Validation of FPSWizard Horizontal Lifeline Calculator

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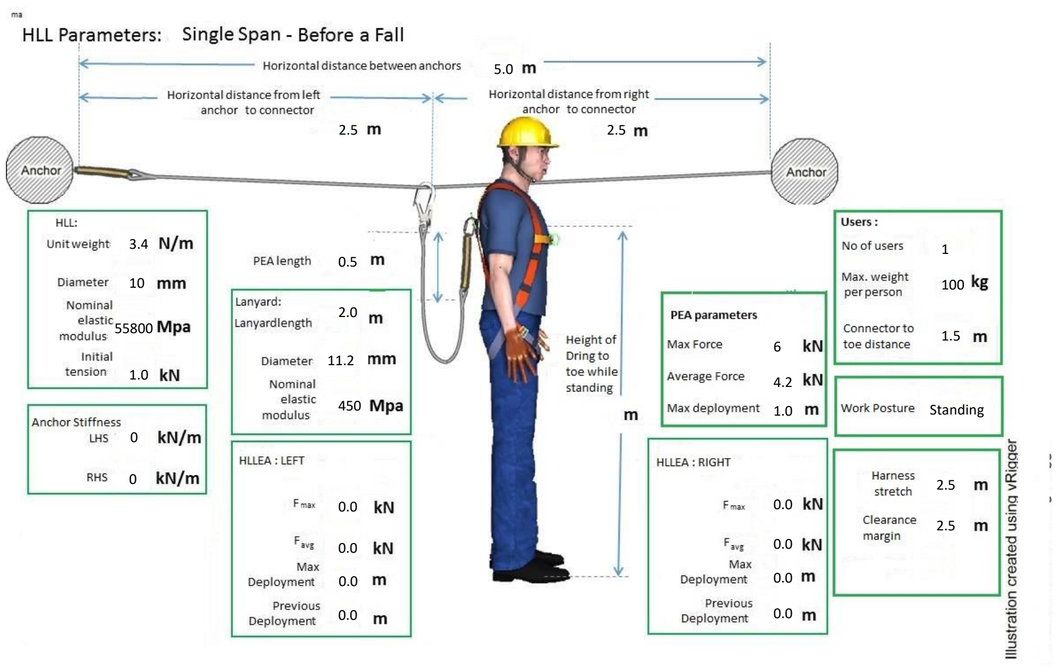
Background: Prevalence of incorrect engineering calculations for Horizontal Lifeline (HLL) designs as reported by Goh and Wang (2015); lack of empirically validated HLL calculators.
Aim: To validate and calibrate FPSWizard calculators based on experiments.

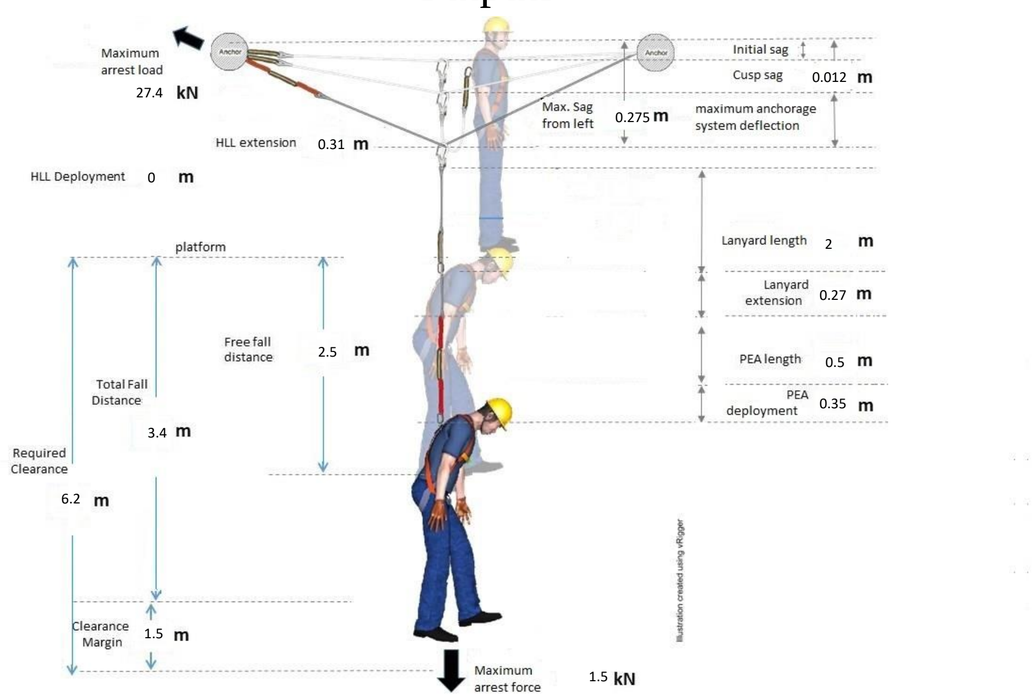
Phase 1	Phase 2	Phase 3
➢ A mathematical formulation is developed based on Newtonian mechanics and energy conservation to ensure safety of the workers and HLL setup.	➢ A calculator (FPSWizard) is developed to calculate maximum arrest load (MAL), total fall distance (TFD) and maximum arrest force (MAF).	➢ Conducted experiments by varying different factors such as span length, rope material, etc. to cross check and validate FPSWizard outputs. ➢ Introduced correction factor in FPSWizard to improve accuracy.

