

Final presentation



Fraunhofer-Institut für Mikrostruktur
von Werkstoffen und Systemen IMWS

ANALYSIS OF THE DAMAGE BEHAVIOUR OF STRAPPING TAPES UNDER DIFFERENT LOAD CASES

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AGENDA

- **WP1: Damage Assessment of Strapping Tapes**
 - Strapping Tests
 - HORIZONTAL STABILITY TEST according to EUMOS 40509
 - INCLINED IMPACT TEST according to ISTA 1E
 - VERTICAL VIBRATION TEST according to ISTA 1E
 - Tensile tests before and after Test (un-used and used)
- **WP2: Determination of the Influence of Temperature**
- **Summary and outlook**

WP1: Damage Assessment of Strapping Tapes

Strapping Tests

Strapping tape	Tape specification Width x Thickness mm x mm	Maximum clamping force at the HUG in N	Measured tension force on the tape after fastening in N
Sekisui / 30% rePP (PIR)	12.0 x 0.55	500	150
Messersi / virign PP	12.0 x 0.7	800	330
Teufelberger/ PET (PCR)	15.0 x 0.6	1800	630 (transverse) / 690 (longitudinal)
Fromm / PET (PCR)	12.0 x 0.6	1650	650 (transverse) / 690 (longitudinal)
Mosca / PET (PCR)	9.5 x 0.64	1000	600



WP1: Damage Assessment of Strapping Tapes

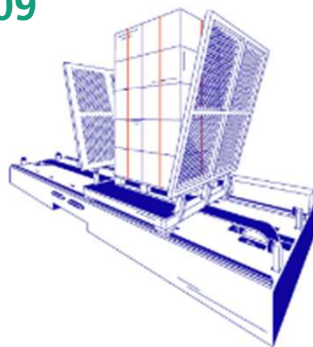
TEST EUMOS / ISTA

➤ HORIZONTAL STABILITY TEST according to EUMOS 40509

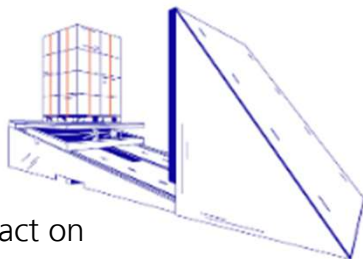
Lengthways and crossways

Acceleration

- 0.3 m/s²
- 0.5 m/s²
- 0.8 m/s²



➤ INCLINED IMPACT TEST according to ISTA 1E

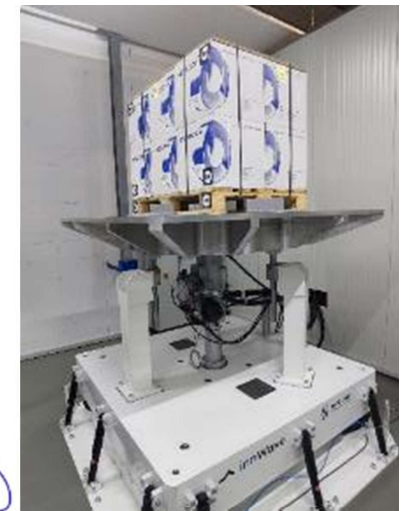
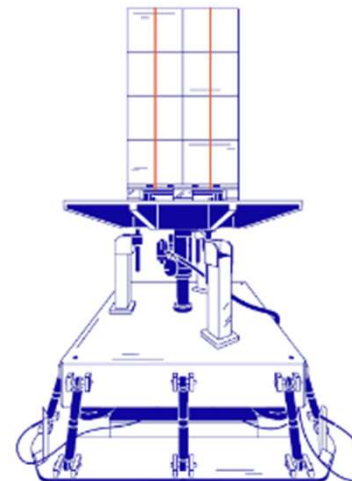


