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An Adaptive Shock Absorber for Perforating Gun Shock

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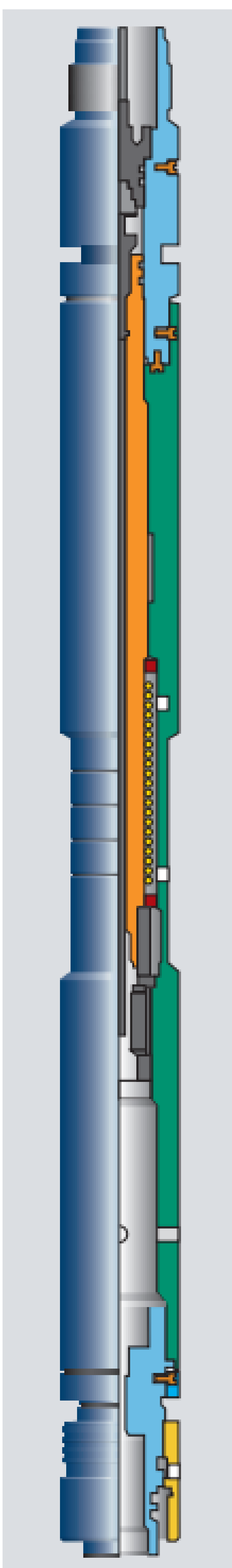
Abstract

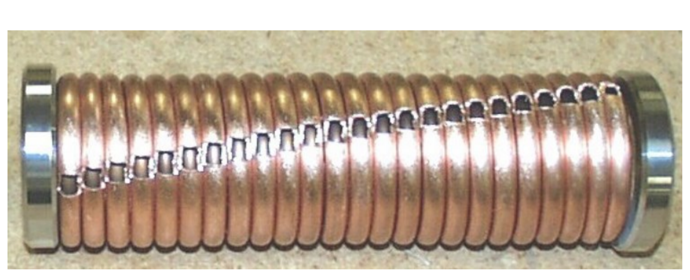


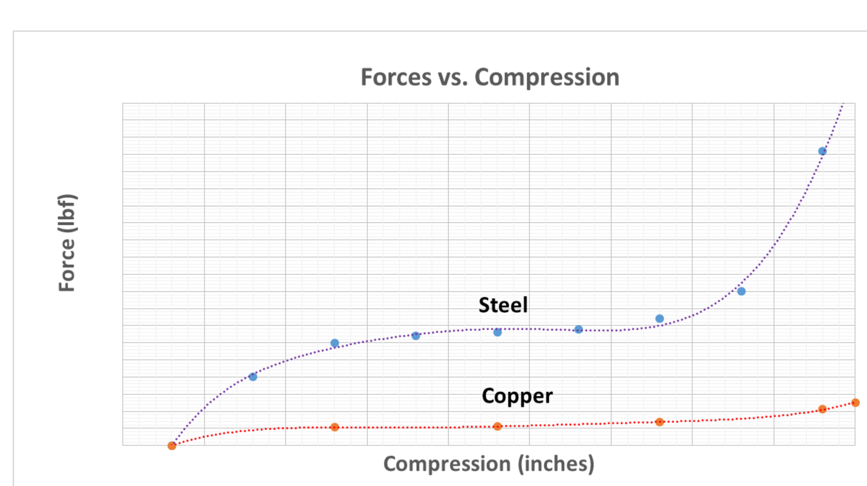
Wireline Perforating Shock Absorber

During a perforating job, the detonation and its induced pressure wave in fluids produces large magnitude stress wave in the gun string. It may damage the delicate electronics, as well as, weak mechanical components. Tremendous shock mitigation efforts, such as design of shock isolation devices, optimization of gun string layout, and numerical modeling, have been investigated by both the Service Company and Operators.

Shock isolation device is designed by a passive shock isolation mechanism with a shock absorber, which is usually a crushable or spring-dashpot element to dissipate the detrimental energy. It is simple and effective for the application in a specific frequency band and energy level, etc. In this work, we present a new design of crushable shock absorber with adaptive shock reduction behavior. This design can be easily adjusted to suit for different gun string deployment and well conditions. The concept was developed by finite element analysis and verified through experiments. Successful job histories have been reported.

