

AFRIROCK

2025

PIONEERING PROGRESS : THE FUTURE OF ROCK ENGINEERING

Performance and mechanical properties of a styrene-free polyester resin produced with
water-based catalyst and a new generation catalyst

G Smolnik, R Penczek, J Franek, D Bucholc - SANDVIK Ground Support, Poland

Our number 1 priority

Safety first



Emergency exit



Assembly point



Protective equipment



Emergency number



First aid kit



In case of emergency



Psychological safety



Health and well-being



Cyber security





Emergency exit



Assembly point



Protective equipment



Emergency number



First aid kit



In case of emergency



Psychological safety



Health and well-being



Cyber security



Safety improvement

Styrene-Based Resin Capsules

Labelling according to Regulation (EC) No. 1272/2008 (CLP)

Hazard Pictograms (CLP):



GHS07



GHS08



GHS09

Signal Word (CLP): Warning

Styrene Hazards (Occupational Safety and Health Administration)

Diamond	Hazard	Value	Description
	Health	2	Can cause temporary incapacitation or residual injury
	Flammability	3	Can be ignited under almost all ambient temperature conditions
	Instability	2	Readily undergoes violent chemical changes at elevated temperatures and pressures

*New generation **of Resin Capsules***

Our goals:



Safety improvement



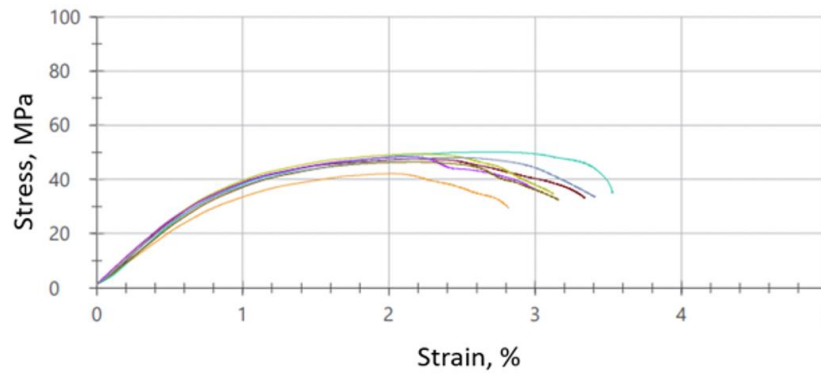
Performance improvement



Installation improvement

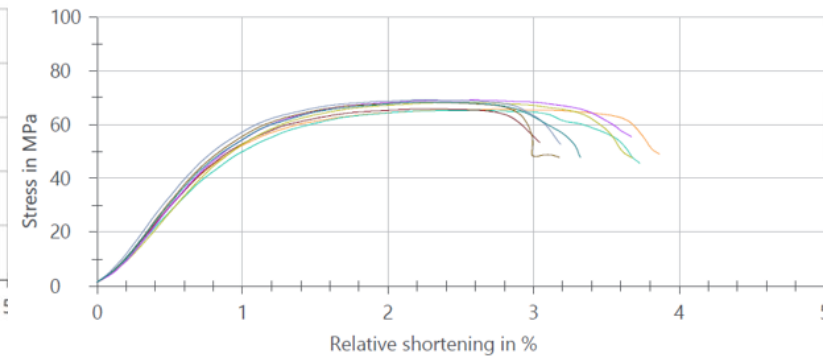
Compressive strength

Fasloc®



<50 MPa

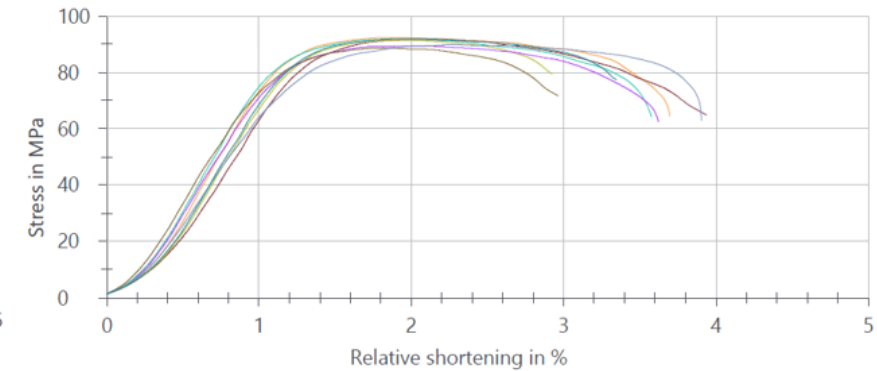
Fasloc® SF
(Water based catalyst)



~67.5 MPa

Fasloc® SF

Emulsified Peroxide Catalyst (EPC)