Impact on
Areas 2, 4, 5, and 6



➤ VERTICAL VIBRATION TEST according to ISTA 1E

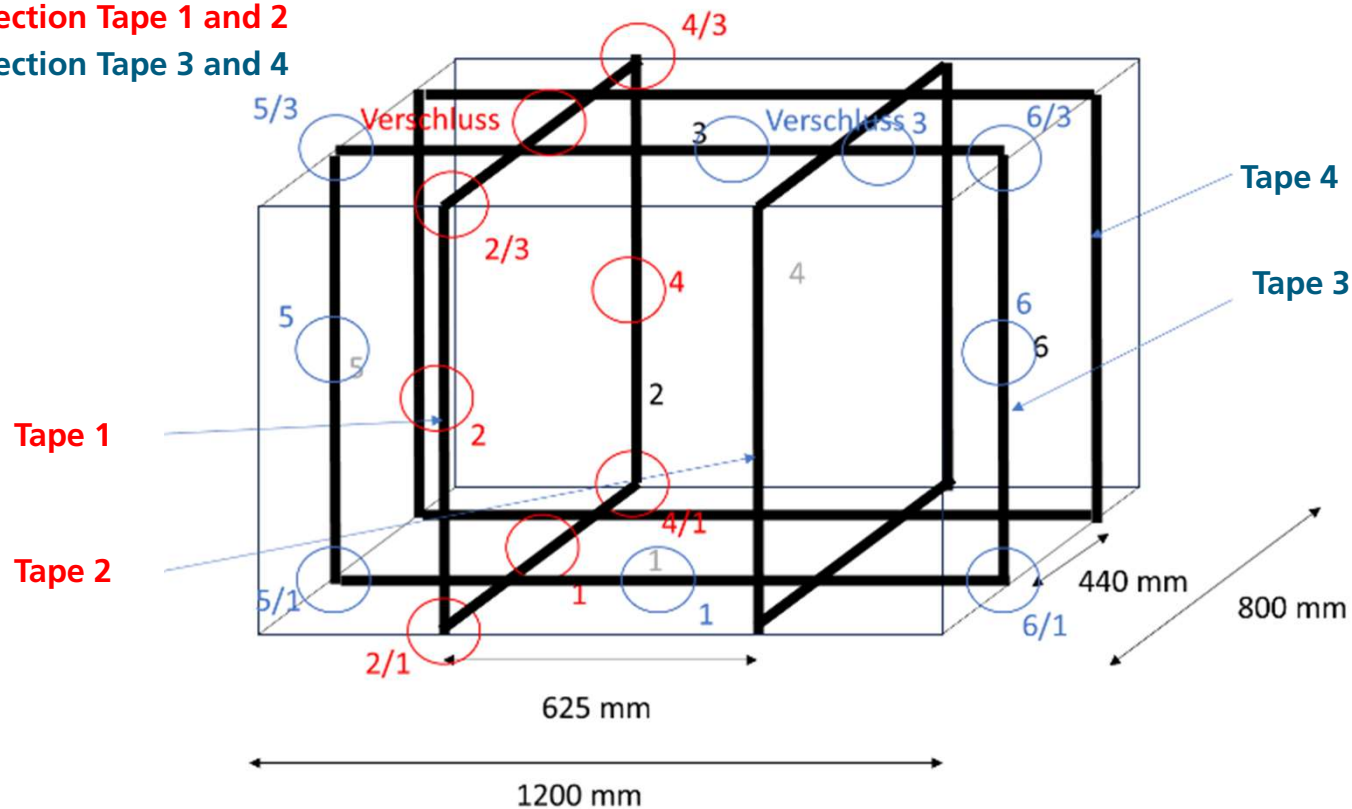
Test time 60 min



WP1: Damage Assessment of Strapping Tapes

Sampling Plan for Tensile Tests

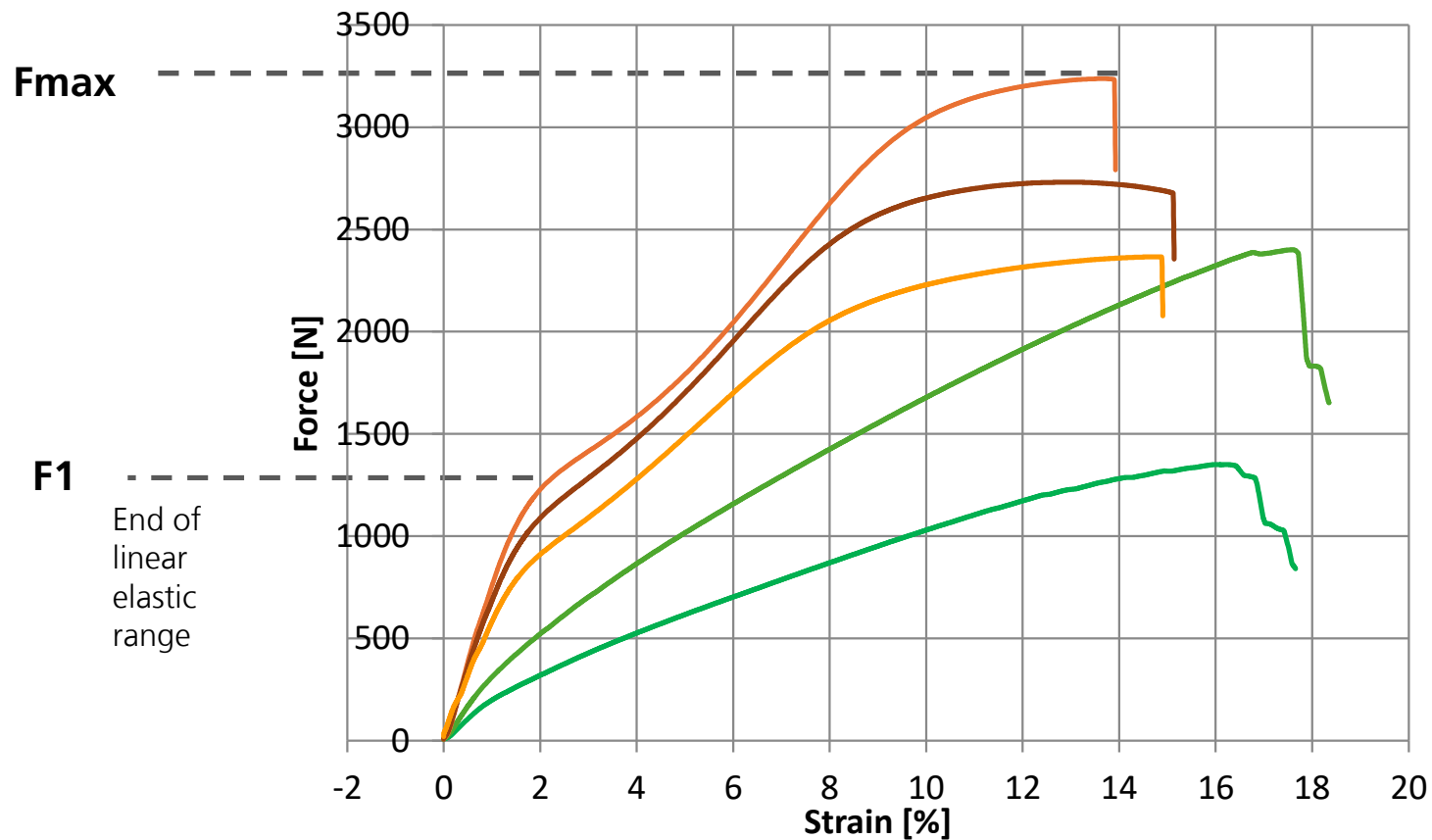
- Section Tape 1 and 2
- Section Tape 3 and 4



Pos. 1-4 Corners
Pos. 5-8 Straight Sections
Pos. 9- Welding Area

WP1: Damage Assessment of Strapping Tapes

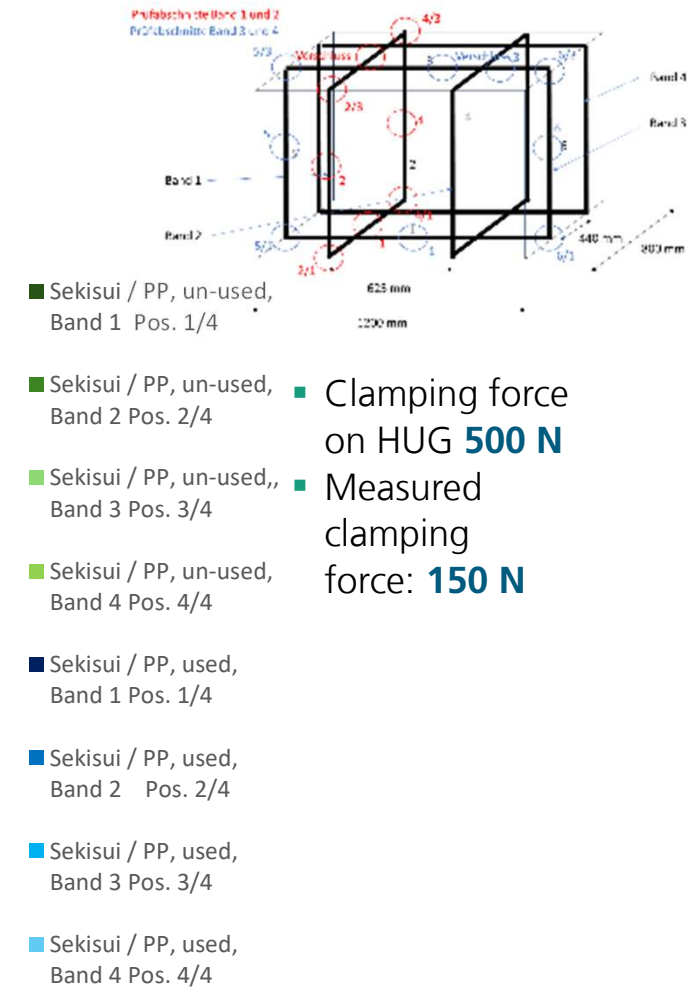
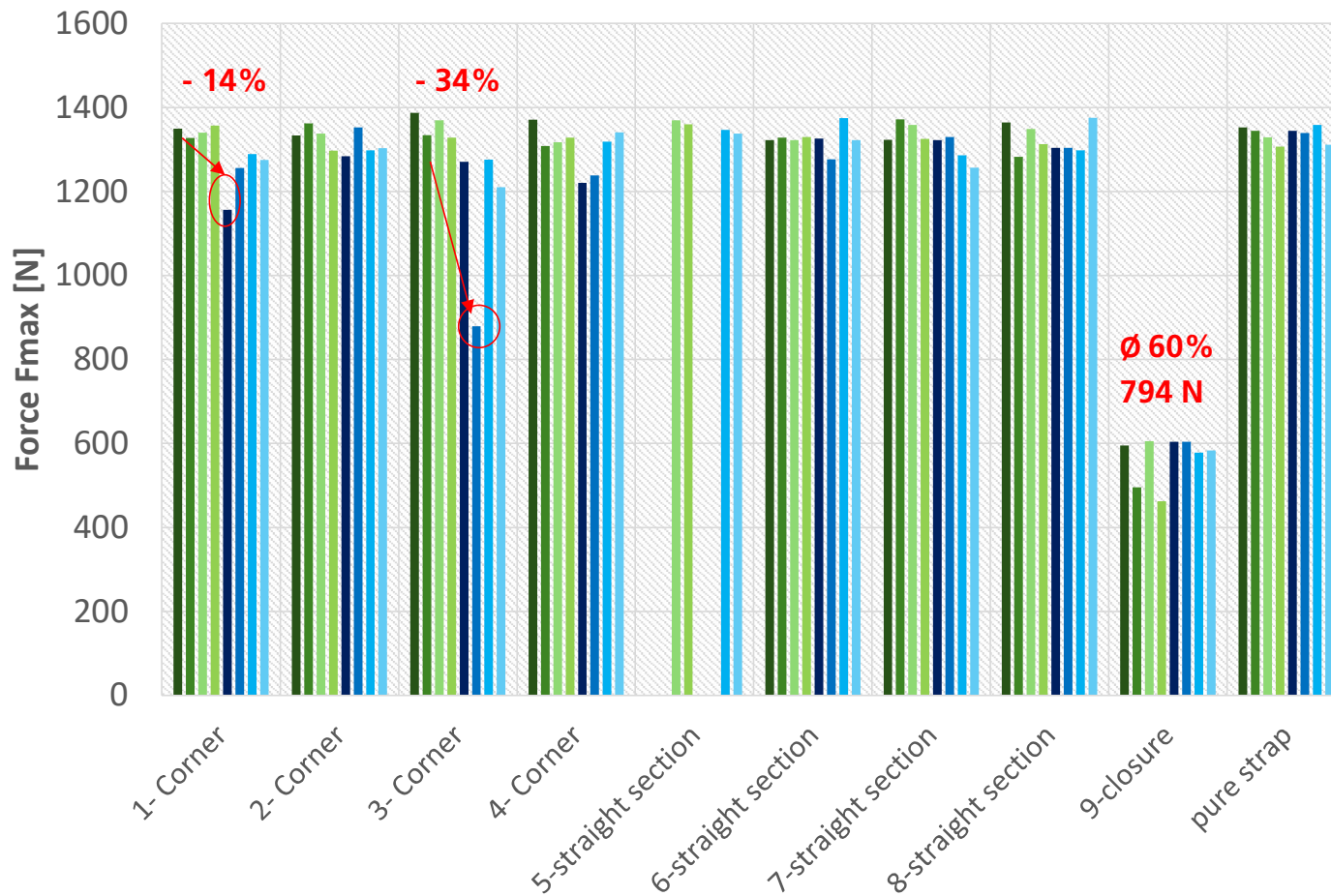
Results of Tensile Tests



- Sekisui / 30% rePP (PIR)
- Messersi / virign PP
- Teufelberger/ PET (PCR)
- Fromm / PET (PCR)
- Mosca / PET (PCR)

