Seismic Resilience of a Carbon Black Plant and the Importance of its Industry Specific Components

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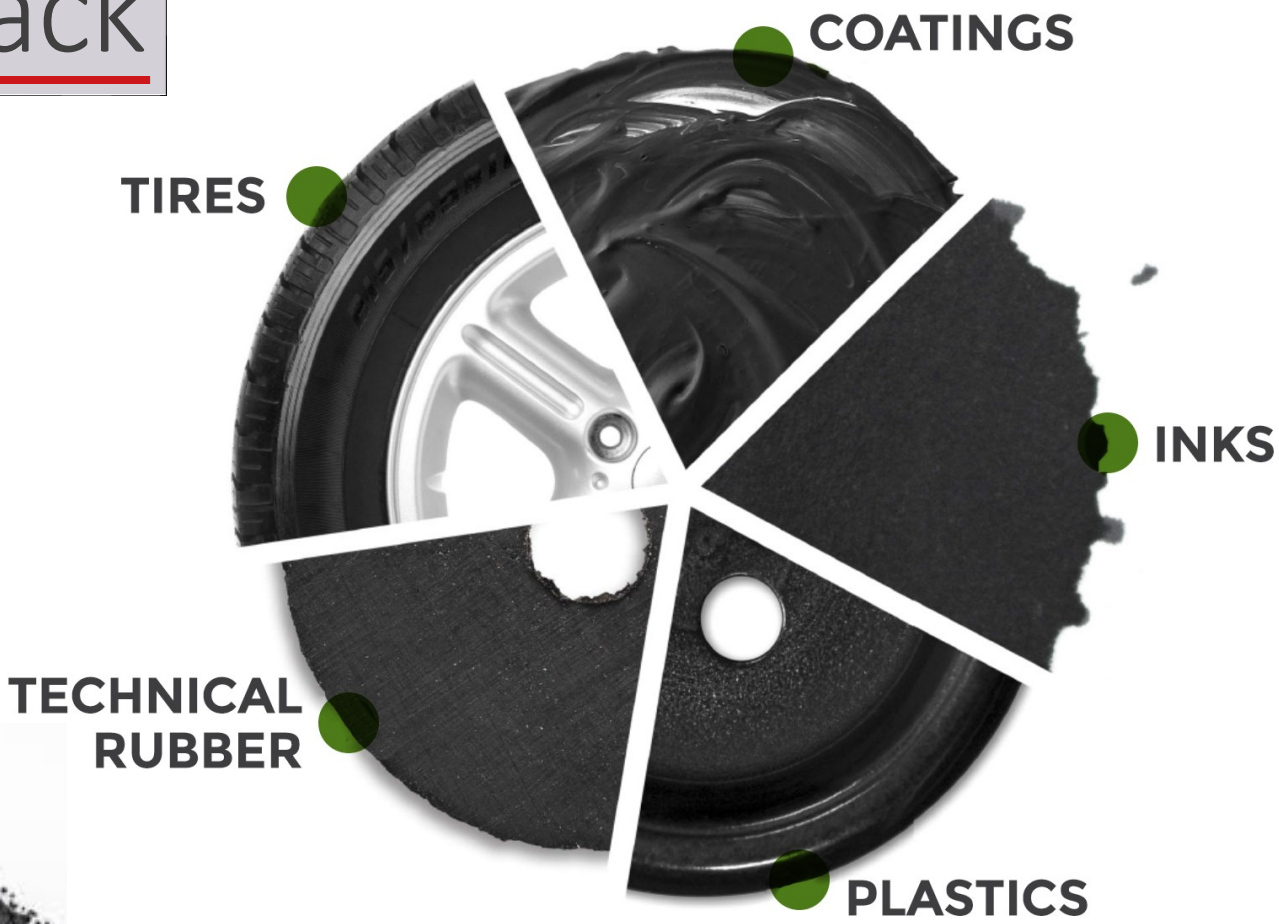
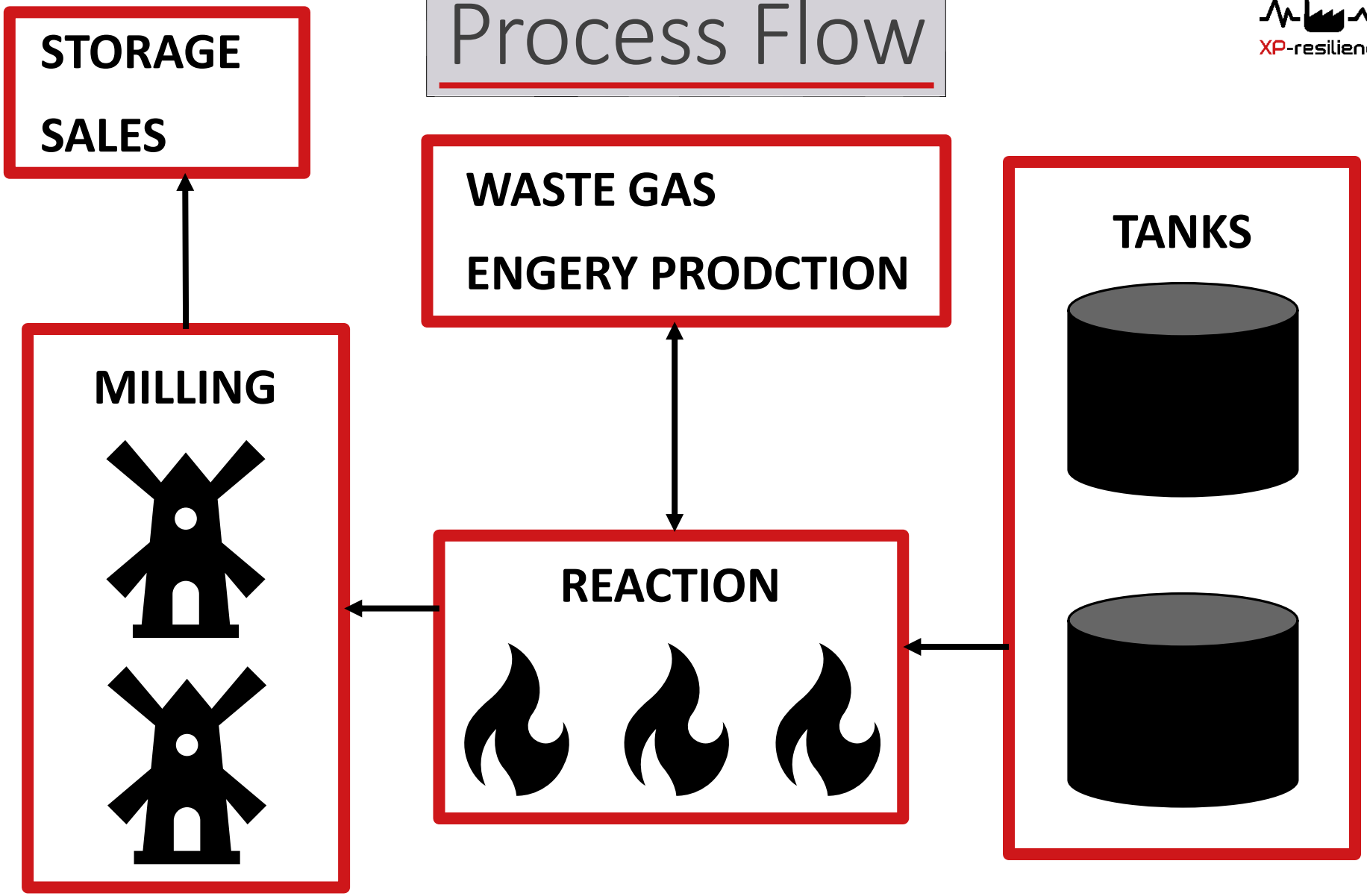
Motivation