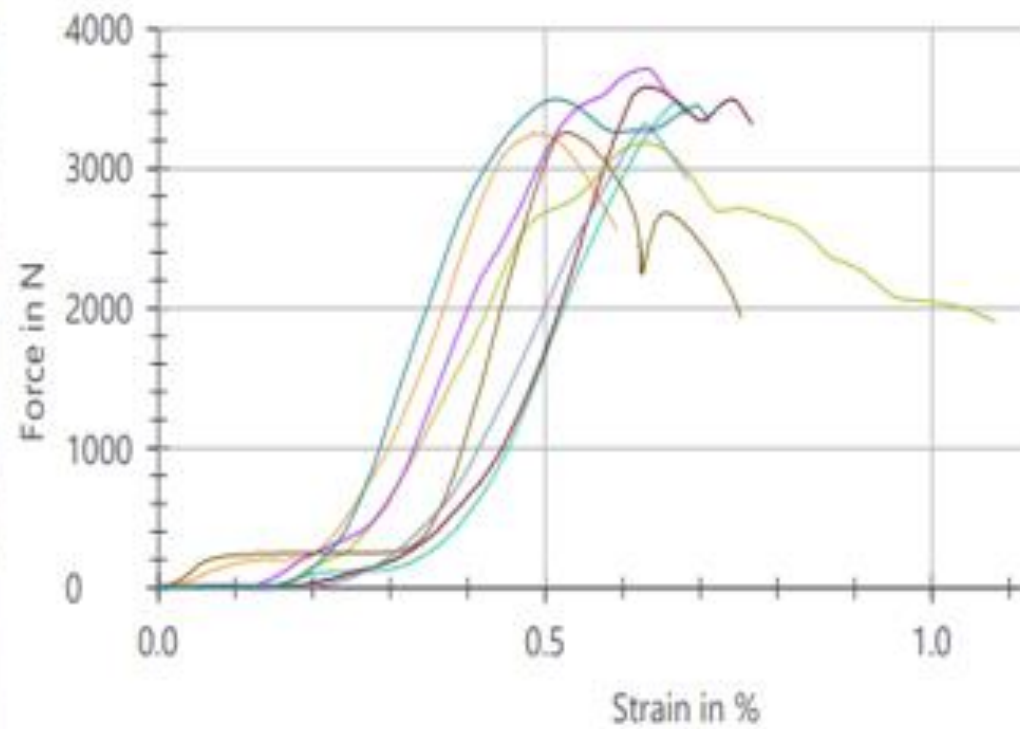
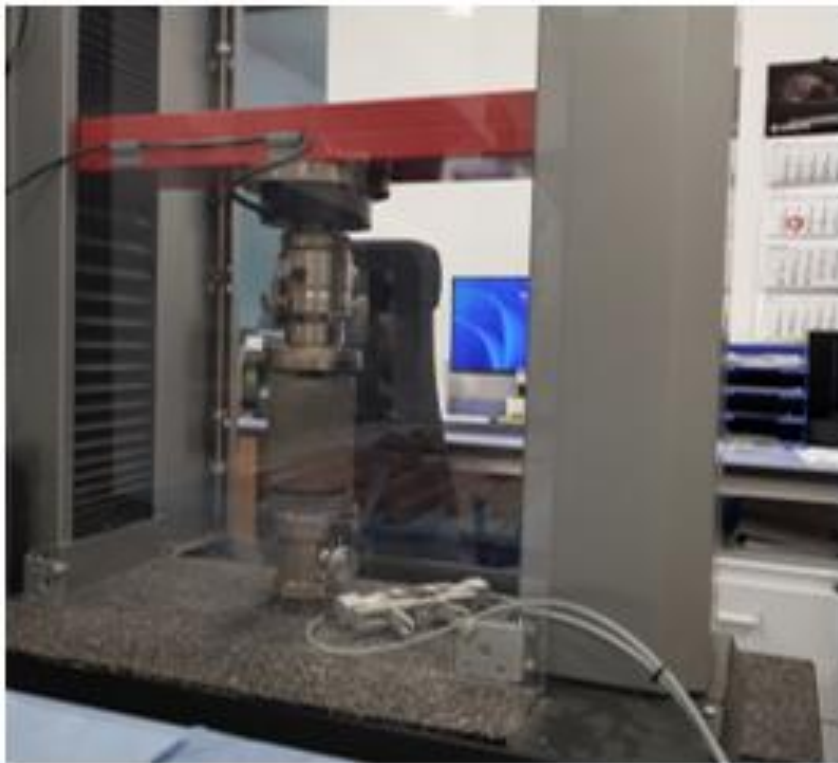


~90 MPa

SHEAR STRENGTH – SANS 2018

Fasloc® SF

Emulsified Peroxide Catalyst (EPC)

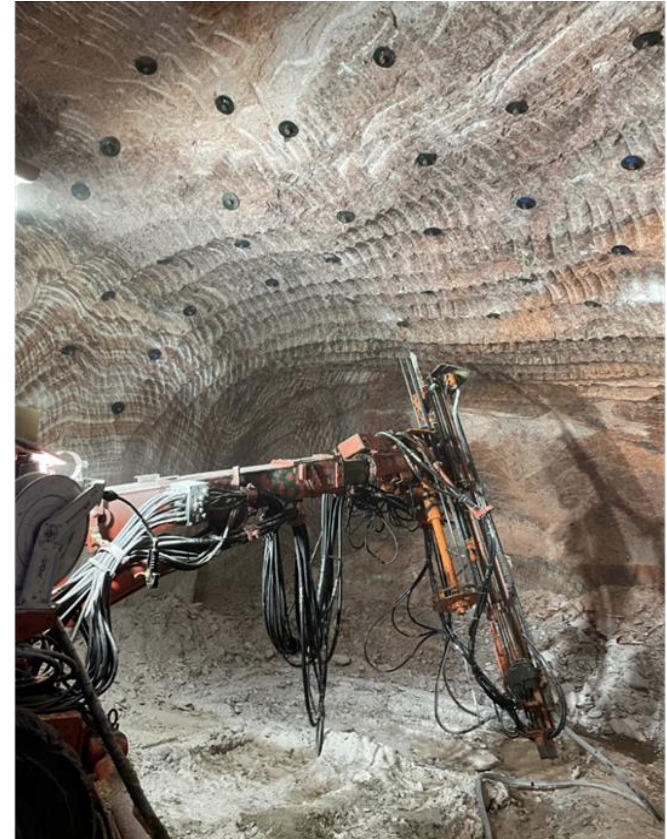
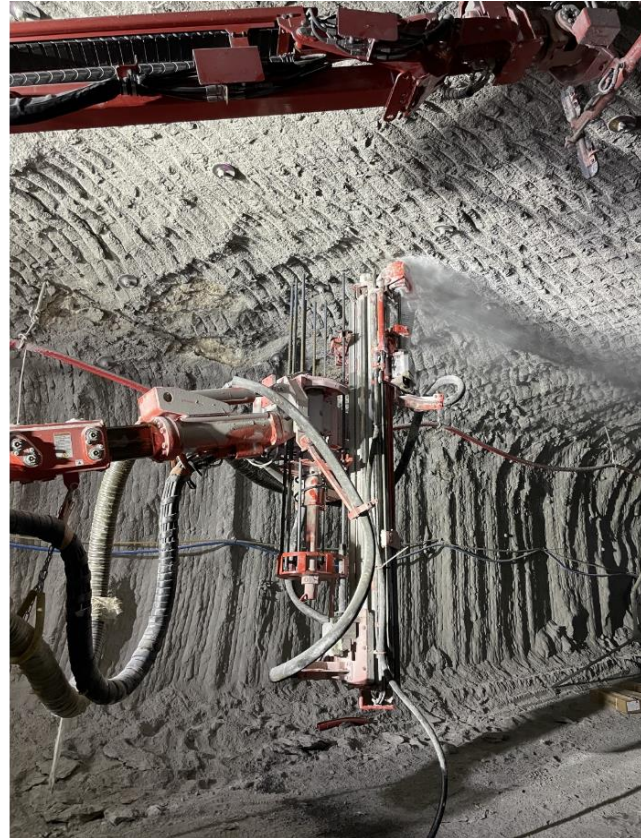