Energy Absorption Mechanism

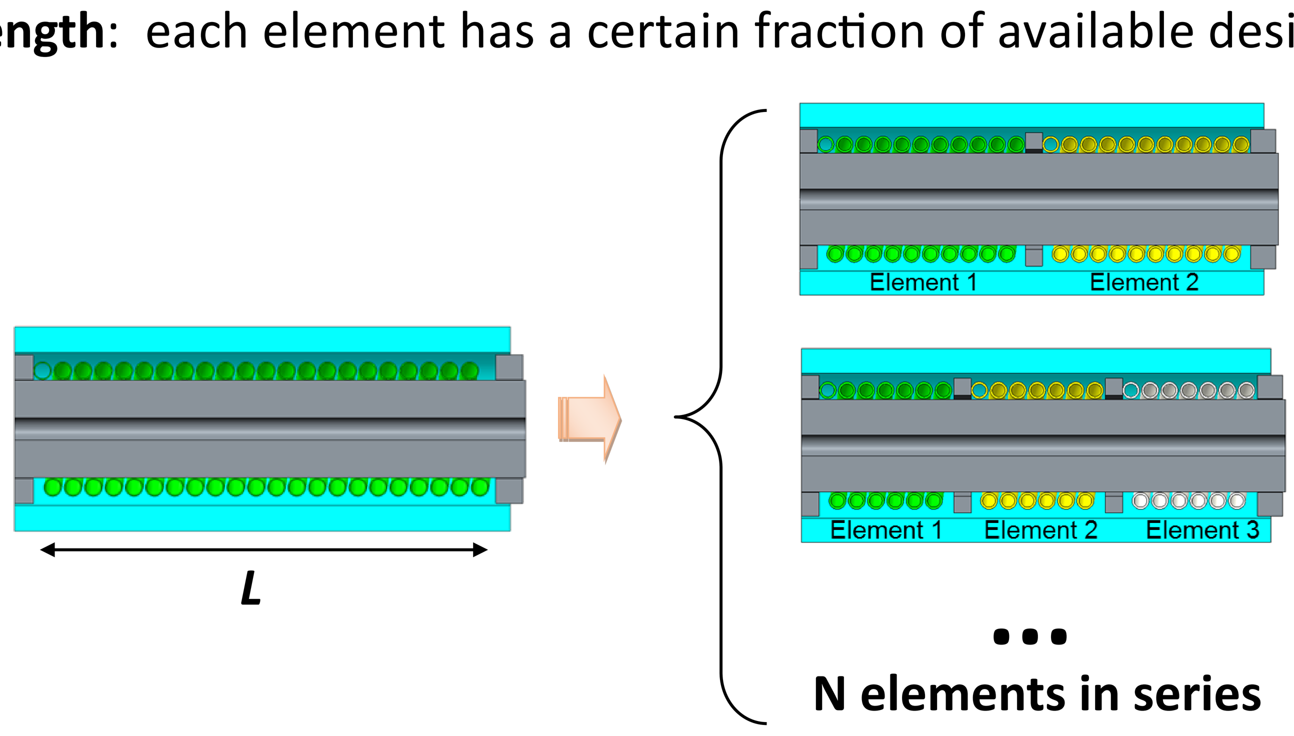




- Copper crushable element as a shock absorber in wireline application
- Steel crushable element can absorb more detonation energy through the deformation of coiled tube due to its higher yield strength

Concept of Adaptive Shock Absorber

- **Material**: Combination of N types of materials, each with different yield strength
- **Length**: each element has a certain fraction of available design length ***L***



Reference

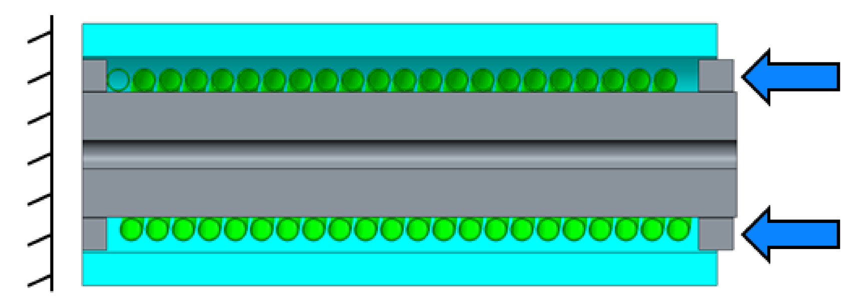
Patent Pending of "Adaptive Shock Absorbing Element", 2016, Schlumberger.