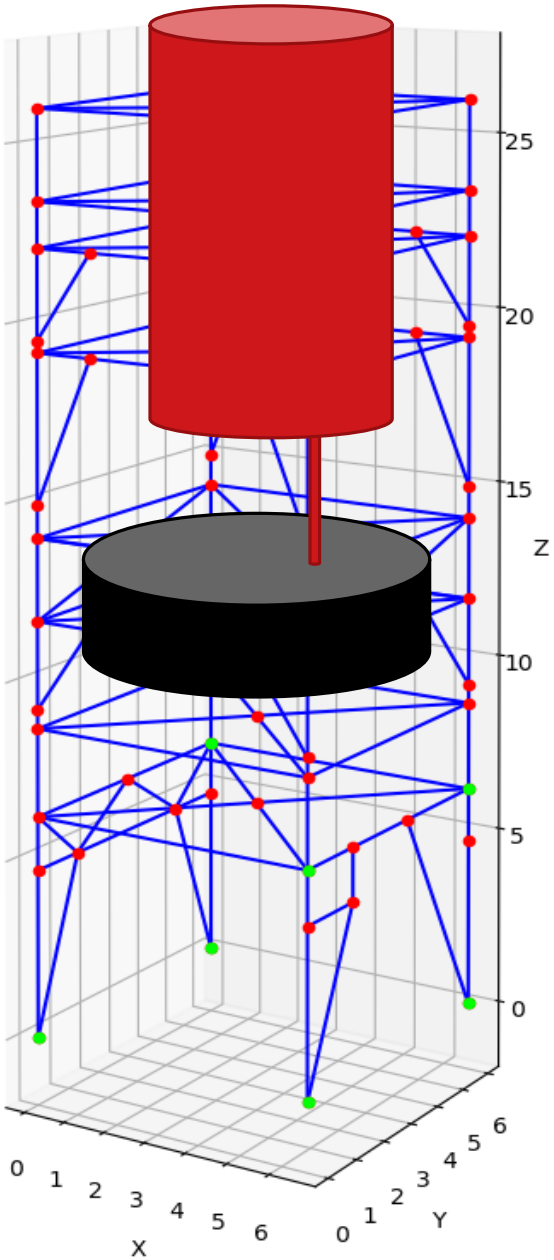

Environment
Economic Loss
RESILIENCE
Community
Human Lifes

Carbon Black



Process Flow



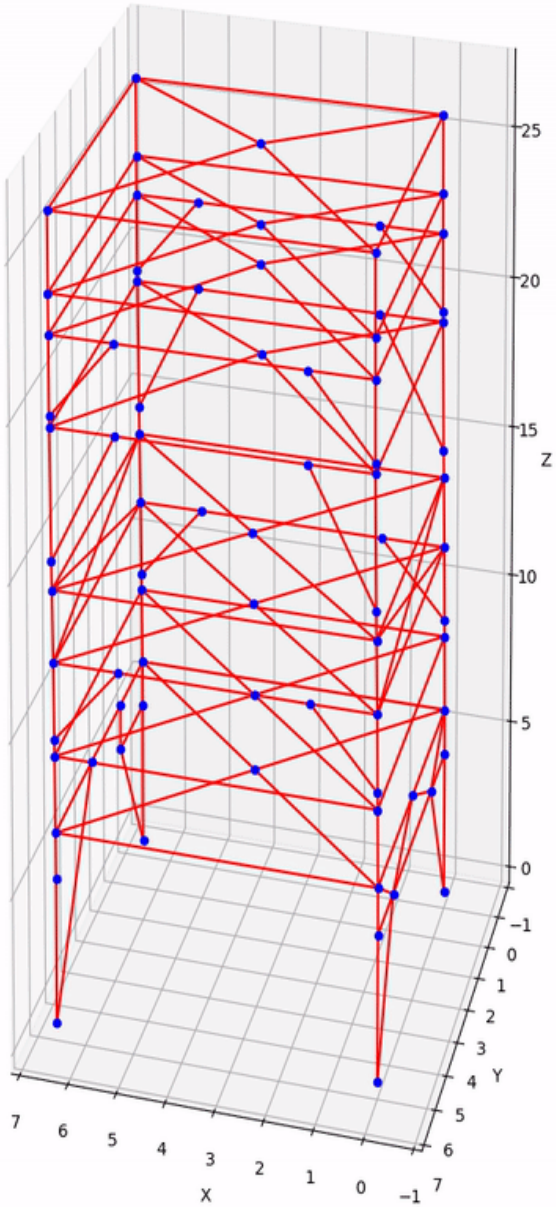


Milling Tower

Equipment:

- **Supports** at 1st floor surrounding Buildings
- Braced in X direction
- Moment Resisting Frame in Y direction
- **30 ton** Top Tank (300m³ 100g/l)
- **10 ton** Bottom Tank
- Connection with a **Bolted Flange Joint**

Push Over

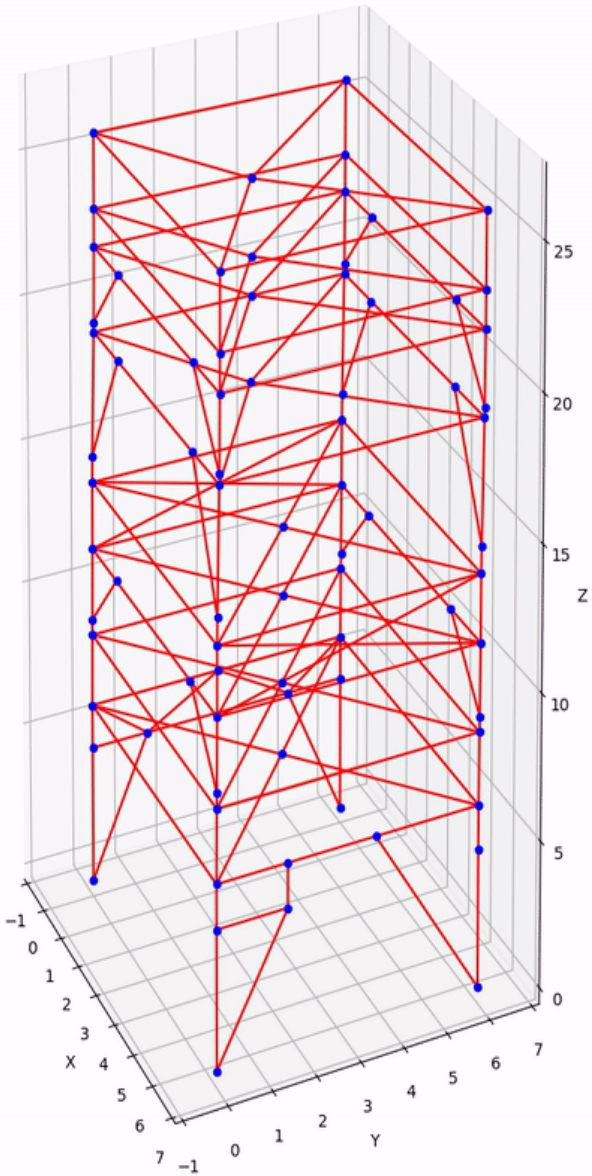


← Push Over X

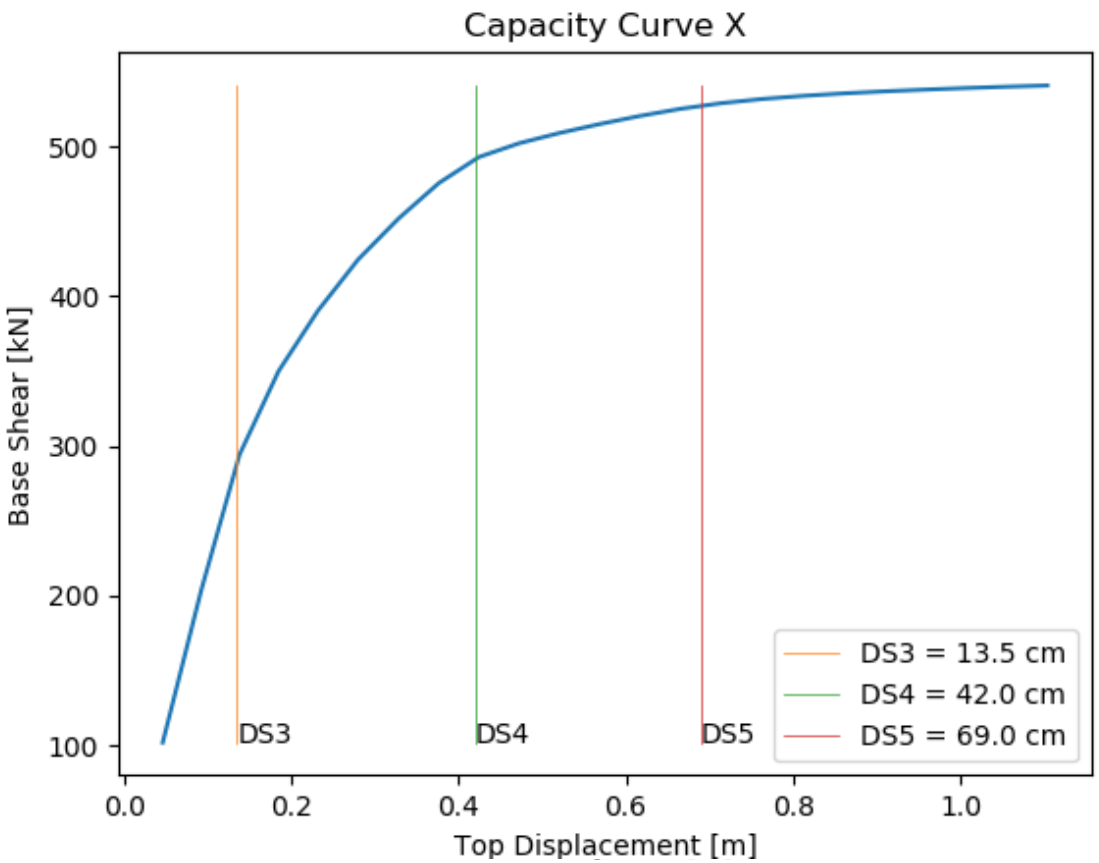
- The Tower shows a good stiffness distribution over its height.
- A significant Load resistance can be achieved

Push Over Y →

- A weak story shows failure first.
- Responsible for system and component failure