~34 MPa

APPLICATION TRIAL IN UNDERGROUND WORKINGS (Testing Gallery)



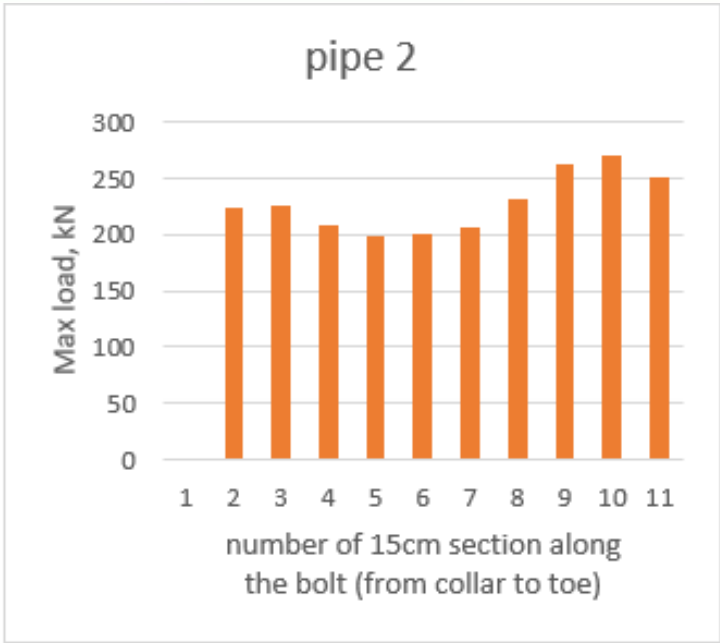
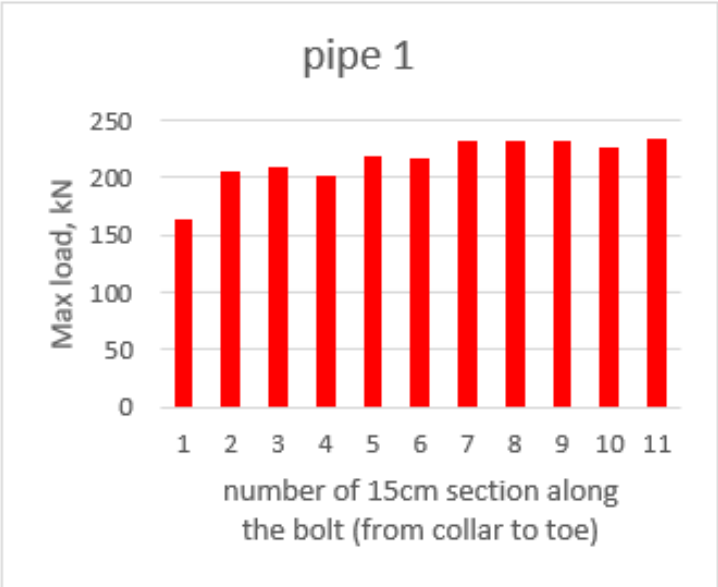
ROOF BOLTING IN UNDERGROUND WORKINGS (Testing Gallery & stoping area)



SANDVIK GROUND SUPPORT DIVISION Advanced Bolting Testing Stand at Sandvik Facility, Tychy Poland



BONDING STRENGTH



IMPACT TESTING at CENTRAL MINING INSTITUTE DYNAMIC TESTING RIG

Rock Mechanics and Rock Engineering
<https://doi.org/10.1007/s00603-024-04159-z>

ORIGINAL PAPER



ISRM Suggested Method for Determining the Properties of Rock Bolt Assemblies by Mass Freefall Impact Testing in the Laboratory

Charlie C. Li¹ · Peter Mikula² · John Hadjigeorgiou³ · Brad Simser⁴ · Manchao He⁵ · Ismet Canbulat⁶ · William Joughin⁷

