Study of the dynamic response of a counterbalance forklift truck by means of experimental measurements and numerical models

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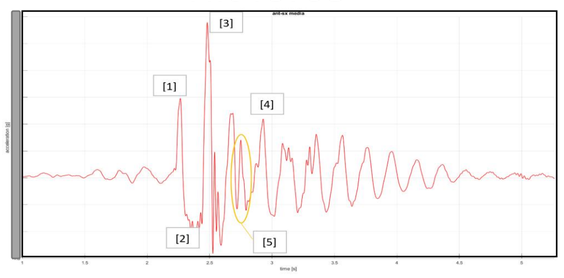
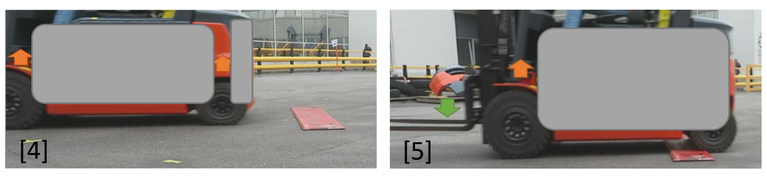
Objective: implementation of a multibody model to predict the dynamic loads on a forklift truck that impacts a steel plate obstacle in rectilinear motion at constant (high) speed

Accuracy criteria: - vertical acceleration of the front axle (peak amplitude/location and frequency content)
- tilt force (peak amplitude/location and frequency content)

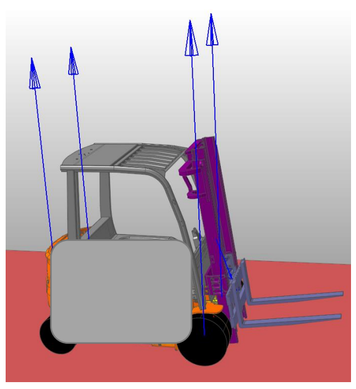
Experimental tests

- **Sensor setup** → 6 Accelerometers, 2 Load cells → Vertical accelerations, Mast accelerations, Tilt force
- **Steel plate obstacle test**





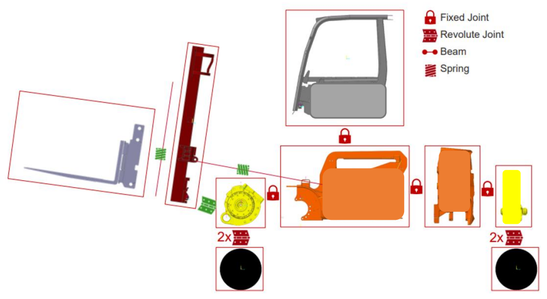
- **Static test** (mass distribution)

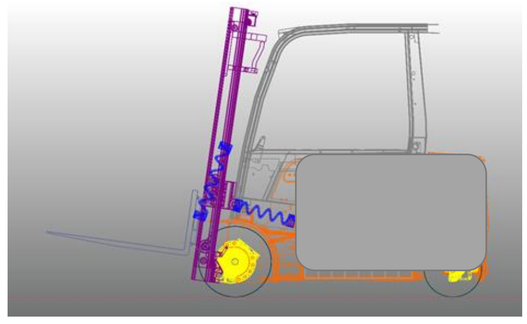


- **Tilt cylinder stiffness test** (main resonance of mast assembly excited by rapidly lowering the load)

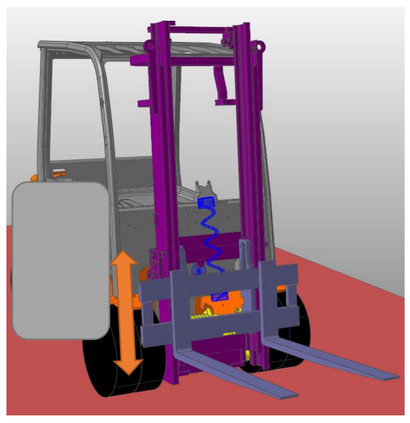
Numerical model

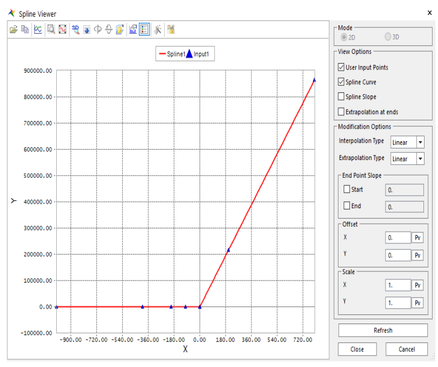
- Multibody model of the complete forklift implemented with RecurDyn (FunctionBay, Seongnam, South Korea).



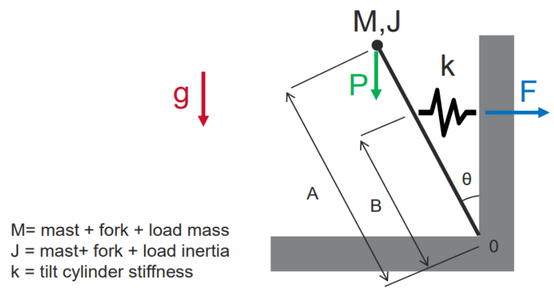


- **Wheels** → Ground/wheels ground/surface contacts; Actual tire compliance modeled with nonlinear lumped stiffness parameter between each wheel and its axle
- **Lifting actuator** → Non Linear Spring



