

Environmental Stress Crack Failure of Polyethylene: Towards Circularity

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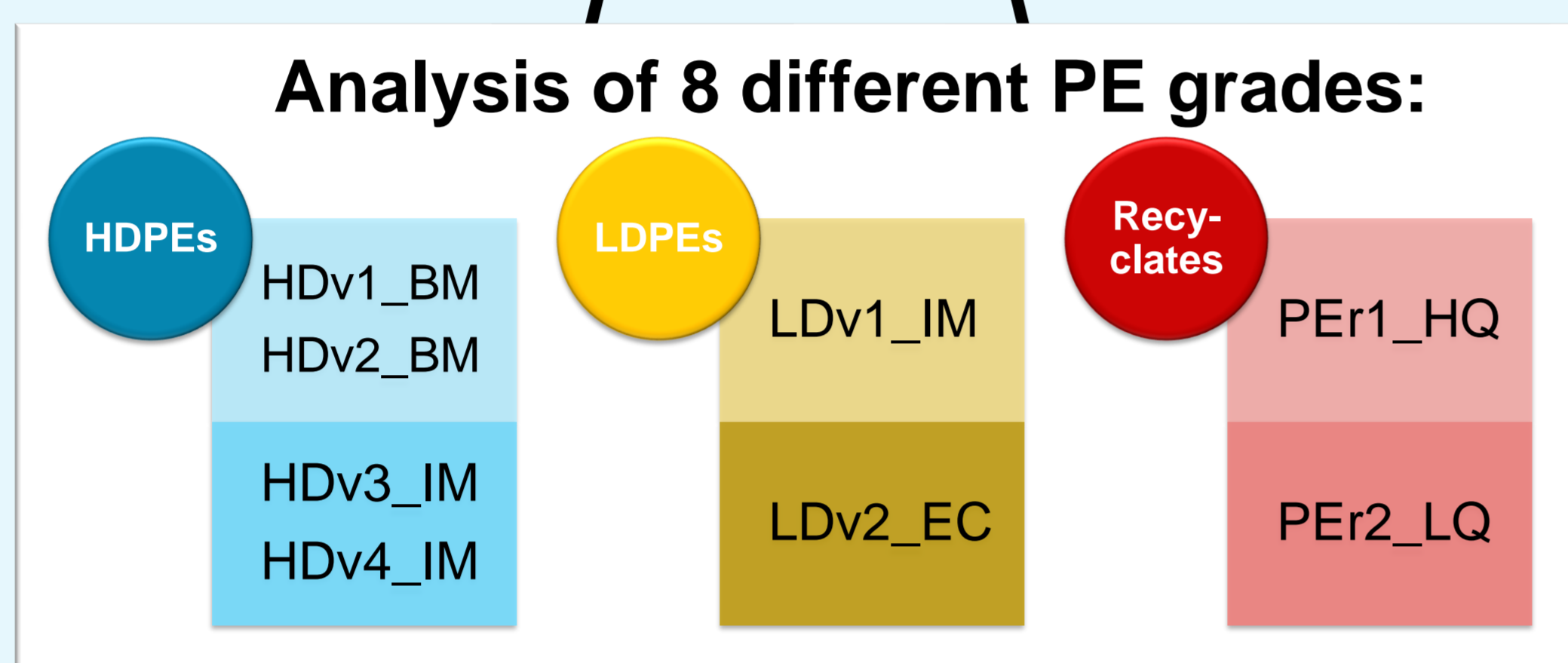
INTRODUCTION

- Problem:** Environmental Stress Cracking (ESC) is a major cause of failure in plastic products, particularly under long-term exposure to stresses, active fluids, and high temperatures.
- Objective:** Find a fast screening method of ESC resistance in various plastics, particularly polyethylene.
- Motivation:** Driven by the need for sustainable plastic usage and recycling.