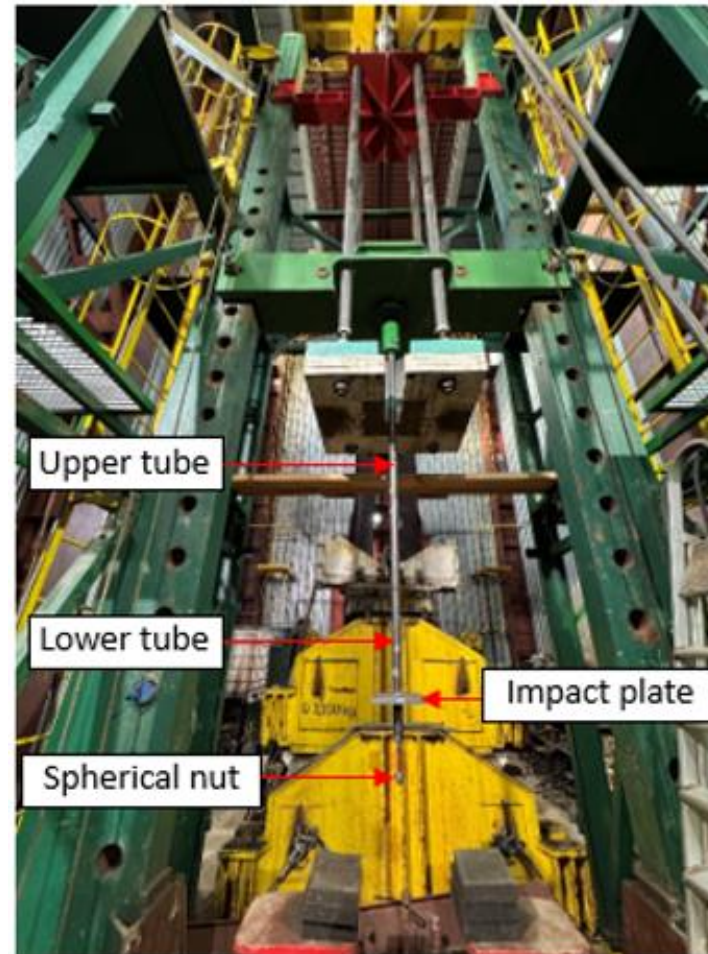
Received: 18 July 2024 / Accepted: 28 August 2024
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Abstract

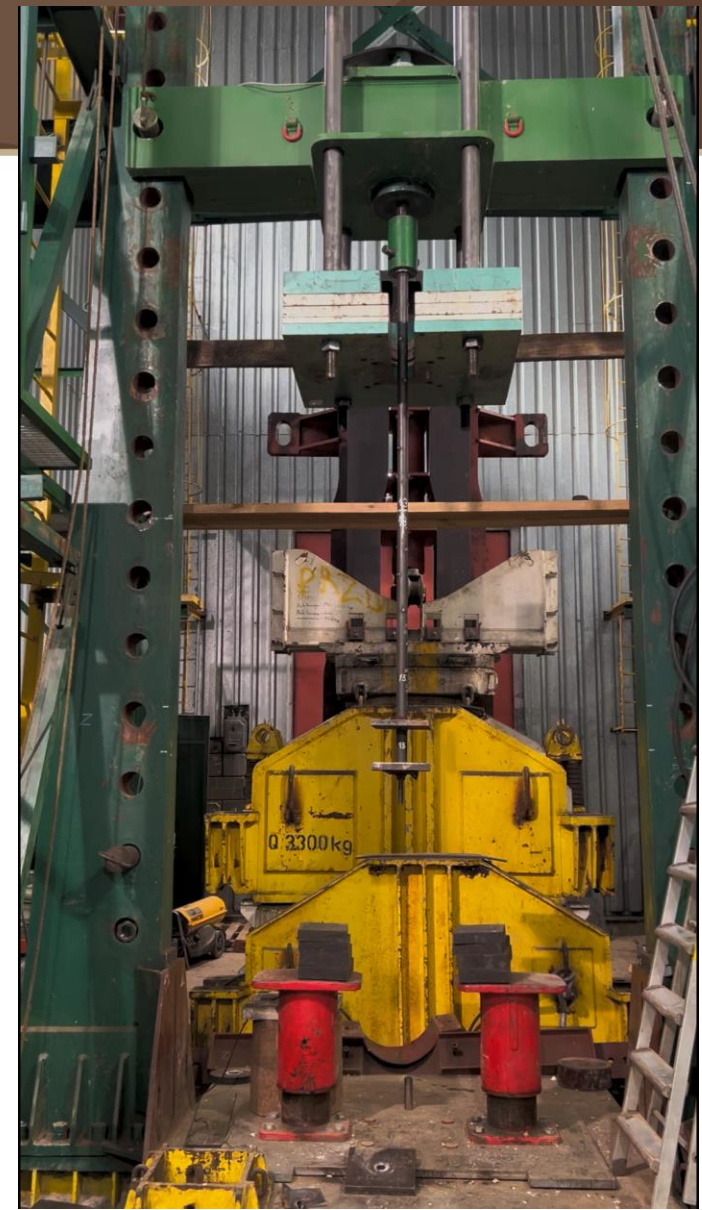
This Suggested Method proposes impact tests to determine selected properties of full-scale rock bolt assemblies subject to an axis-aligned impact force. These properties include the stiffness of the bolt assembly, the rise time, the tensile strength, the ultimate displacement, and the energy absorption of the rock bolt assembly. These properties may be used to design or select ground support for burst-prone ground conditions. This Suggested Method is limited to the mass freefall impact test method. It is performed using a test frame in the laboratory. The Method specifies the requirements for the testing apparatus and measurement sensors, the test procedures, the data processing methods and the reporting items.