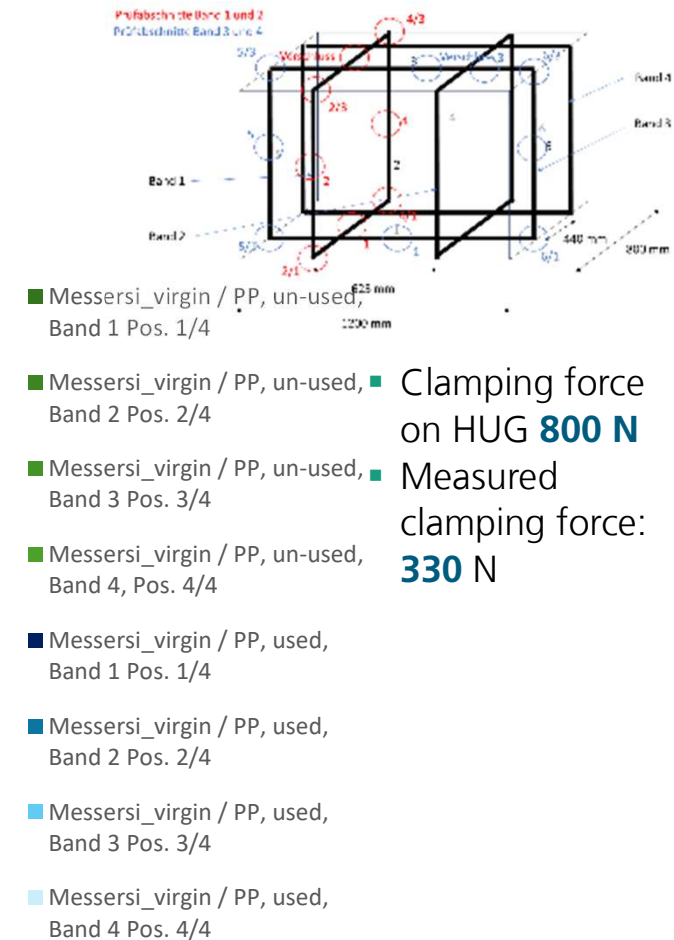
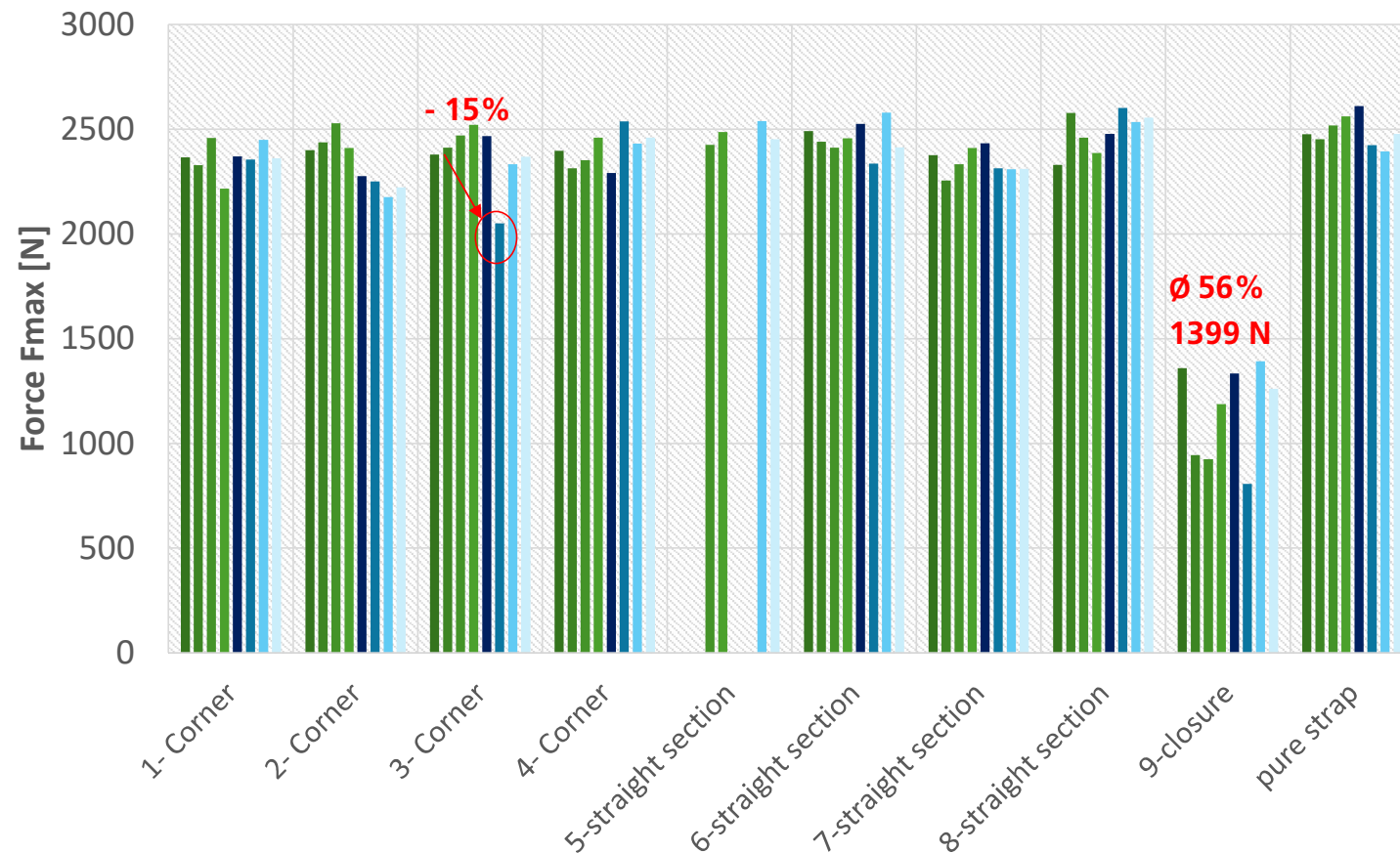
WP1: Damage Assessment of Strapping Tapes

Results of tensile tests 1. Sekisui/ 30% rePP (PIR) un-used / used



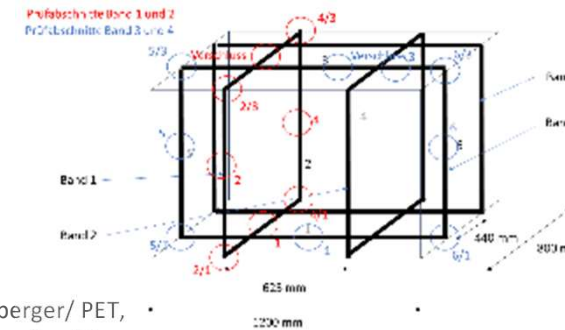
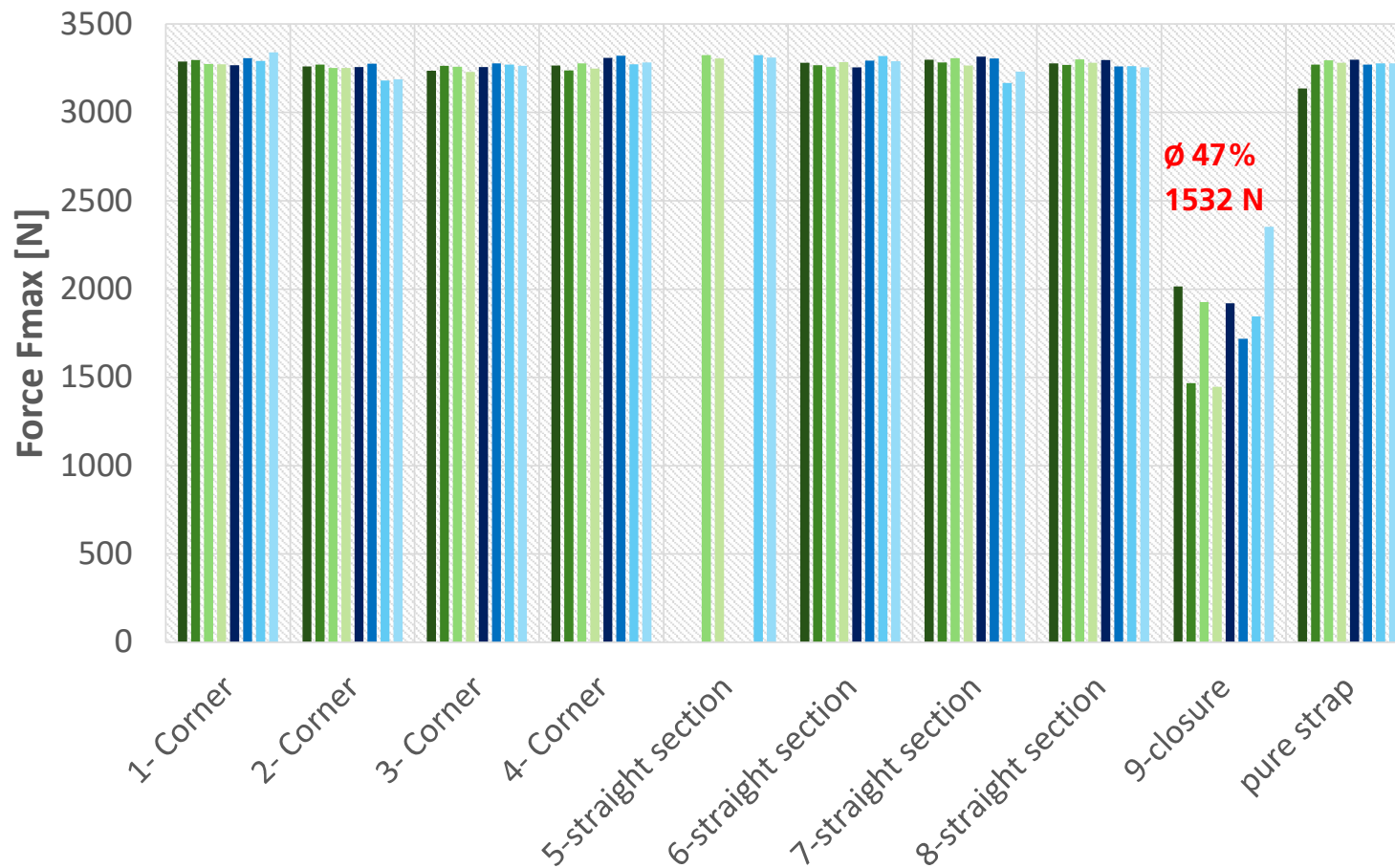
WP1: Damage Assessment of Strapping Tapes