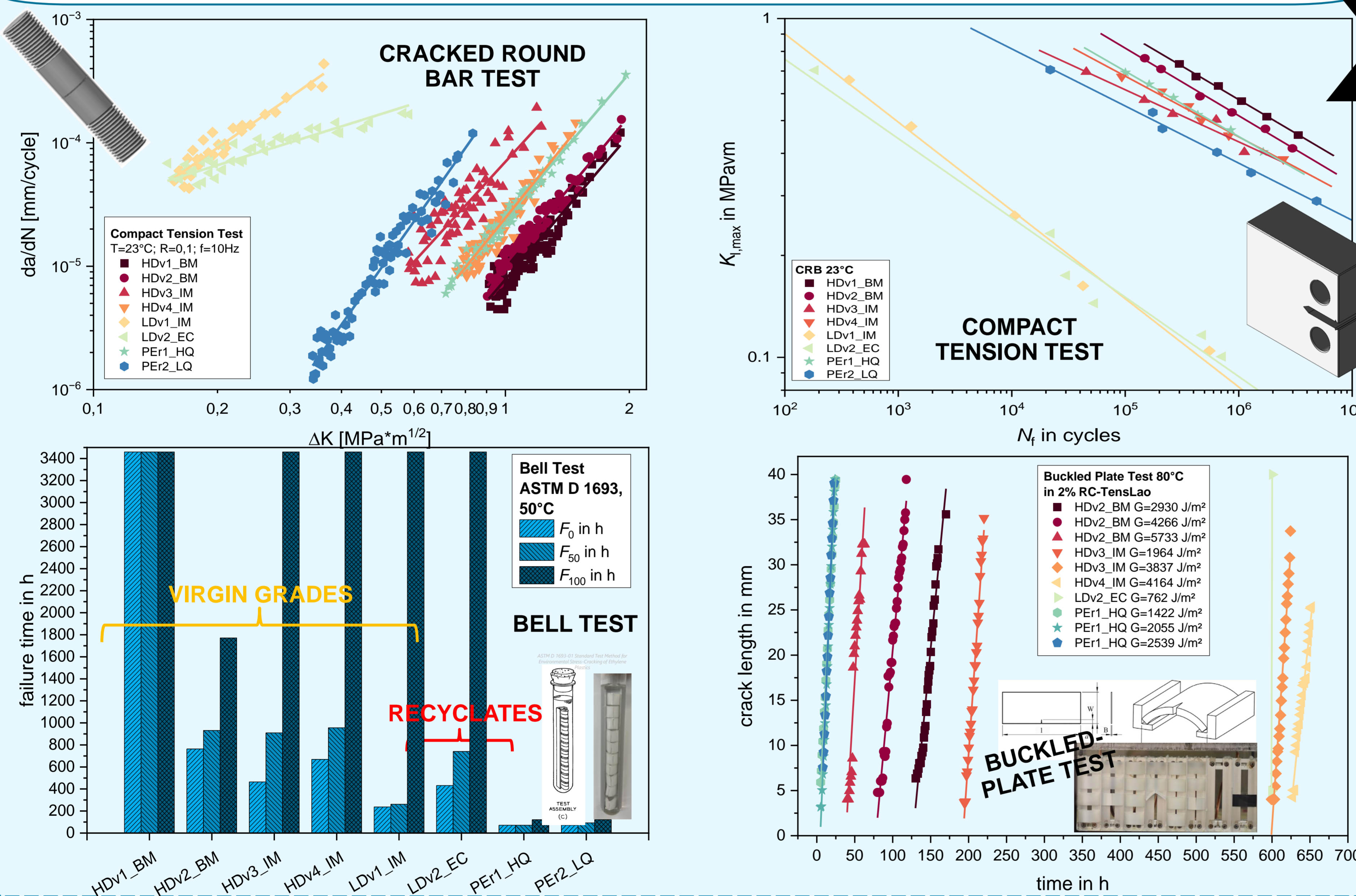
RESULTS

COMPARING TEST METHODS