Highlights

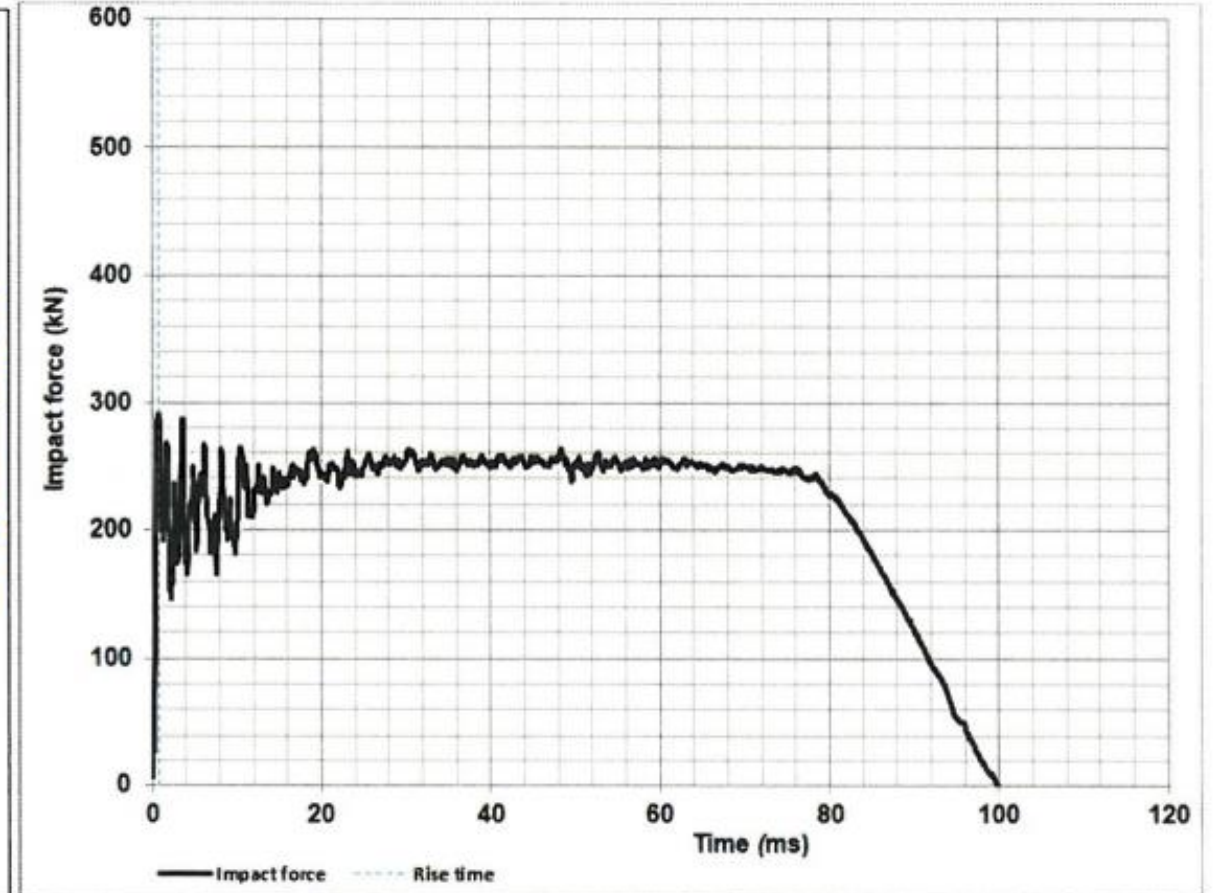
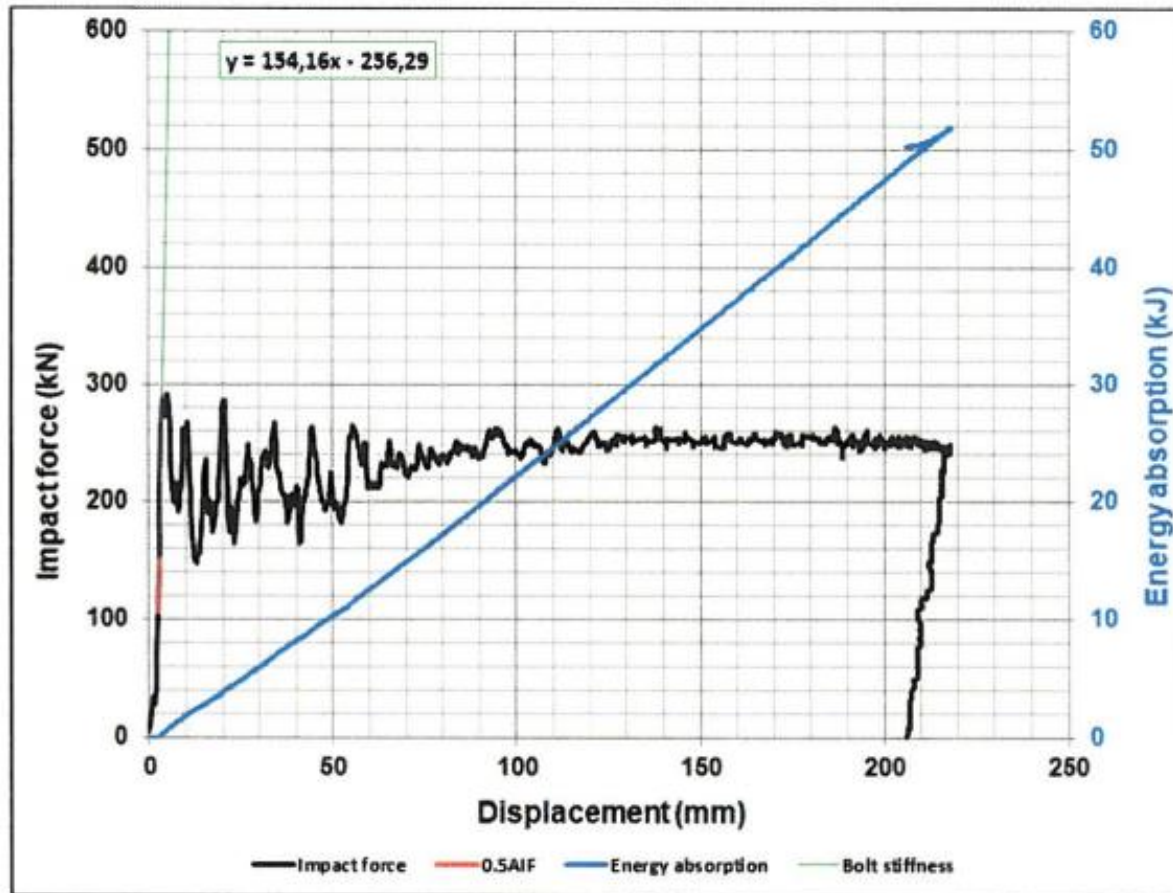
- A Suggested Method is proposed for dynamic tests of full-scale rock bolt assemblies by a mass freefall impact
- Properties to be determined include energy absorption, ultimate displacement, average load, etc.
- The Method specifies the requirements to the testing apparatus, measurement sensors, test procedures, and data processing