Results of tensile tests 2. Messersi / virign PP un-used / used



WP1: Damage Assessment of Strapping Tapes

Results of tensile tests 3. Teufelberger/ PET (PCR) un-used/ used

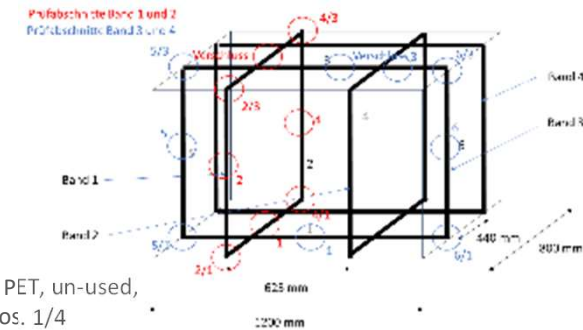
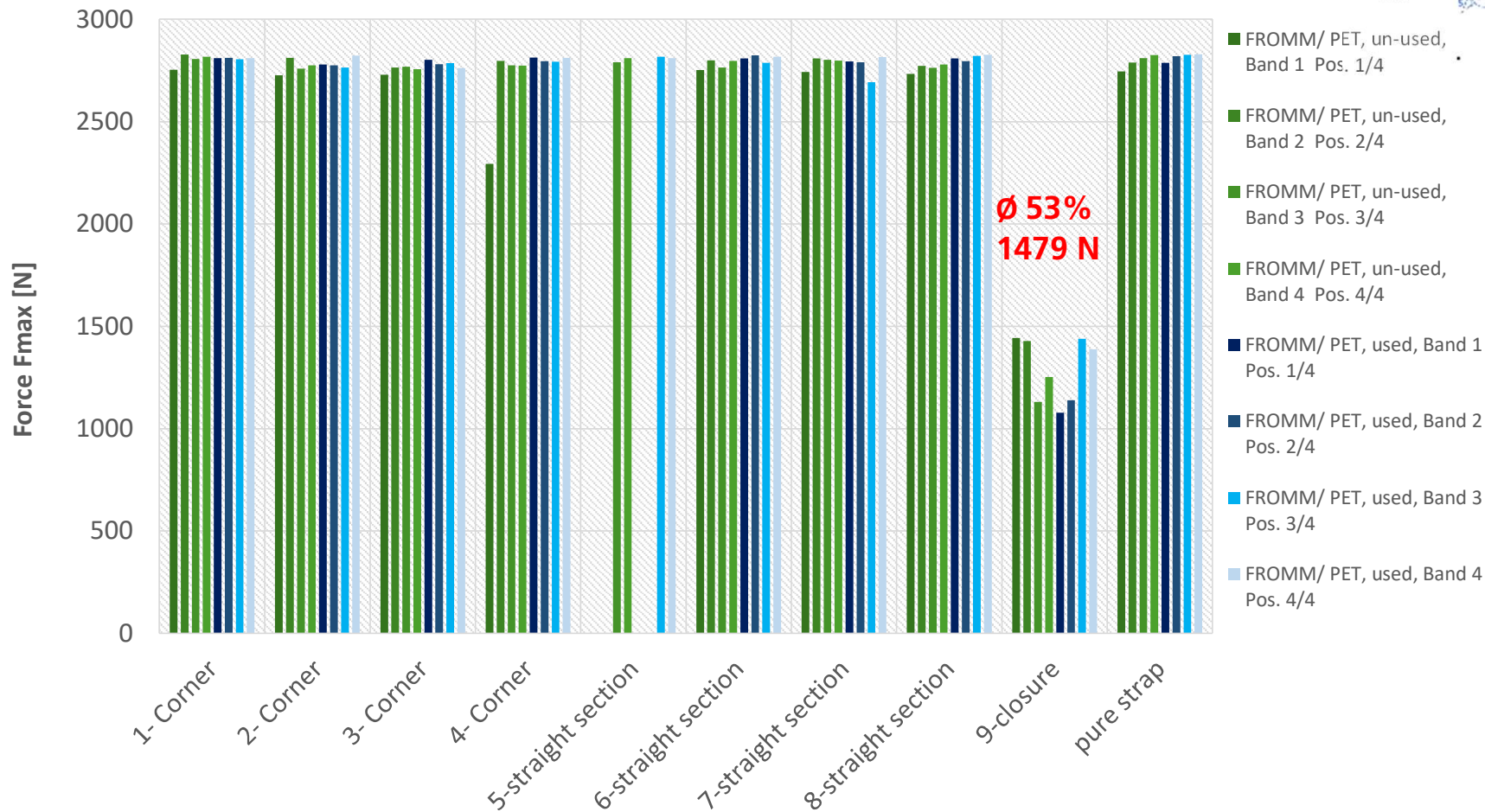


- Teufelberger/ PET, un-used, Band 1 Pos. 1/4
- Teufelberger/ PET, un-used, Band 2 Pos. 2/4
- Teufelberger/ PET, un-used, Band 3 Pos. 3/4
- Teufelberger/ PET, un-used, Band 4 Pos. 4/4
- Teufelberger/ PET, used, Band 1 Pos. 1/4
- Teufelberger/ PET, used, Band 2 Pos. 2/4
- Teufelberger/ PET, used, Band 3 Pos. 3/4
- Teufelberger/ PET, used, Band 4 Pos. 4/4