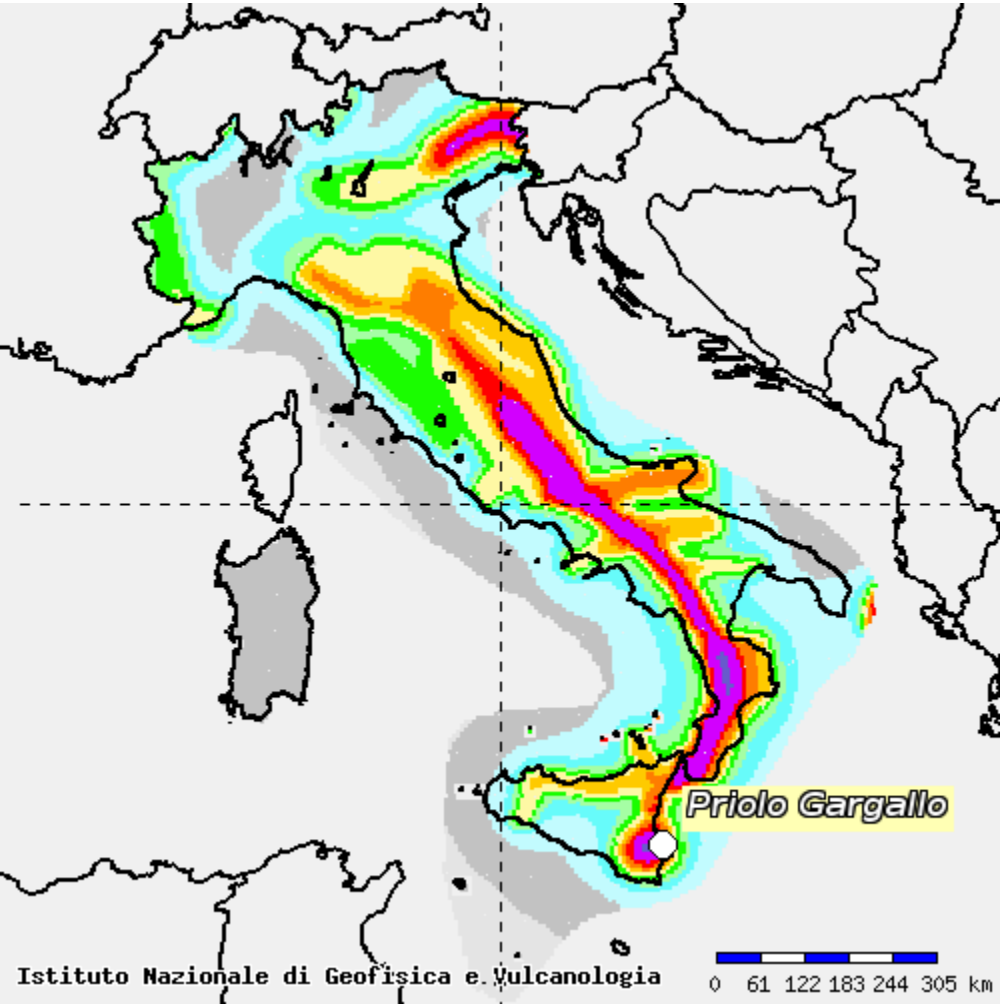


Damage States

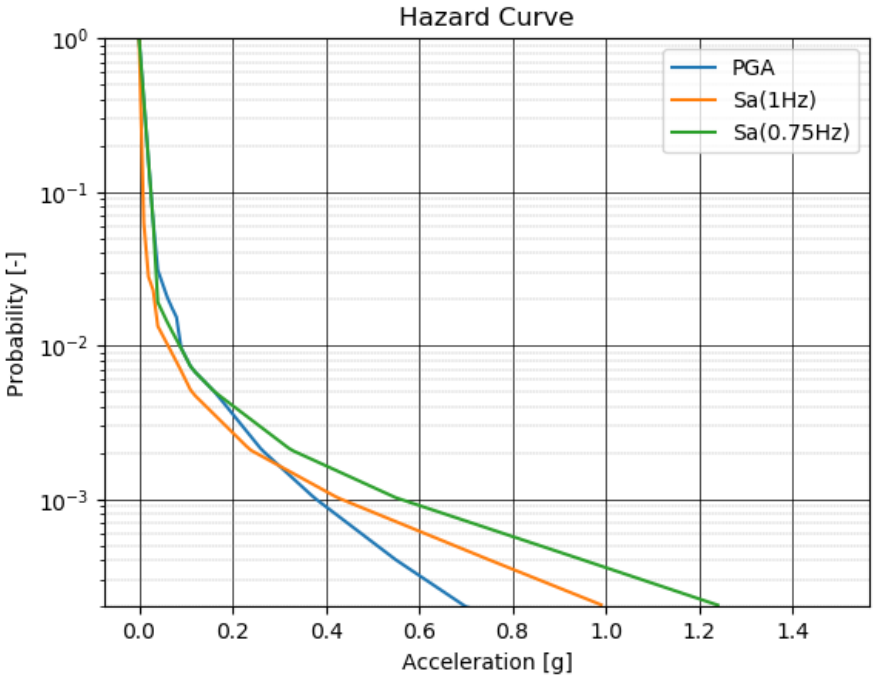


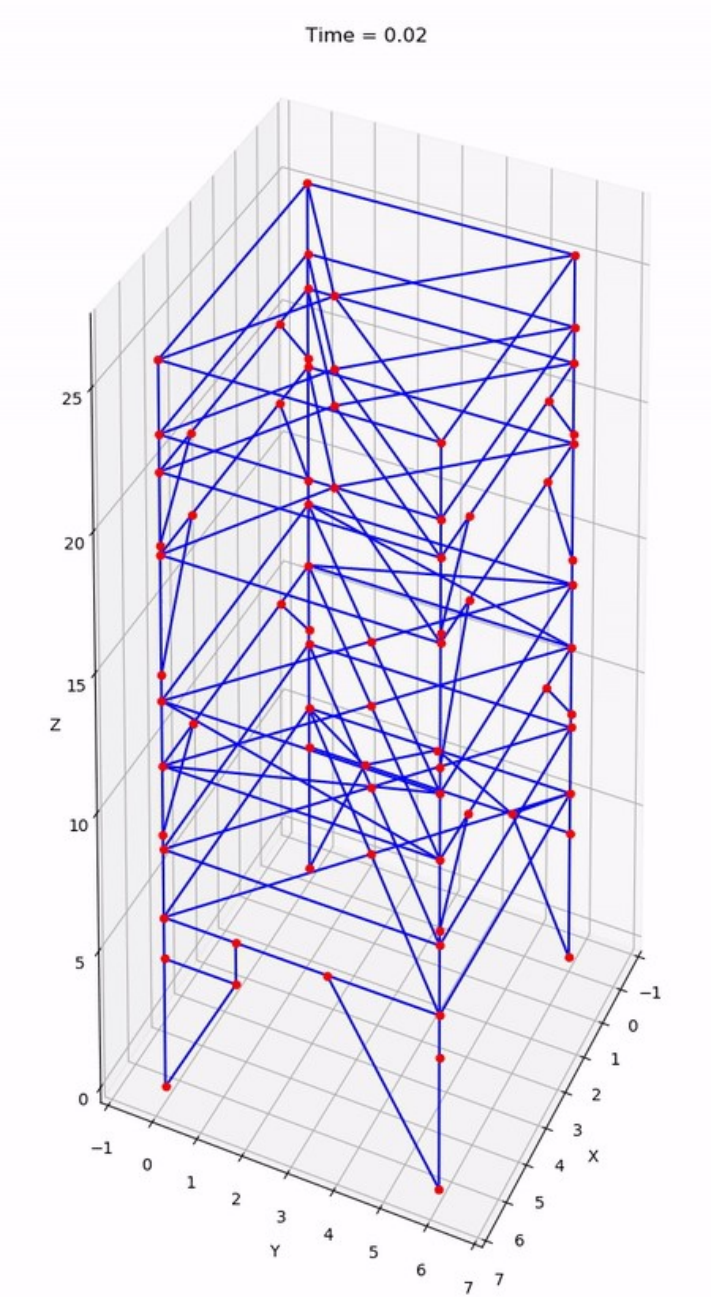
- Damage State 1: Loss of Containment LOC Bolted Flange Joint. Drift: 0.2 %
- Damage State 2: Plastic deformation of Bolted Flange Joint. Drift: 0.5 %