IMPACT TESTING at CENTRAL MINING INSTITUTE DYNAMIC TESTING RIG



IMPACT TESTING at CENTRAL MINING INSTITUTE DYNAMIC TESTING RIG



Performance improvement

- **High mechanical properties, British and South African (SANS) Standard compliant:**
 - Compressive strength ≈ 90 MPa (BS threshold >80 MPa)
 - Elastic modulus ≈ 13 GPa (BS threshold >11 GPa)
 - Creep $\approx 0.068\%$ (BS threshold $\leq 0.12\%$)
 - Shear strength ≈ 34 MPa (SANS thresholds ≥ 19 MPa or ≥ 23 MPa)
- **Universal product**
 - Suitable for manual or automatic application
 - Approved for use with ARI (Automatic Resin Injection)
 - Can be used in wet & dry rock conditions
- **Designed for a wide range of application conditions**
- **Can be used for wet & dry drilling**

Safety improvement

Styrene-Based Resin Capsules

Labelling according to Regulation (EC) No. 1272/2008 (CLP)

Hazard Pictograms (CLP):



Signal Word (CLP): Warning

- **Strong odor:** Styrene has a strong odor that can be noticeable even in small quantities.
- **Highly flammable:** Styrene is highly flammable and can ignite easily at low temperatures. It's essential to handle it with caution.
- **Evaporation:** Styrene readily evaporates at room temperature, releasing vapors that can quickly disperse in the air. Proper storage conditions are recommended.
- **Potential carcinogenic effects:** Prolonged exposure to styrene may increase the risk of cancer. Individuals working with this compound should use appropriate personal protective measures. According to OSHA (USA, Canada) the styrene is reasonably anticipated to be a human's carcinogen.
- **Inhalation Symptoms:** Inhaling styrene vapors can lead to symptoms such as drowsiness and headaches, affecting overall well-being.
- **Caution During Pregnancy:** Styrene exposure during pregnancy may harm an unborn child. Avoid exposure to this compound while pregnant.
- **Impact on Air Quality:** The release of styrene into the atmosphere contributes to air pollution, negatively affecting environmental air quality.

Fasloc® SF Styrene-Free Resin Capsules

Labelling according to Regulation (EC) No. 1272/2008 (CLP)

Hazard Pictograms (CLP):