- Clamping force on HUG **1800 N**
- Measured clamping force: **690 N**

WP1: Damage Assessment of Strapping Tapes

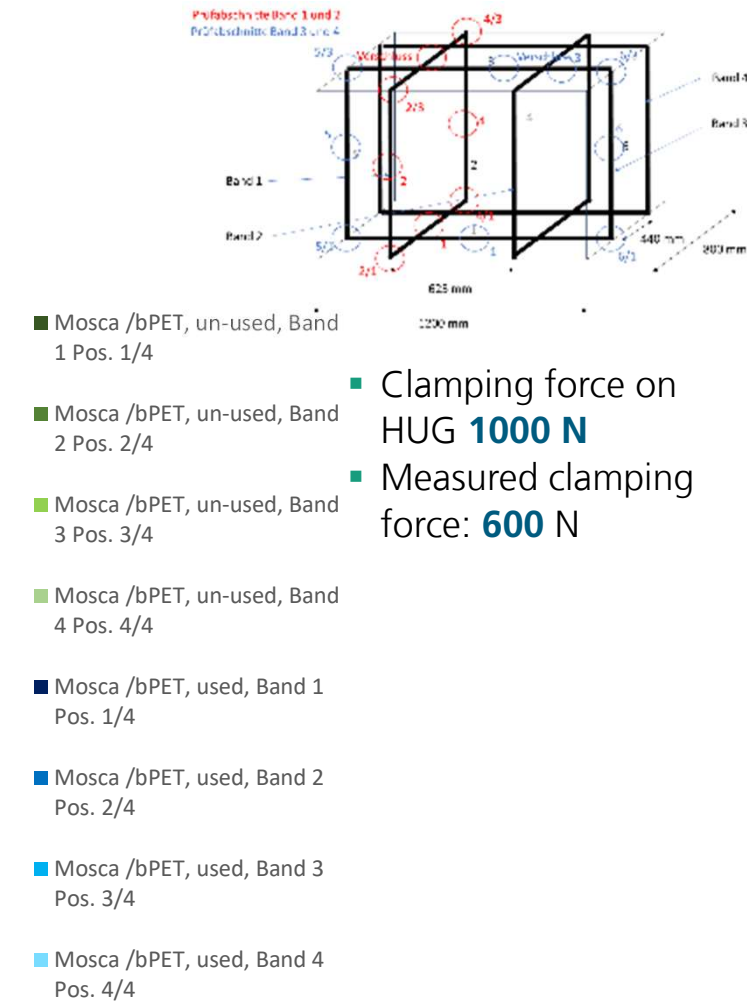
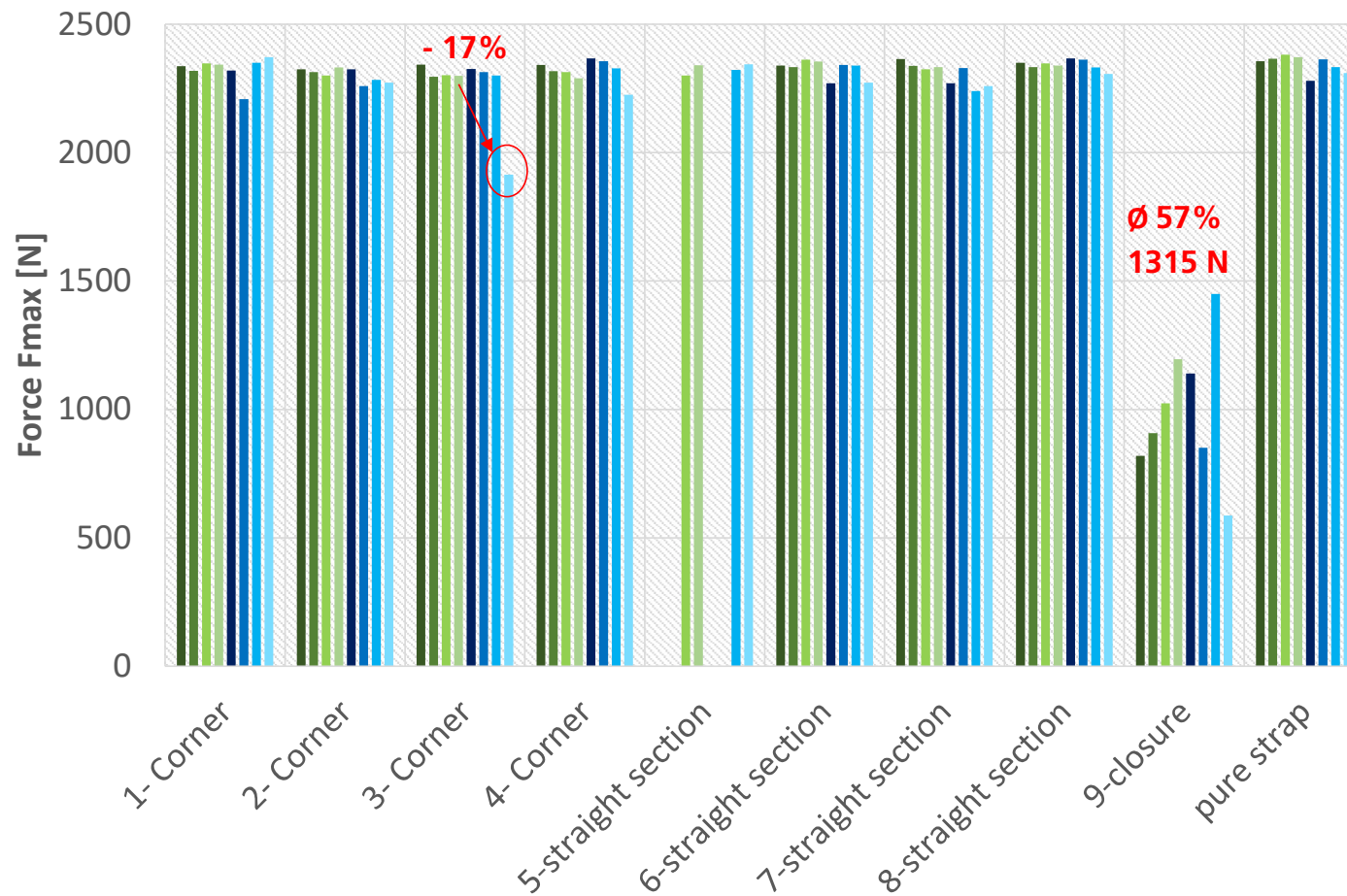
Results of tensile tests 4. FROMM/ PET (PCR) un-used/ used



- Clamping force on HUG **1650 N**
- Measured clamping force: **690 N**

WP1: Damage Assessment of Strapping Tapes

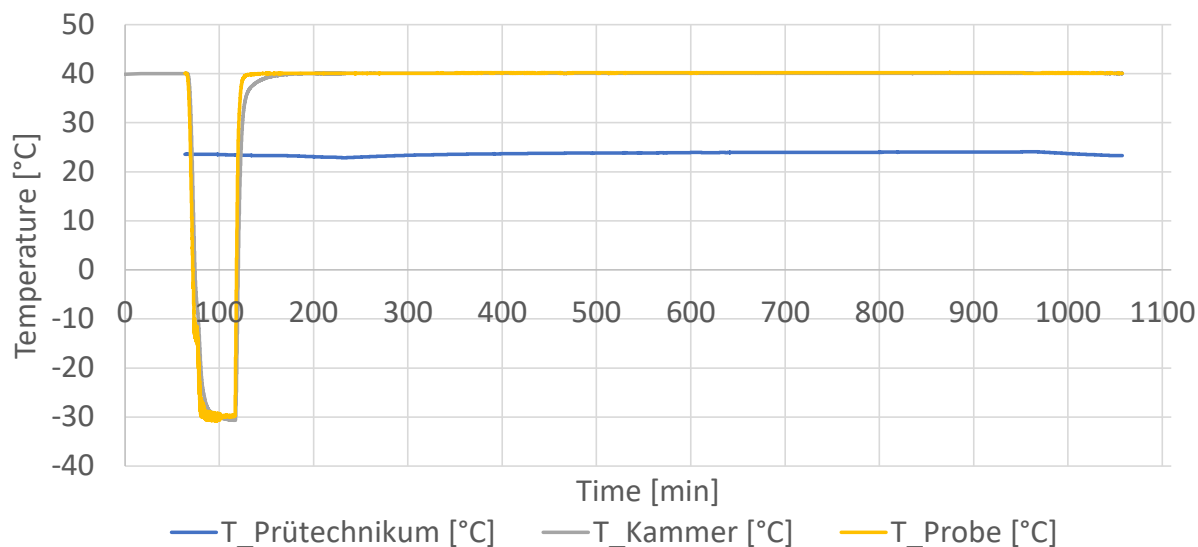
Results of tensile tests 5. MOSCA/ PET (PCR) un-used/ used