Feasibility Study with Finite Element Analysis

Typical Yield Strength Range of Engineering Materials

Material	Yield Strength [ksi]
Copper	20
Aluminum	35
Steel	120

Boundary Condition and Loading Condition

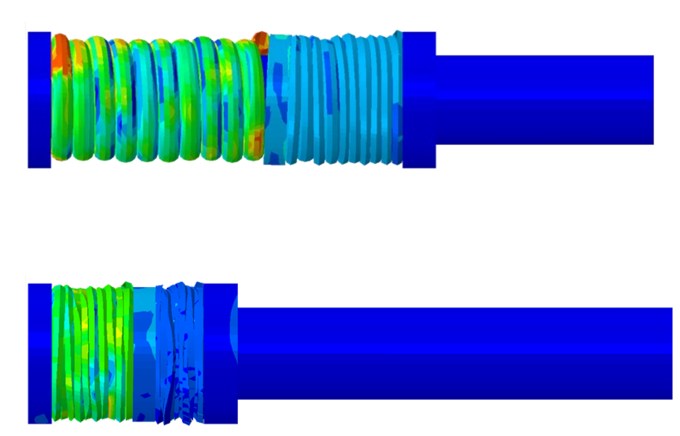


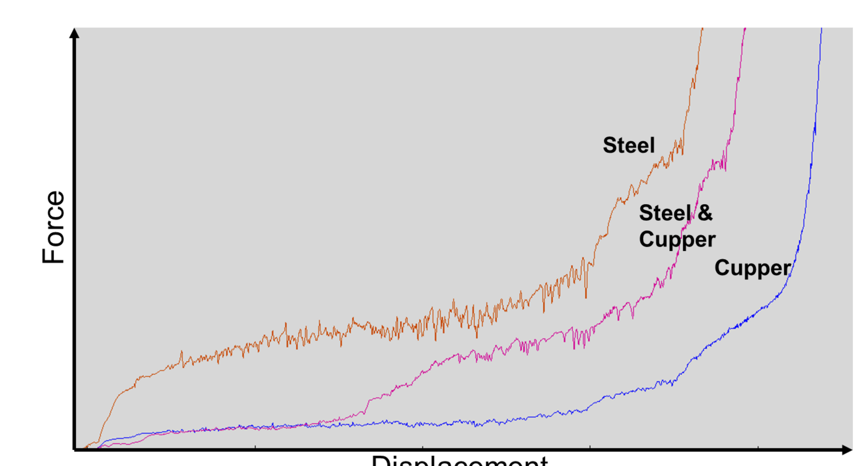
- Left end fixed
- Right end compressed by displacement
- Transient dynamics simulation

Case Study

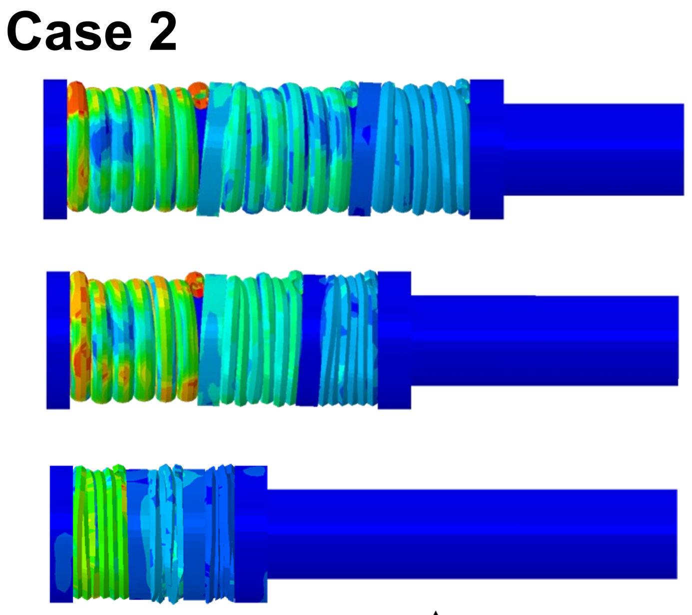
Case #	Element 1	Element 2	Element 3
1	Steel, *L/2*	Copper, *L/2*	-
2	Steel, *L/3*	Aluminum, *L/3*	Copper, *L/3*
3	Steel, *L/3*	Steel, *L/3*	Copper, *L/3*