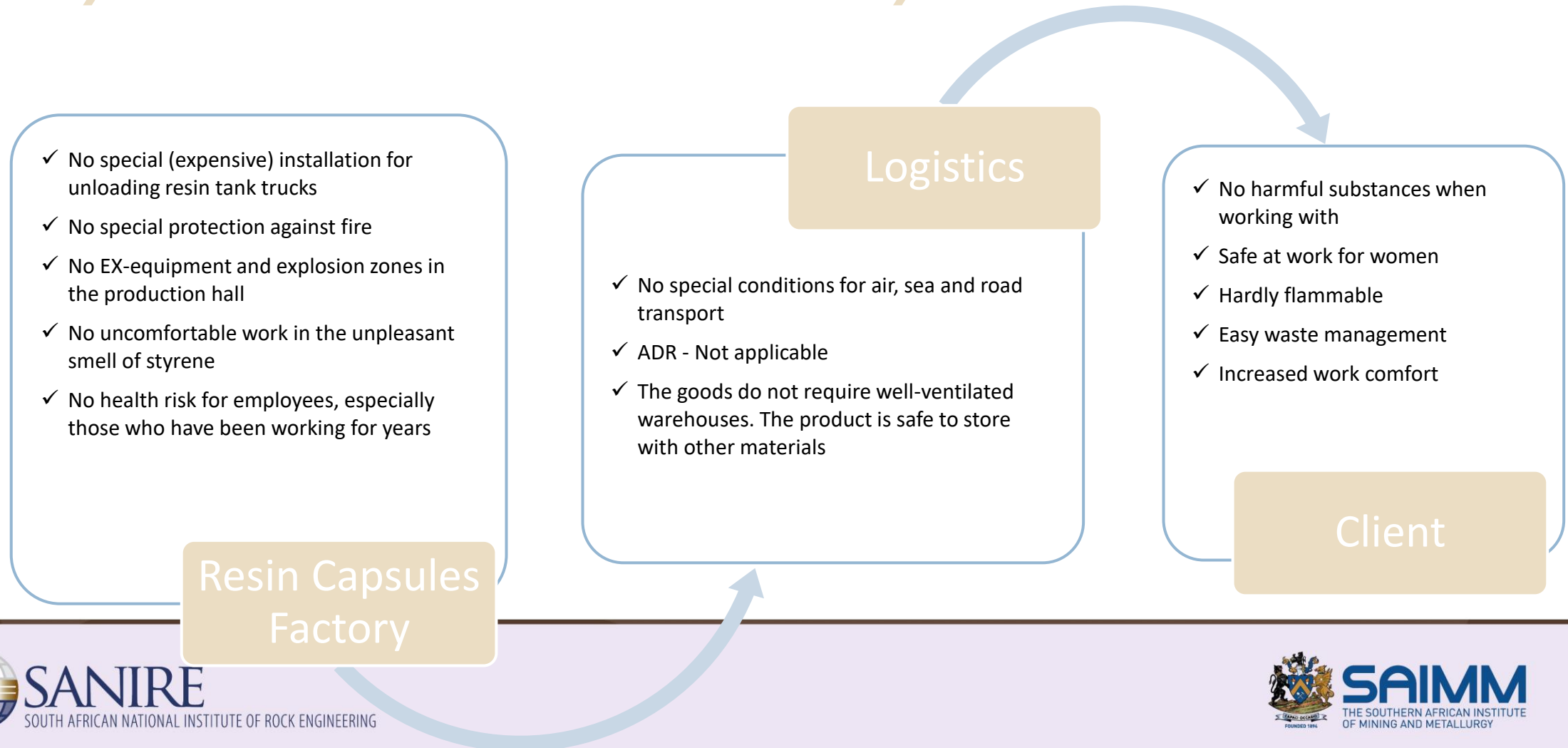


Signal Word (CLP): Warning

- **Barely noticeable smell:** This product doesn't have any bad odors.
- **Low flammability:** The product uses a safer alternative to styrene, reducing the risk of fire.
- **No evaporation:** The product does not contain any substances that easily turn into gas. It does not release anything into the air, so it will not make the air worse or affect breathing.
- **No cancer risk:** Using this product won't increase the risk of cancer, keeping users safe.
- **Safe for unborn children:** The product is safe and does not affect unborn children, making it suitable for expectant mothers.

Safety improvement

Styrene-free is beneficial for everyone!



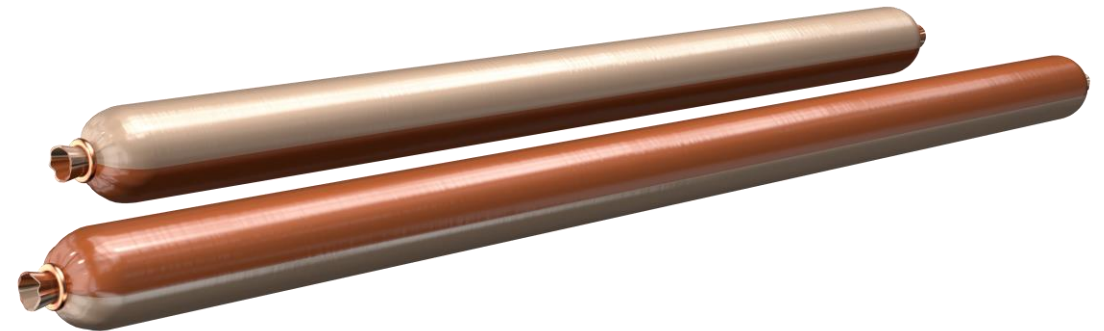
IT'S HERE - THE FUTURE OF RESIN CAPSULES

The new Fasloc® SF resin capsules are completely styrene-free.

No unpleasant smells, no dangerous emissions and no evaporation that affects air quality or breathing. That's why Fasloc® SF contributes to way better health conditions for all workers.

The new formulation boosts resin performance and shows improved mechanical properties, outperforming all other versions of Fasloc®.

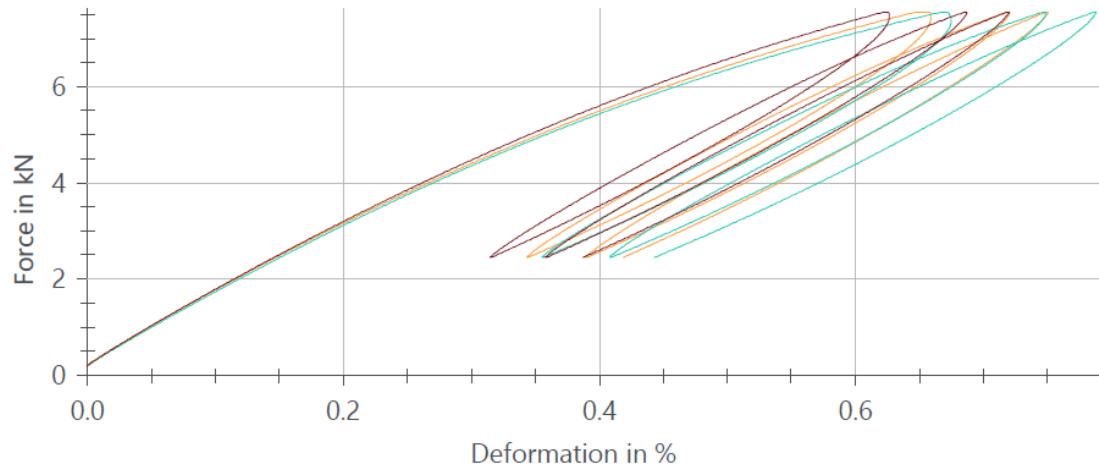
Change to new Fasloc® SF. It's the future of mining. And you can't afford to be left behind.