WP2: Determining the Influence of Temperature

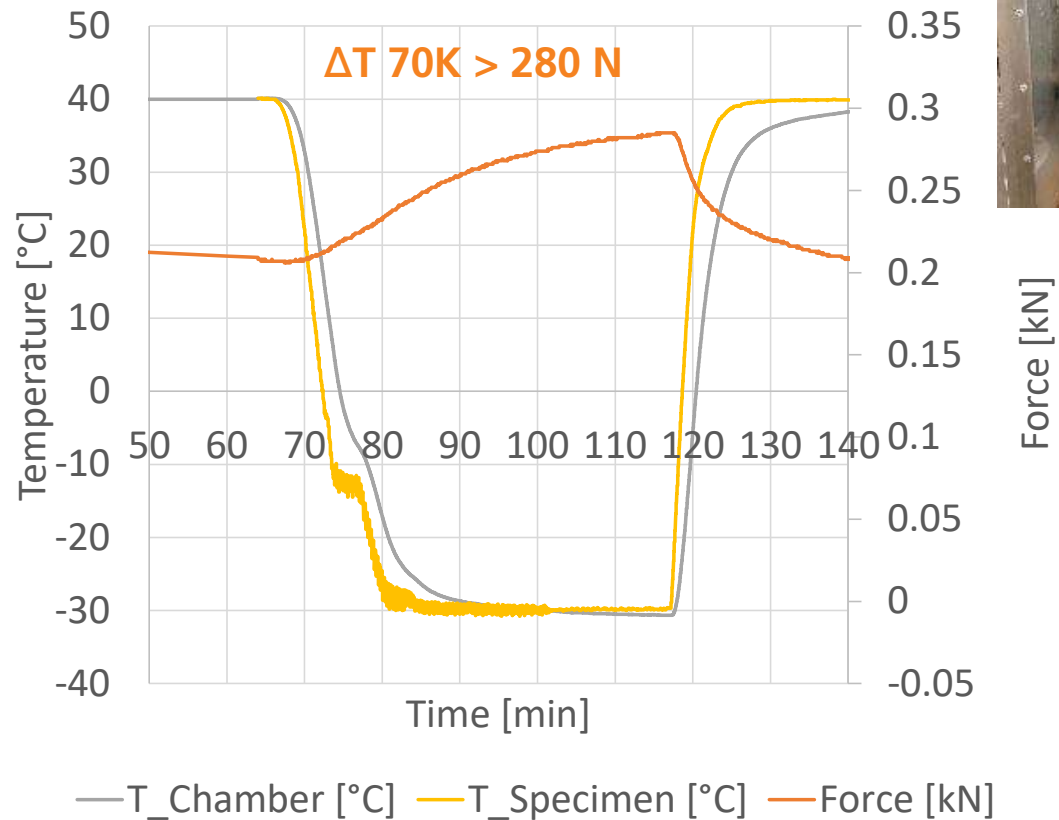
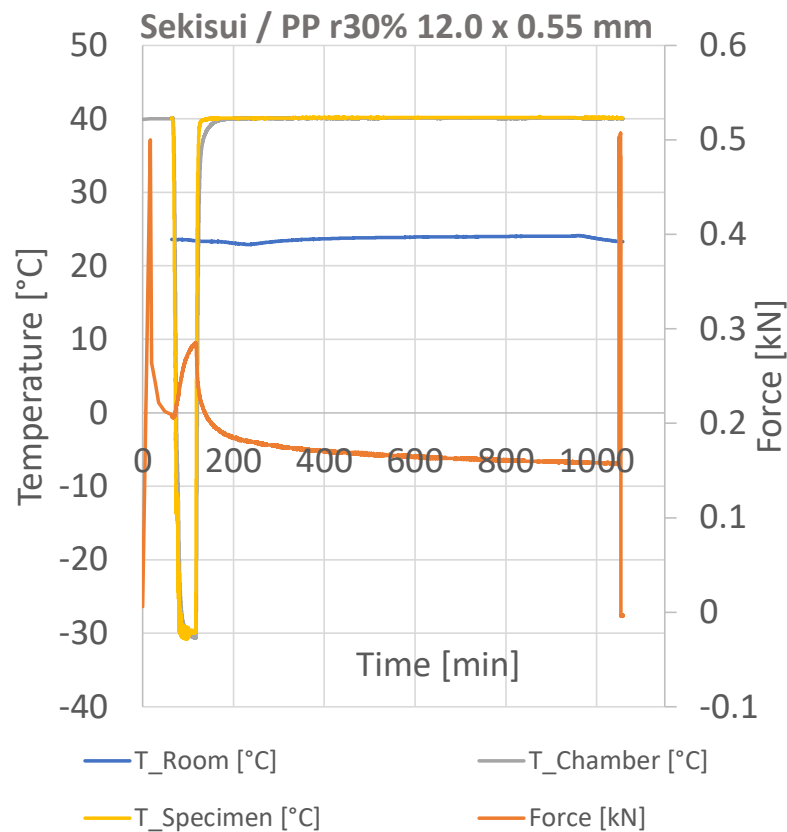
Temperature cycle 40°C to -30°C (70 K):

At 40°C, the initial tension (maximum tension force at HUG strapping) is set on the strap, then the drop in force is awaited until it reaches a plateau (relaxation), after which the temperature is allowed to drop to -30°C while the force is measured. After the temperature test, the strap is tensioned again with the HUG tension force.



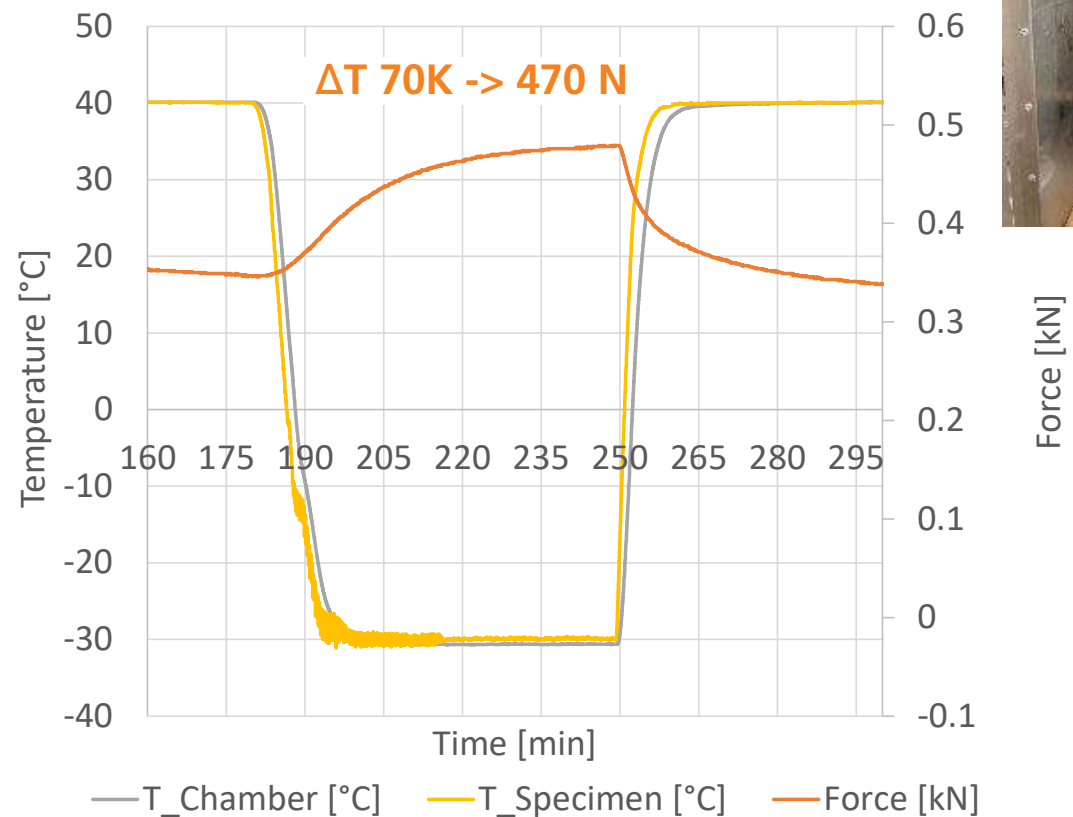
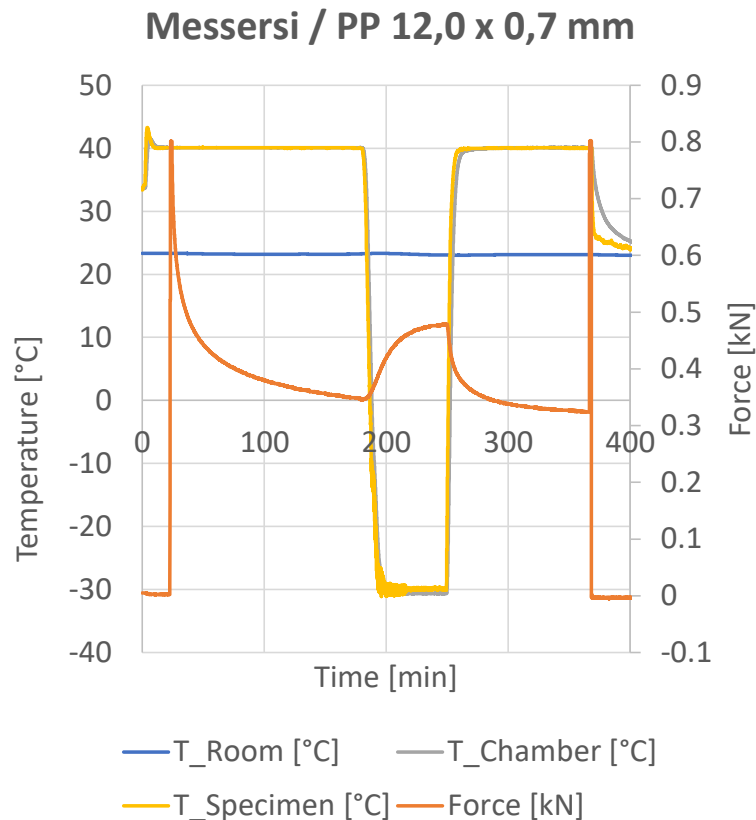
WP2: Determining the Temperature Effect

Temperature cycle 40°C to -30°C (70 K): 1. Sekisui/ 30% rePP (PIR)