- Damage State 3: Minor Structural Damage and Equipment failure
- Damage State 4: Major structural Damage occurs
- Damage State 5: Collapse of the Structure

Seismic Hazard



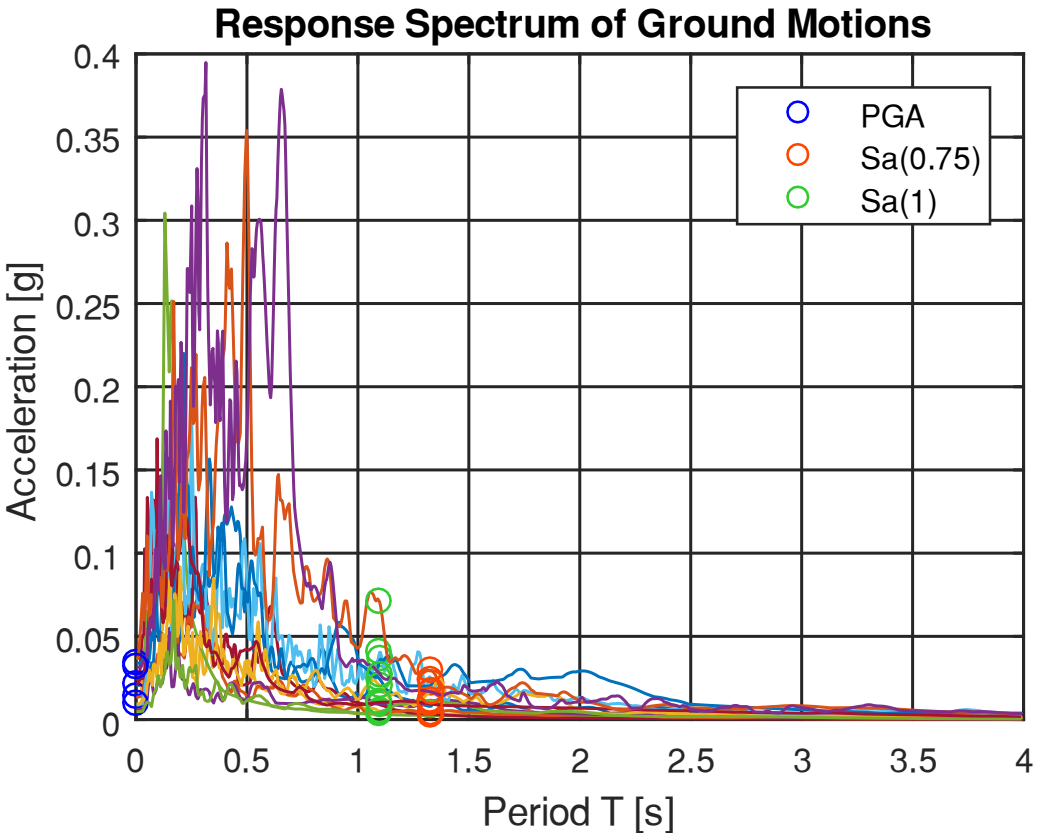
- Priolo Gargallo
- Very high seismizity
- Hazard curve shows the likelyhood of observing an EQ with specific IM



