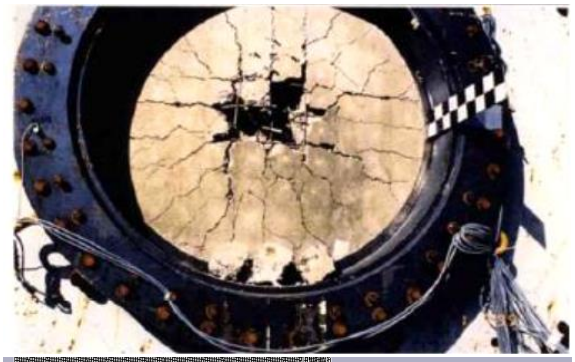
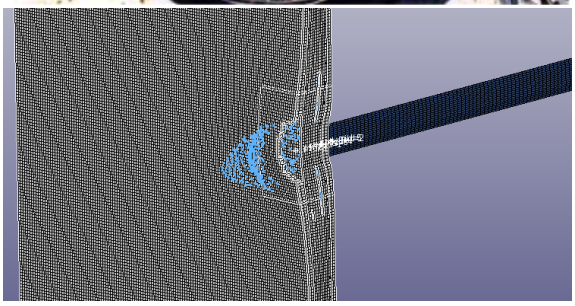
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Structural simulation of collisions, impacts, falls and explosions

Such as severe earthquakes, extreme weather events, industrial explosions, rupture of pressurized systems, malicious attacks

Simulation enhances safety and provides design input to protect sensitive equipment.





Challenge

Your structures and buildings may be exposed to:

- Severe earthquakes
- Falling loads resulting from handling, lifting, transportation, or storage accidents
- Impacts from projectiles propelled by tornadoes or explosions
- Blast waves generated by distant explosions or bursts
- Impacts resulting from malicious acts, such as missile strikes or near-field solid charge explosions.

Solution

Framatome provides technical assistance for:

› Determining the source terms of hazardous events in order to derive the dynamic mechanical loads applied to structures, including the energy of gaseous or solid explosions, wave propagation in fluids or soils, reflections on structural boundaries, projectile impact velocities, water hammer effects in piping systems, etc.

› Defining mechanical criteria associated with safety requirements

› Implementing time-domain dynamic numerical simulations using:
- Classical Lagrangian methods with geometric, contact and material non-lineartites (plasticity, damage, rupture etc.)
- Eurelian or ALE methods incorporating both fluids and solids Paritcle-based méthodes such as SPH or DES

Key Figures

15 years of experience in fast dynamics simulations

Customer benefits

Benefit from our expertise in impact, falling load, and explosion simulations:

› Support in defining loads and requirements, based on experience gained from projects in France and on international markets,

› End-to-end mastery of the safety demonstration or design process, from the determination of applicable loads through to the justification and qualification of impacted equipment or structures.

Your performance
is **our** everyday **commitment**

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Examples of achievements

Resistance to severe earthquakes
- Justification of the stability and integrity of anti-vibration bars under seismic loading, including the definition of a testing methodology and test-to-analysis correlation.
- Seismic effects on a water storage tank: buckling of the tank induced by internal fluid sloshing. Reproduction of the deformed shapes observed on the tank after the incident and support in defining a repair method.

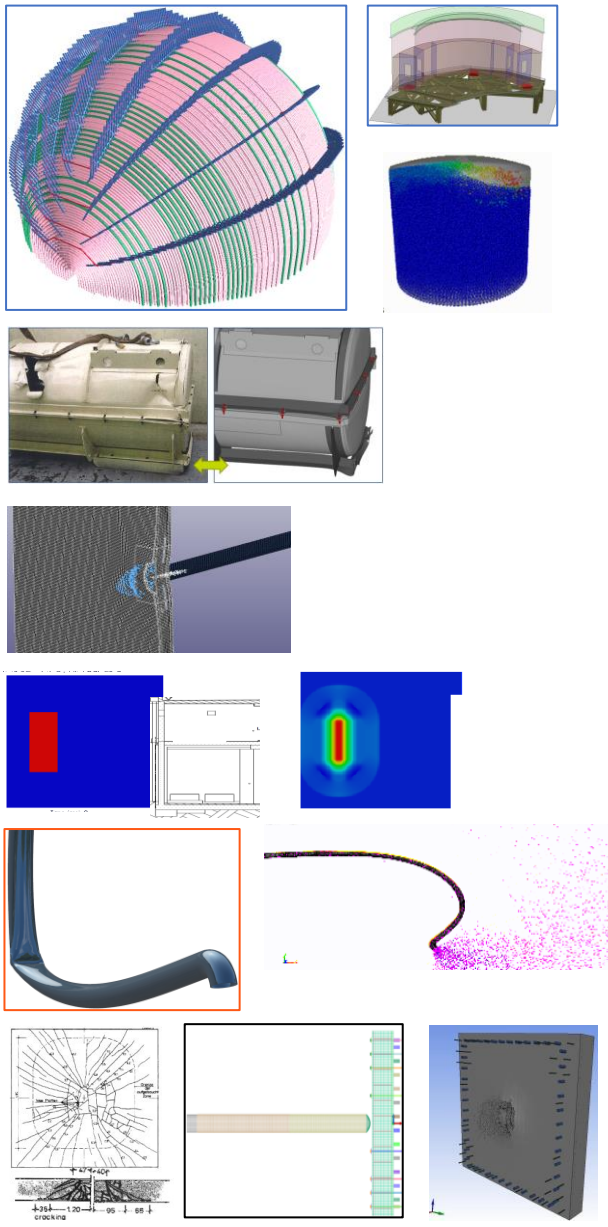
Falling loads
- Design and verification of fuel transport containers under regulatory drop tests.
- Handling drops of heavy components onto reinforced concrete slabs.

Tornado risk
- Resistance to tornado events: effects of pressure drop and wind loads on buildings.
- Impact effects of projectiles such as steel pipes, vehicles, timber beams, etc.

Explosion consequences
- Modeling of a detonative hydrogen-air explosion and its impact on surrounding structures and buildings.
- Explosions of flammable gas cylinders and rupture of large-capacity cryogenic inert gas tanks.
- Modeling of hydrogen combustion in the detonative regime and shock wave propagation in air.

Pressurized piping rupture
- Assessment of the consequences of a primary piping rupture on distant supports and structures.

Malicious acts
- Definition of a demonstrator for simulating the impact of a deformable missile on a reinforced concrete slab.
- Resistance of a slab to blast waves.
- Development of demonstrators to assess the effects of a TNT charge placed close to a plain reinforced concrete structure.



References

Framatome's factories

EDF

CEA

ORANO

Tools

The studies are carried out using a range of qualified tools:
- EUROPLEXUS, LS-DYNA, VPS
- HPC Calculation cluster

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