Case 1

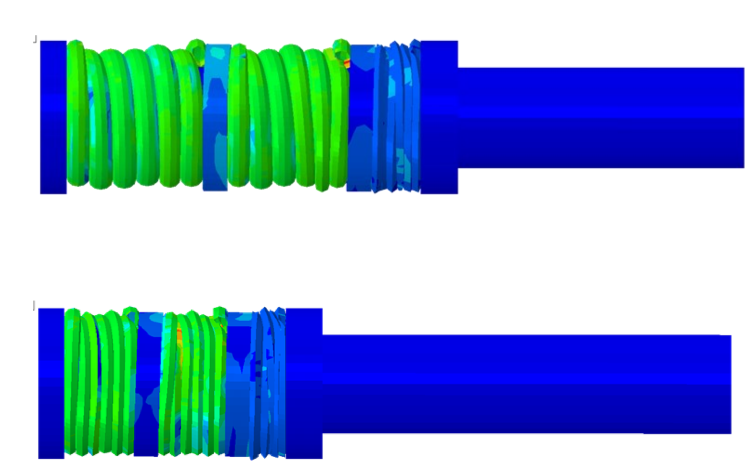


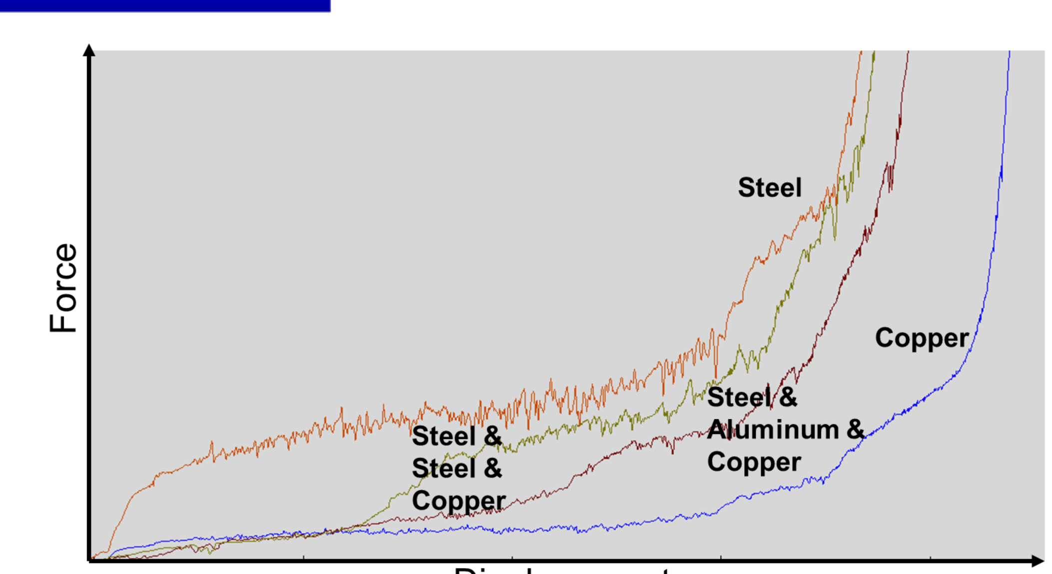


Case 2



Case 3

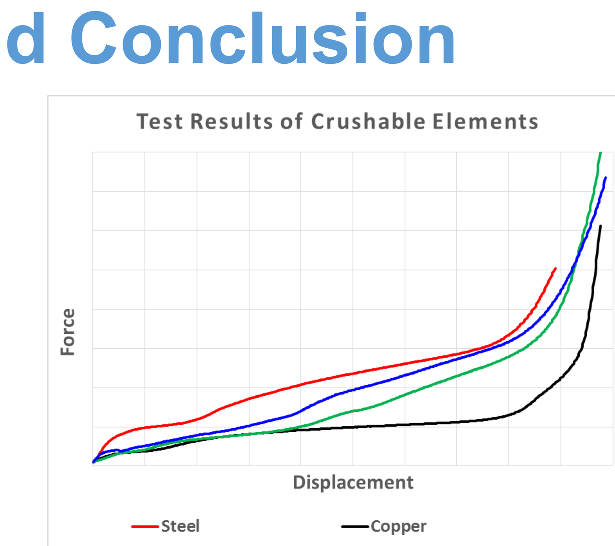




Experimental Verification and Conclusion

50%Copper +50% Steel

30% Copper + 70% Steel



According to FEA analysis and experimental test results, in a high-load, high-shock perforating environment, a hybrid crushable element can deliver better performance. For the purpose of fitness for service, an optimal design with a smooth shock absorption behavior can be achieved by tuning the length ratio of materials with low- and high-yield strength.