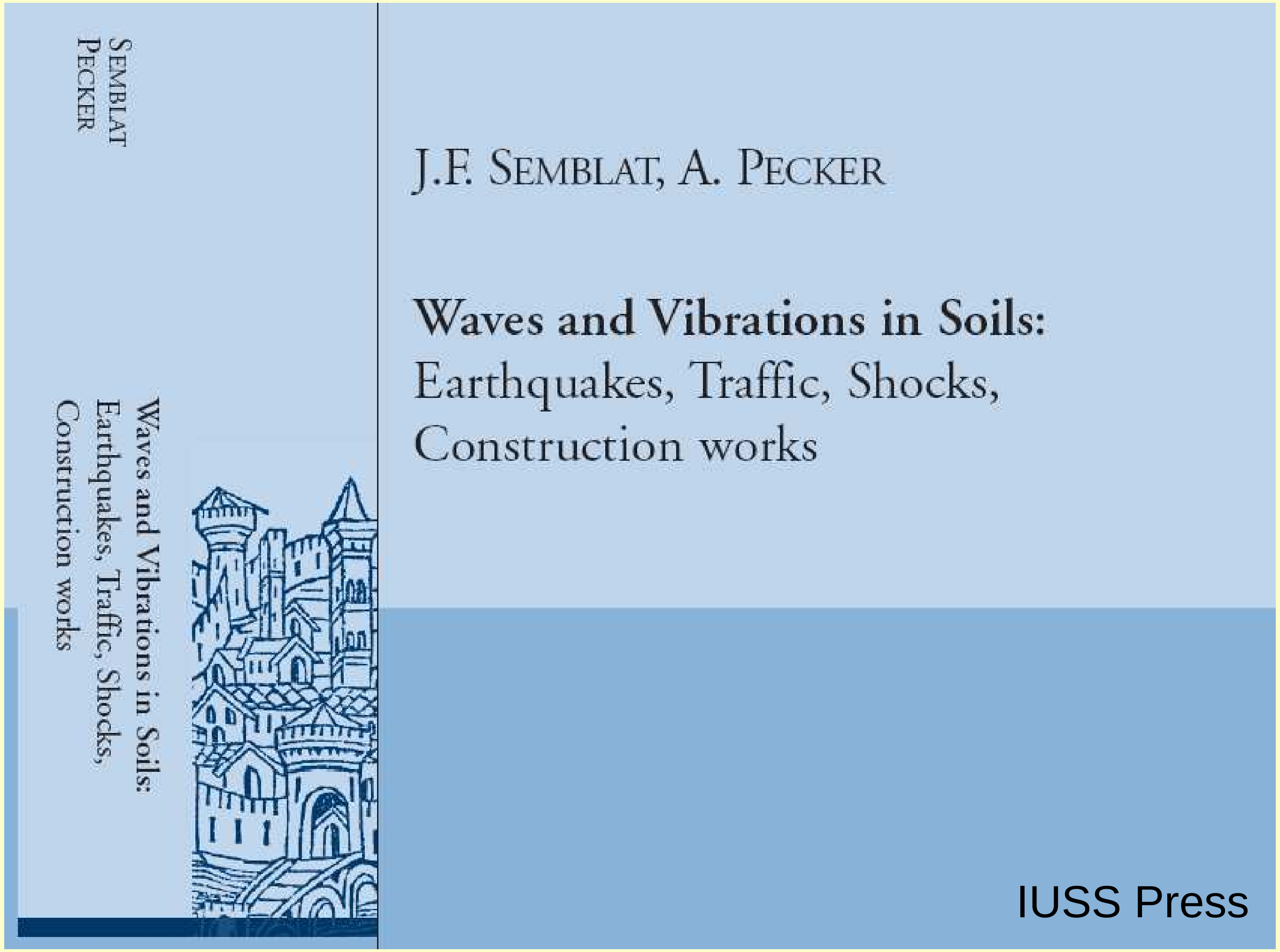


(Kalström & Boström, SDEE, 2007)

V/ Conclusions

- Mesures sur site :
  - Source et sol réels
  - Complexité, généralisation difficile
- Modèles physiques/numériques :
  - Représentativité, erreurs…
  - Influence paramètres (échelle réduite !)
  - Efficacité dispositifs d'isolation
- Autres aspects :
  - Règles et normes : mesure + nuisances (circulaire 86, NF E 90-020…)
  - Dispositifs de mitigation innovants !

Merci !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Merci !

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