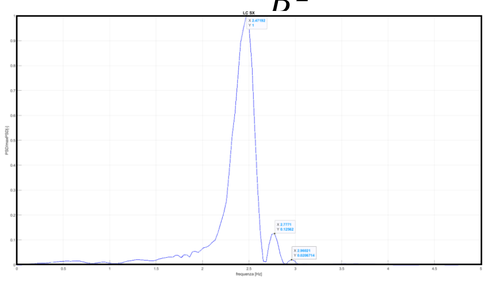


- **Tilt Cylinders** → Linear spring with stiffness estimated experimentally

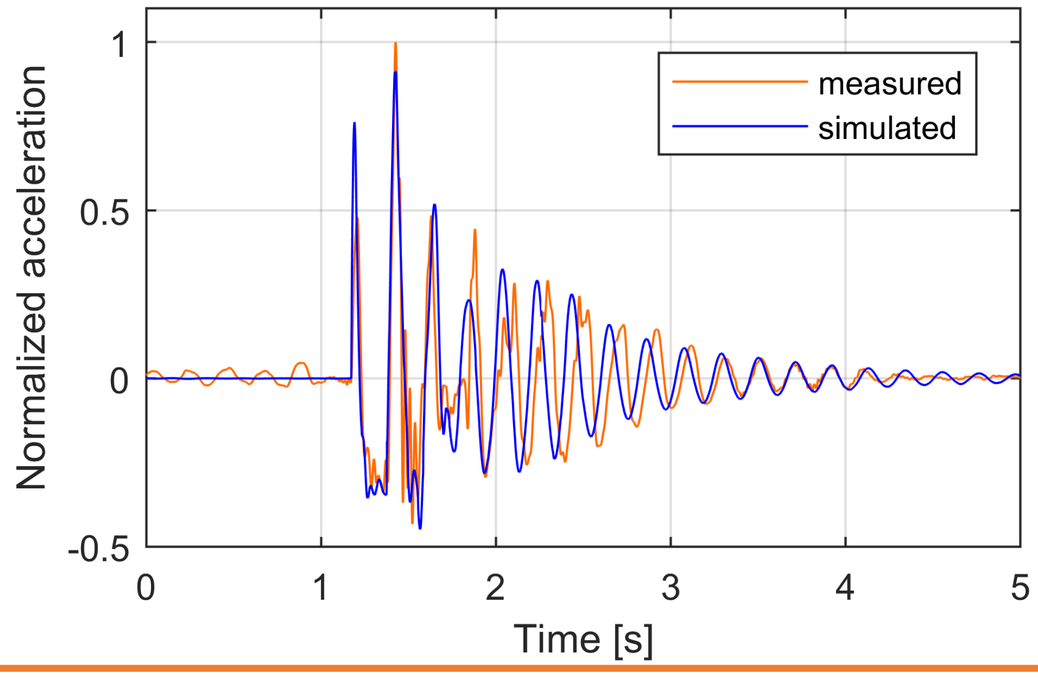


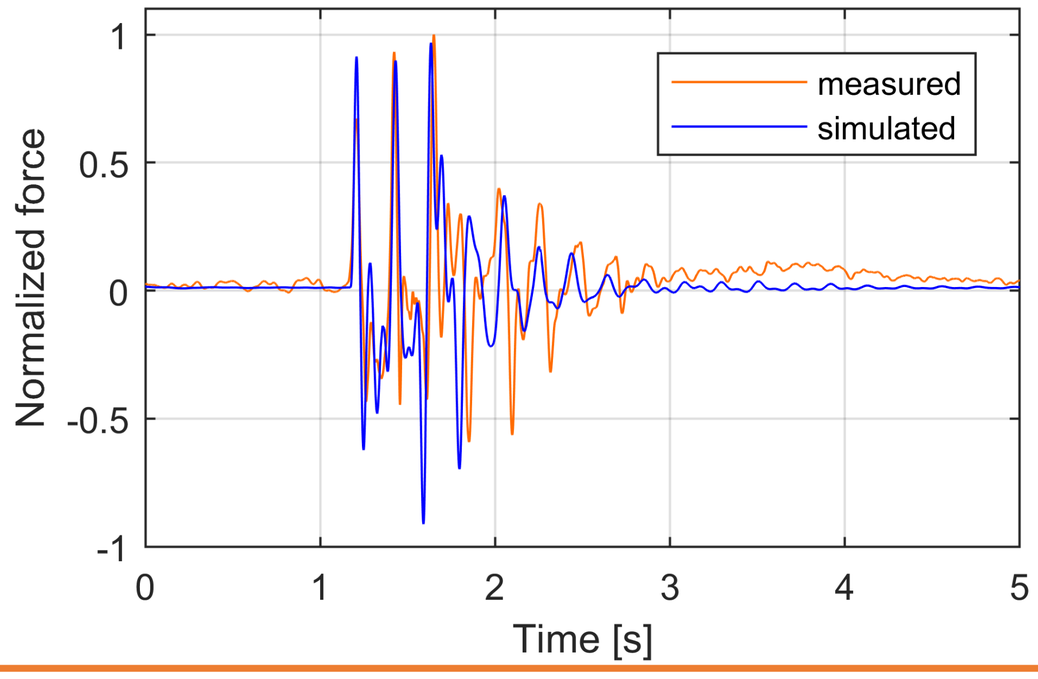
M= mast + fork + load mass
J = mast+ fork + load inertia
k = tilt cylinder stiffness

$$K = \frac{(f \cdot 2\pi)^2 \cdot (J + M \cdot A^2)}{B^2}$$



Unloaded forklift results





Conclusions

Satisfactory accuracy of the simulations after model updating/validation:

- Acceleration and tilt force peaks and general trends predicted precisely
- Main vibration phenomena correctly replicated

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