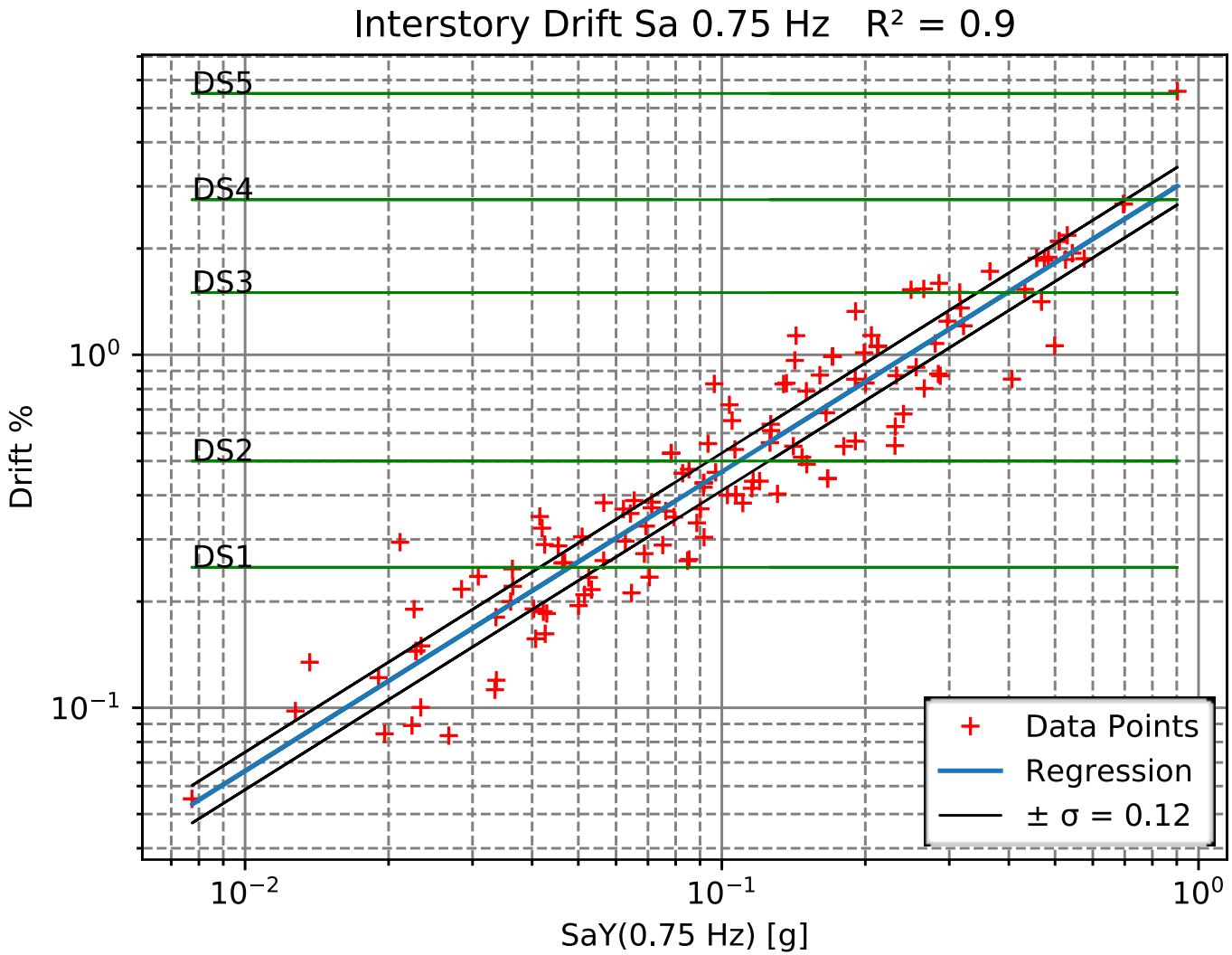


Cloud Analysis

- Probability of reaching each Damage State
- 140 Ground Motions



Cloud Analysis



DS1: 0.25 %

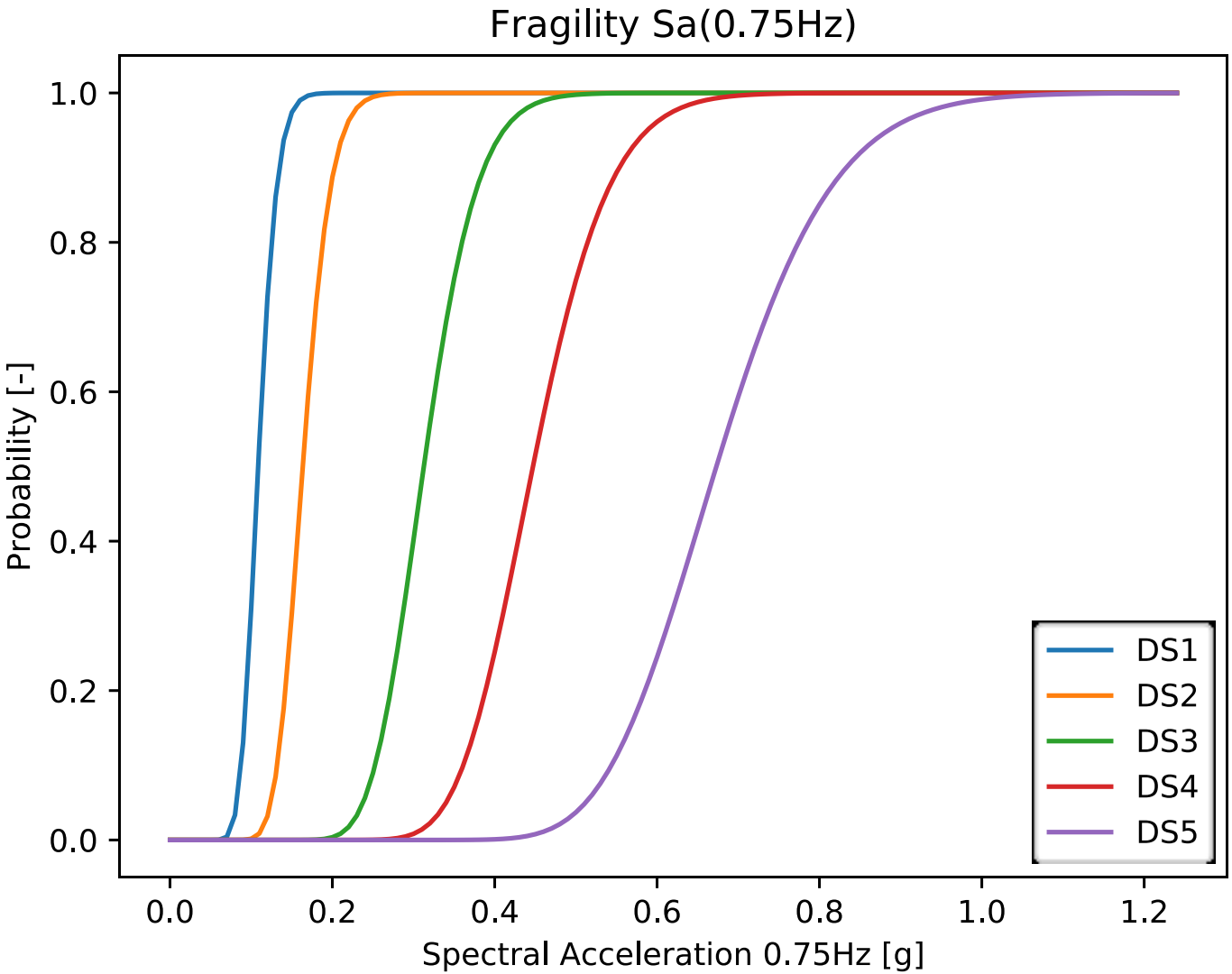
DS2: 0.5 %