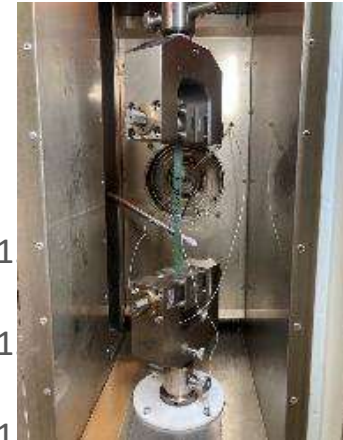
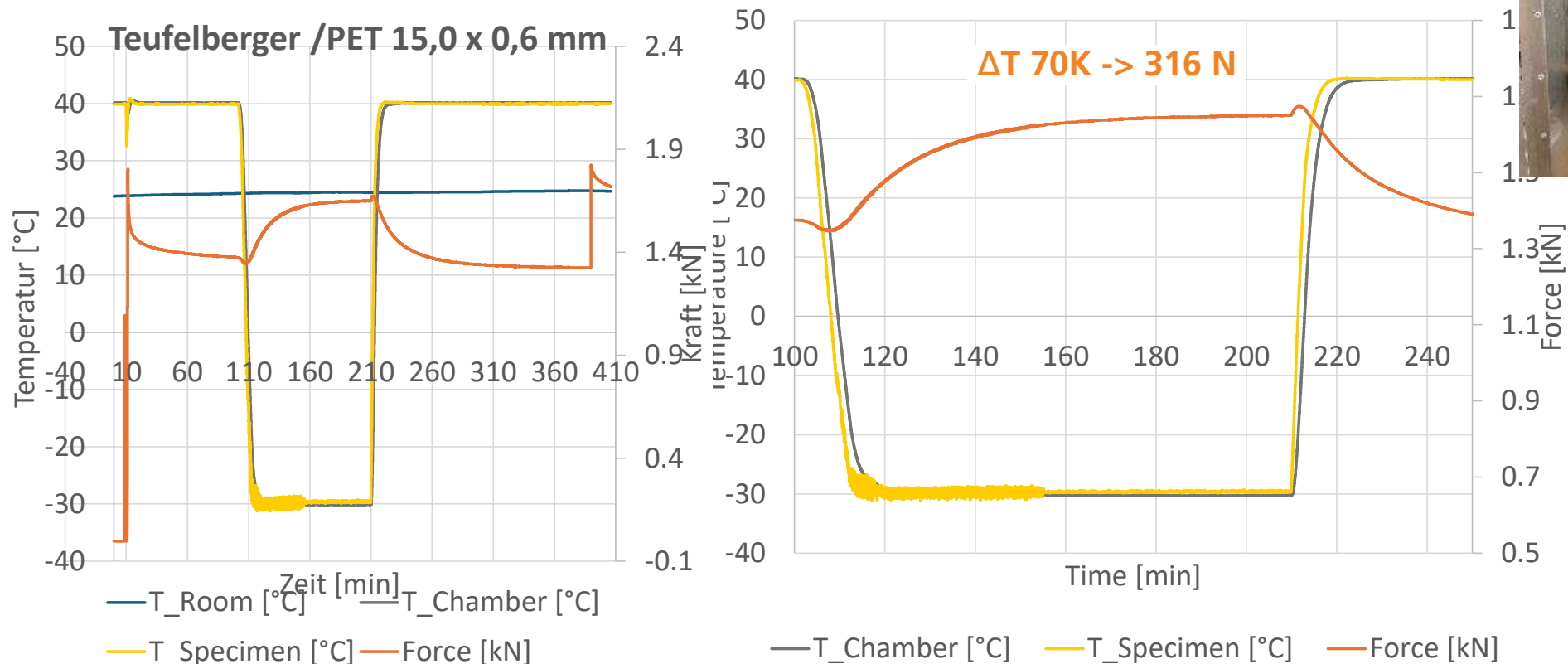
WP2: Determining the Temperature Effect

Temperature curve 40°C to -30°C (70 K): 2. Messersi / virign PP



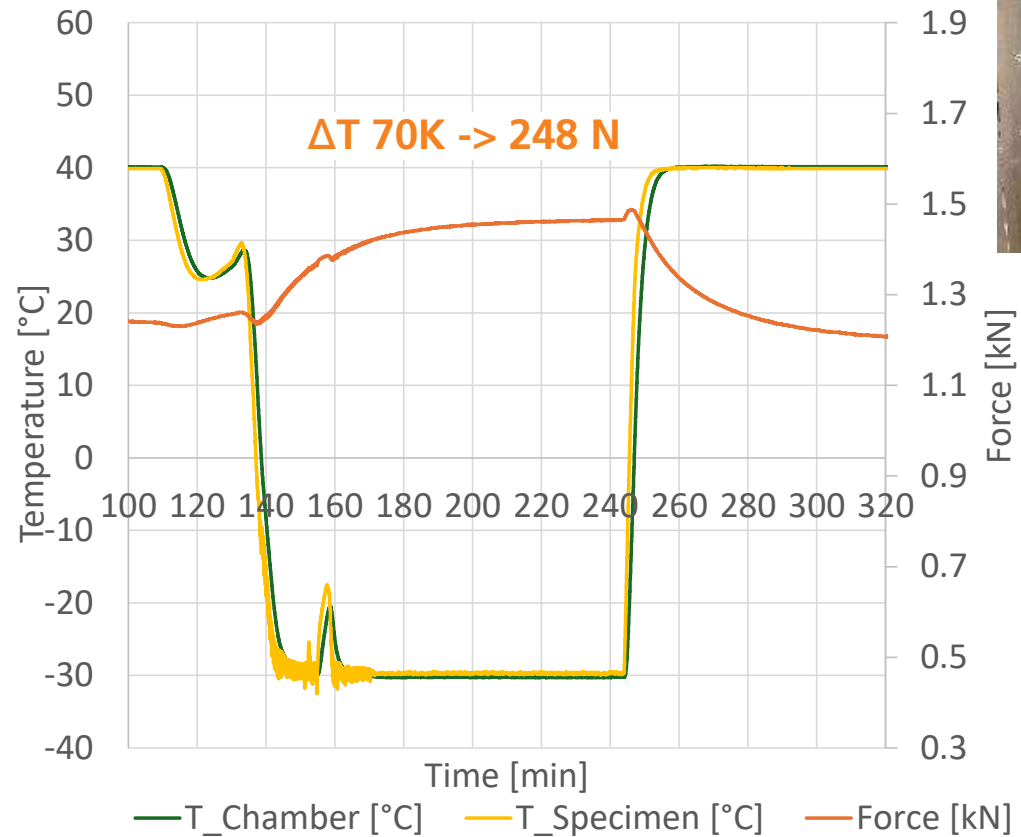
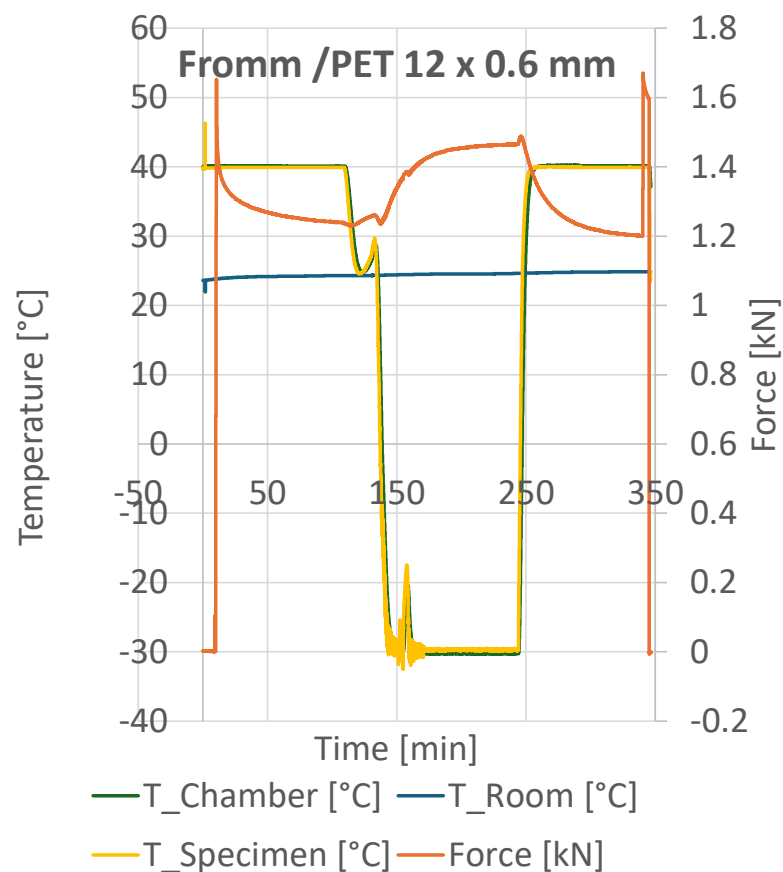
WP2: Determining the Temperature Effect

Temperature cycle 40°C to -30°C (70 K): 3. Teufelberger/ PET (PCR)