FPSWizard: Horizontal Lifeline Calculator Template

Inputs

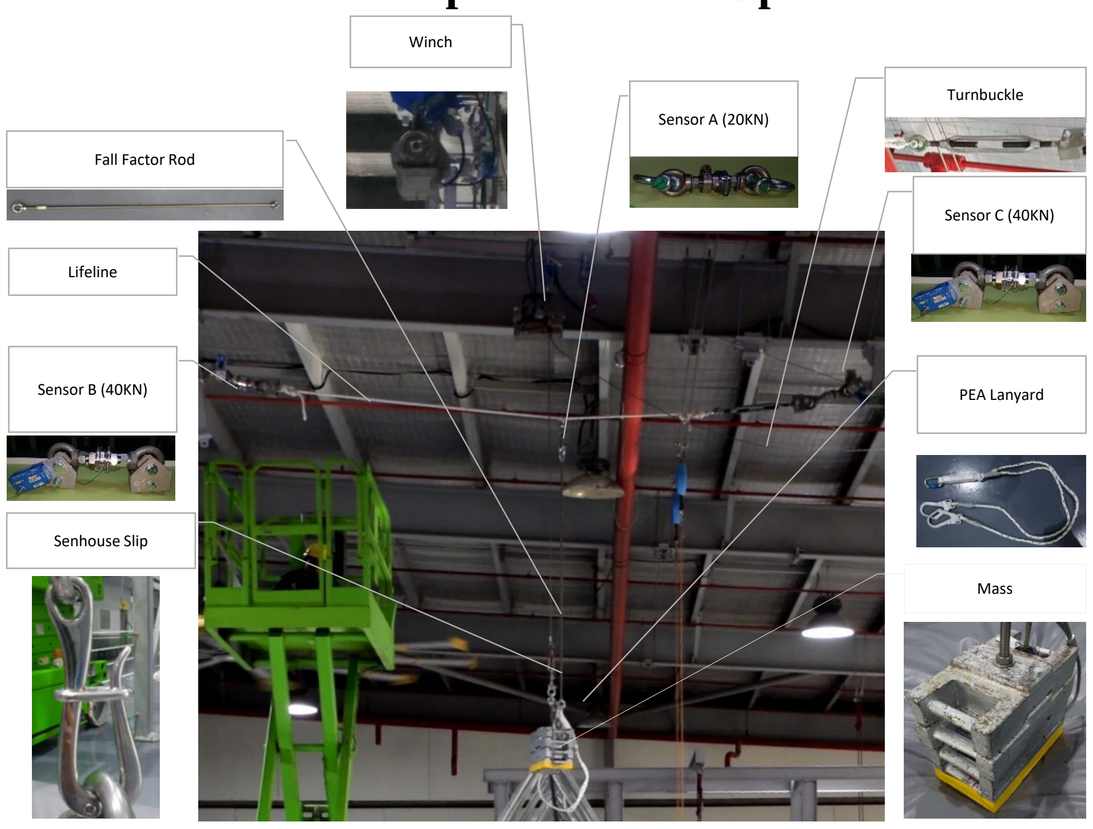


Outputs



Experimental Validation of FPSWizard

Experimental Setup



Methodology

- For each experiment, free fall distance (FFD) is measured by analyzing the video of the drop.
- Total fall distance is determined from the force-time data of the force sensors and FFD.
- Maximum arrest load is recorded from the force sensors.
- According to the law of conservation of energy, total energy of a system is conserved.

Energy conservation

Loss in GPE during Free Fall + Loss in GPE during PEA extension + Loss in GPE due to extension of Lanyard + Loss in GPE due to extension of HLL = Energy absorbed by Lanyard + Energy absorbed by PEA + Energy absorbed by HLL

Total Loss in Gravitational Potential Energy | Energy absorbed by HLLS

Validation of FPSWizard

- 48 Drop tests performed.
- TFD and MAL are compared with FPSWizard outputs.
- FPSWizard is improved by introducing correction factors and safety factors based on validation.

Conclusion

- Strong correlation between experimental TFD and FPSWizard.
- Newly introduced correction factors will improve the reliability of FPSWizard.
- MAL calculated from the FPSWizard is adequate to ensure structural integrity of the HLL system.

Benefits to Industry

- Professional Engineers and WSH officers with suitable training can use the FPSWizard for designing or checking HLL in accordance to SS607:2015.

Future Work: Train Professional Engineers and WSH officers to use the calculator and convert the calculator into a mobile app.

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