DS3: 1.5 %

DS4: 2.75 %

DS5: 5.5 %

Assessment



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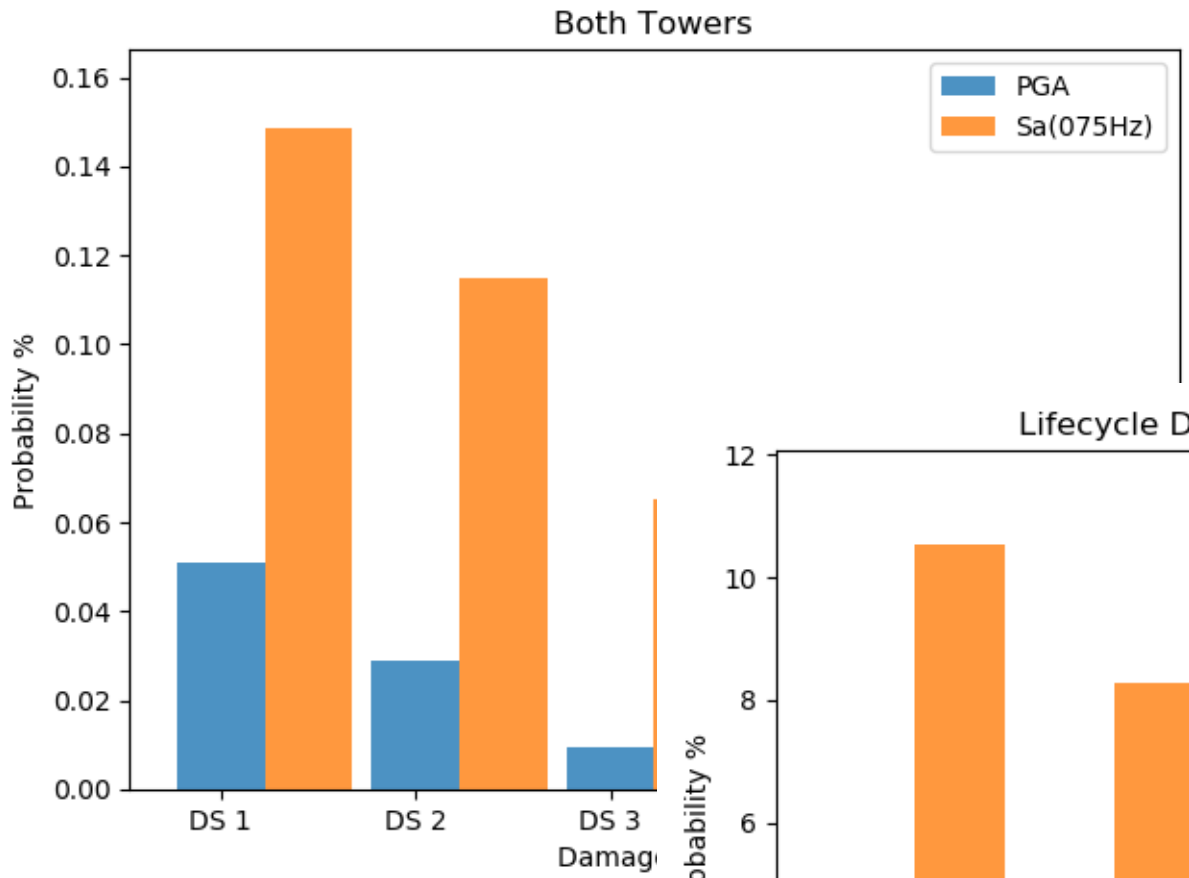
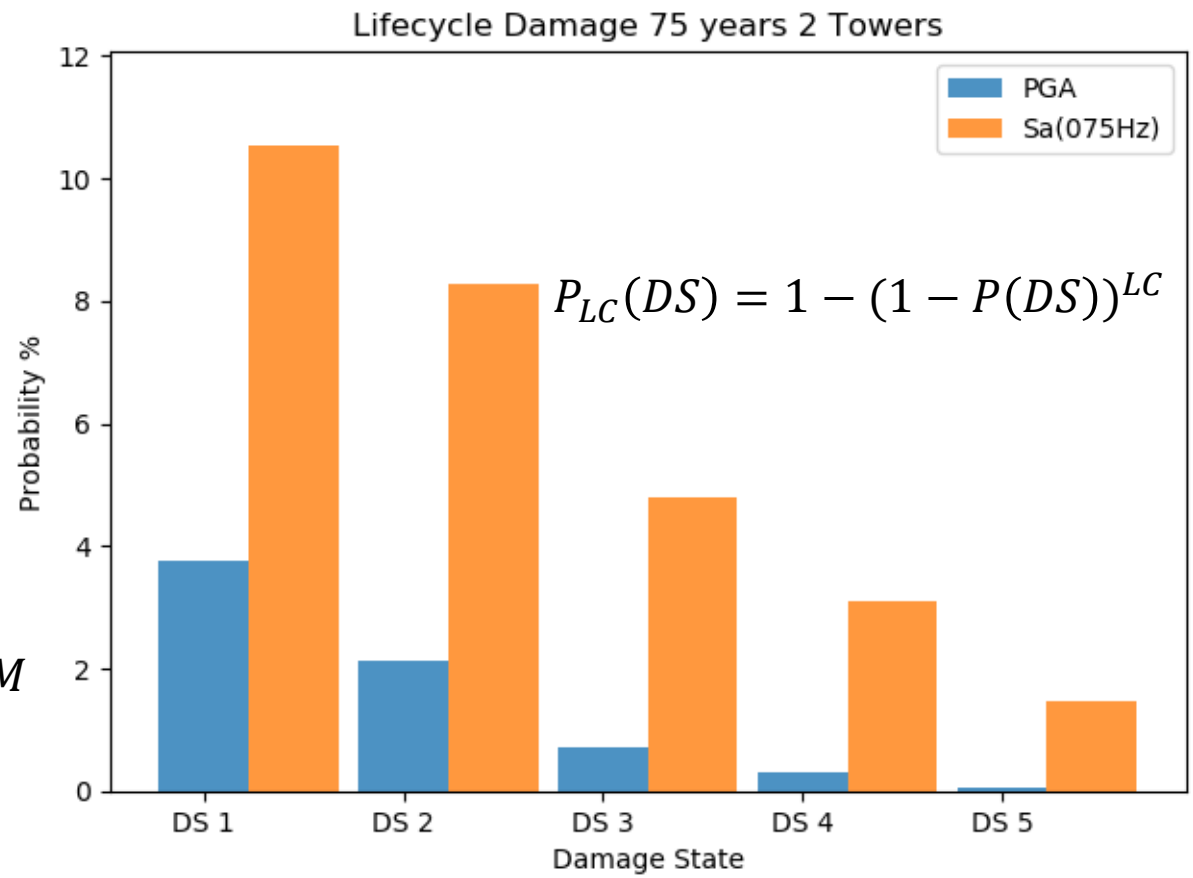
Probability