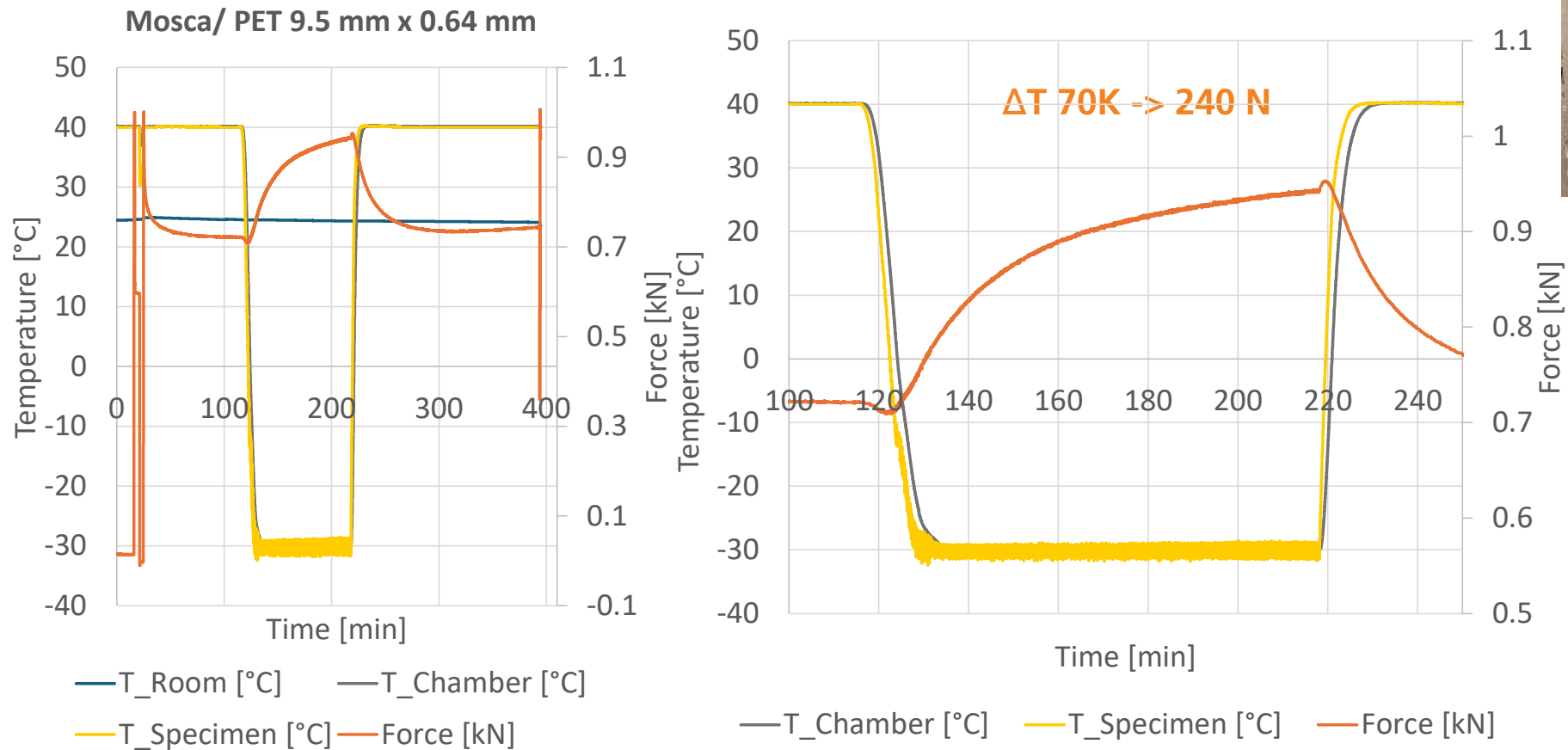
WP2: Determining the Temperature Effect

Temperature cycle 40°C to -30°C (70 K): 4. FROMM/ PET (PCR)



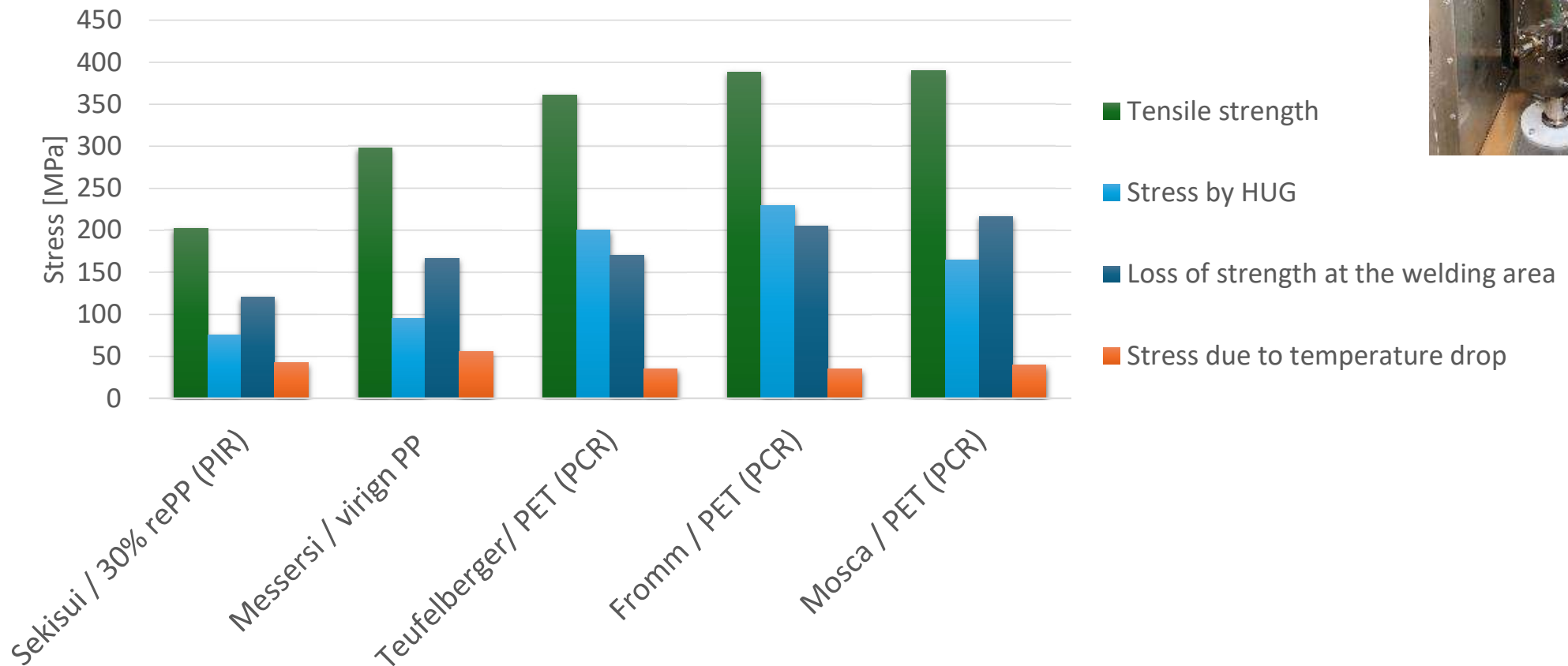
WP2: Determining the Temperature Effect

Temperature curve 40°C to -30°C (70 K): 5. Mosca/ PET (PCR)



Summary and Conclusion

Stresses



Summary and Conclusion

WP1: Damage Assessment of Strapping Tapes

- A significant drop in tensile strength can be seen in all tapes in the area of the welding area; on average, there is a drop of 47% to 60% of the breaking strength compared to the un-used tape.
 - > When short tapes are reused, they would have to be welded several times; the first weld would no longer be able to withstand the tension that occurs during the second welding.
- In both cases of PP (30% rePP and virgin PP), a significant drop in tensile strength after load tests is clearly visible (up to 34%)
 - > when reused, it is unknown where in the material is pre-damaged and where the weakest point is located
- The load on PET (PCR) strapping is obviously too low in the research scenarios
 - > No significant influence of the load, but there is still a significant drop in the strength of the welding area

Summary and Conclusion

WP2: Determining the Temperature Effect

- **Temperature effects can cause the strap to fail (example: Finland: strapping at 20°C, then out onto the truck loading area at -30°C) in case of re-use (because of unknown damage history)**
- **Pre-existing strapping damage is invisible and thus unclear to predict in reality**
- **Unlike PP, PET tapes do not relax to initial level in the same period of time, the residual stresses initiated by welding are unknown for PET**
- **In view of a preload and correspondingly high stress by the HUG process, an additional temperature load can possibly lead to failure in case of re-use**
- **If there is a combination of effects, such as in the welding area and the HUG tension, the residual strength is reduced during reuse. In addition, thermal stresses can occur, which requires detailed documentation of the preload, but this cannot be done for every strap in reality**

Executive Summary

Investigation on Damage and Temperatur Effects on Plastic Strapping Tapes

- Plastic strapping tapes made from PP and PET are essential aids in the logistics and packaging industry. They are used to securely bundle and stabilize goods and protect them from damage during transport.
- This light weight packaging provides with a very small amount of plastic a safe and secure supply of goods in various supply chains
- The straps are used only one time and destroyed by removing.
- The investigations of this report show the following:
 - Re-use if highly not recommended due to the lower mechanical properties of the welding area, which would be reused again (drop in mechanical properties of ~60% in PP)
 - By simulating load cases during transport a pre-damage is detectable but not visible and not traceable
 - in case of thermal treatment while re-using the straps the tensile strength could become critical

Based on the results a reuse of straps for transport packaging and bundling can technically not be recommended.

Thank you for your attention.

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