THANK YOU

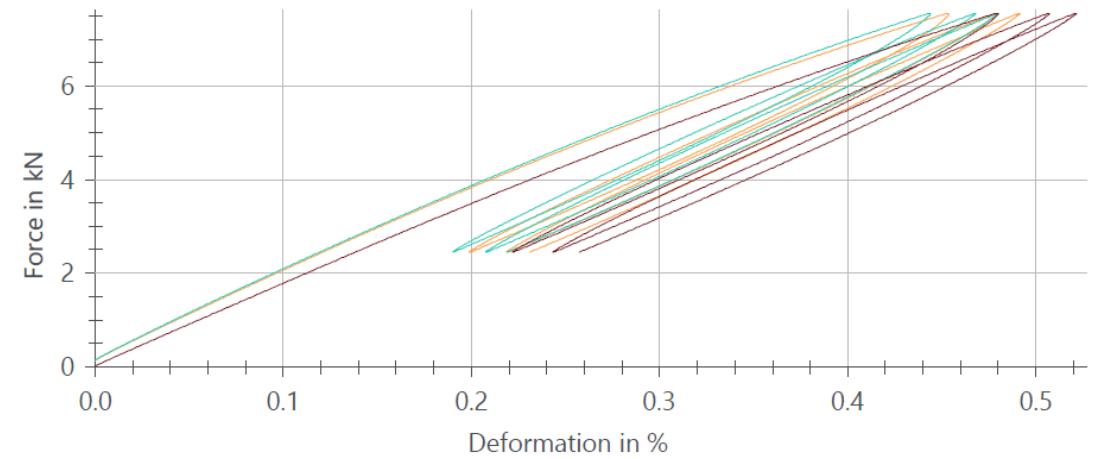
Elastic modulus

Fasloc[®] SF
(Water based catalyst)



~10 GPa

Fasloc[®] SF
Emulsified Peroxide Catalyst (EPC)

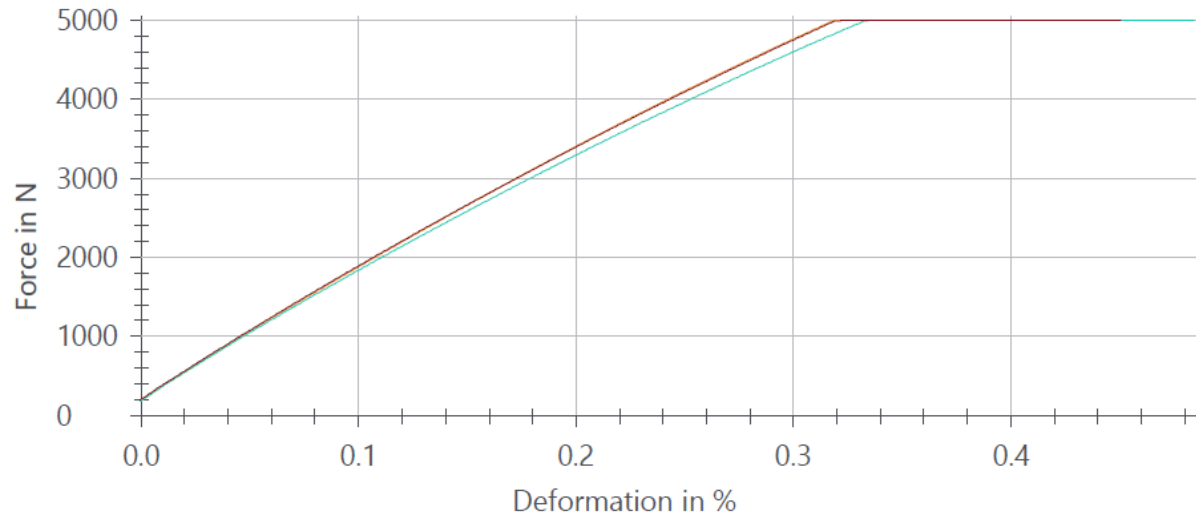


~13 GPa

CREEP

Fasloc® SF

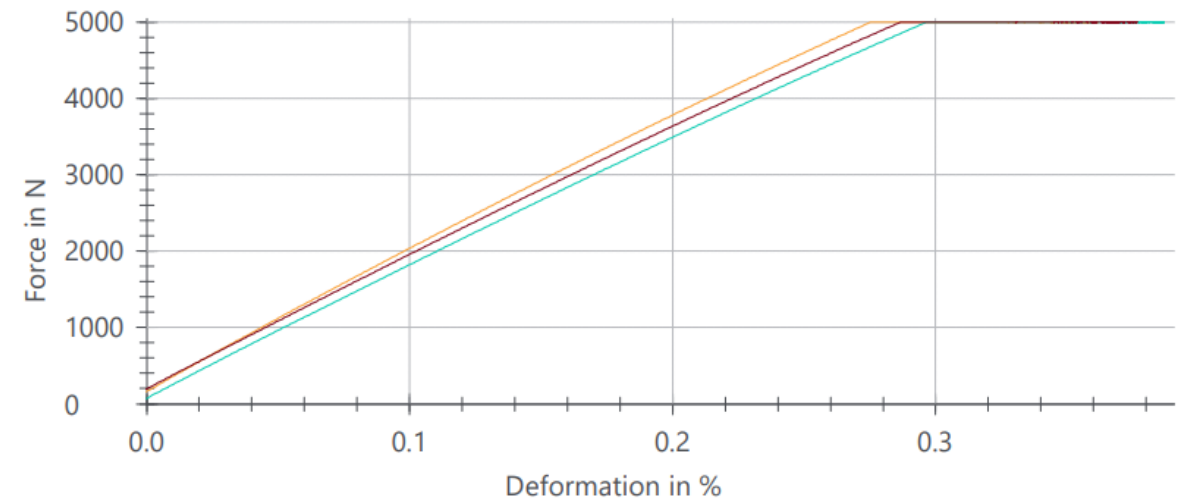
(Water based catalyst)



~0.11%

Fasloc® SF

Emulsified Peroxide Catalyst (EPC)



~0.068%