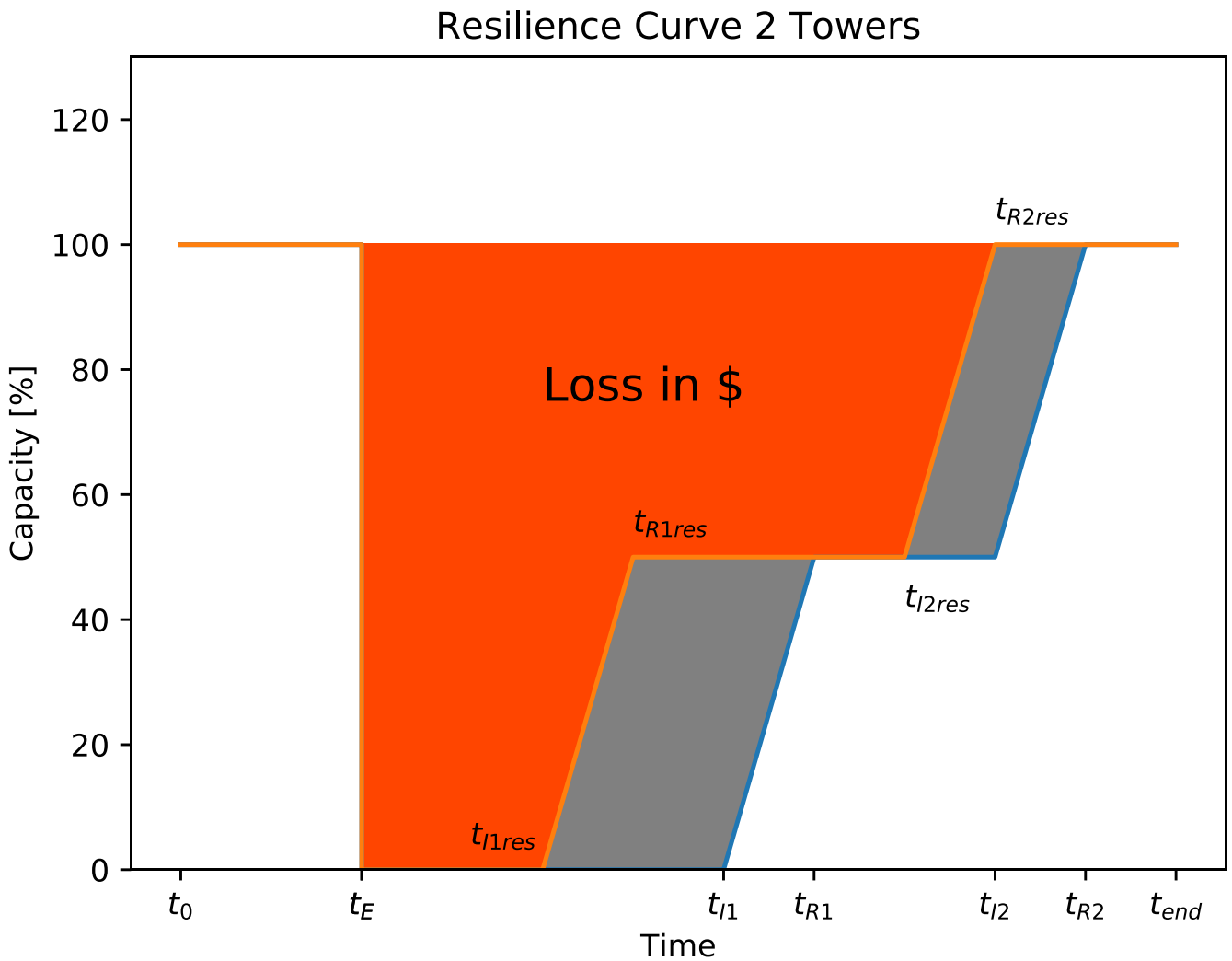


$$P_{LC}(DS) = 1 - (1 - P(DS))^{LC}$$

$$P(DS) = \int P(EDP|IM)^2 P(IM)dIM$$

Resilience

$$R_{LOSS} = \int_{t_E}^{t_R} [100 - C(t)]dt$$



Reduce:

- Area of Loss
- Risk of Failure
- Capacity Loss
- Repair Time

Acknowledgements:

XP-Resilience
Ref: 721816

https://r.unitn.it/en/dicam/xp-resilience

Conclusion

- Resilience provides additional options to the Stakeholder for Loss mitigation
- In Depth Risk analysis of the components crucial to the Resilience calculation