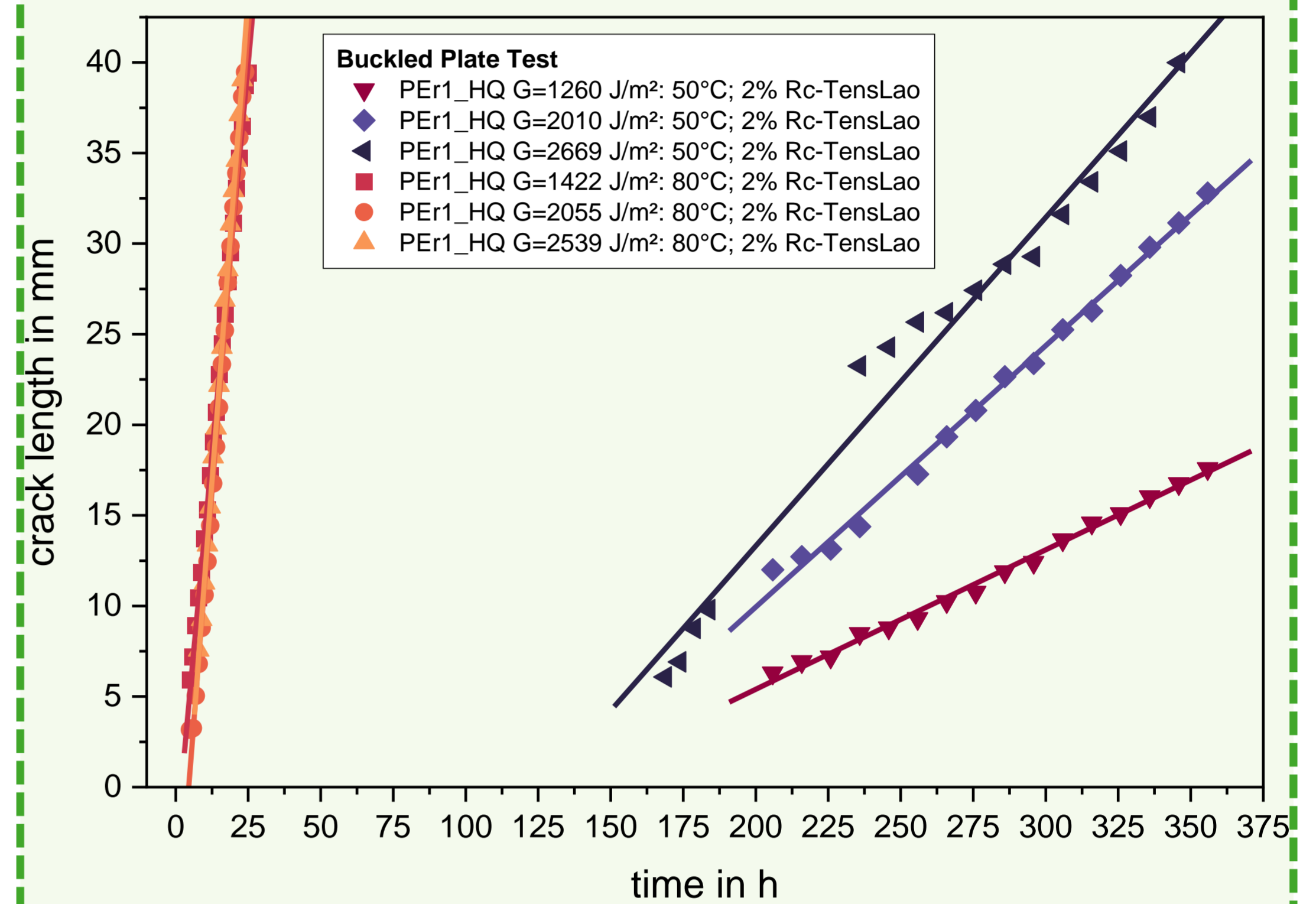
ENVIRONMENTAL STRESS CRACKING RESISTANCE IN DIFFERENT PE GRADES



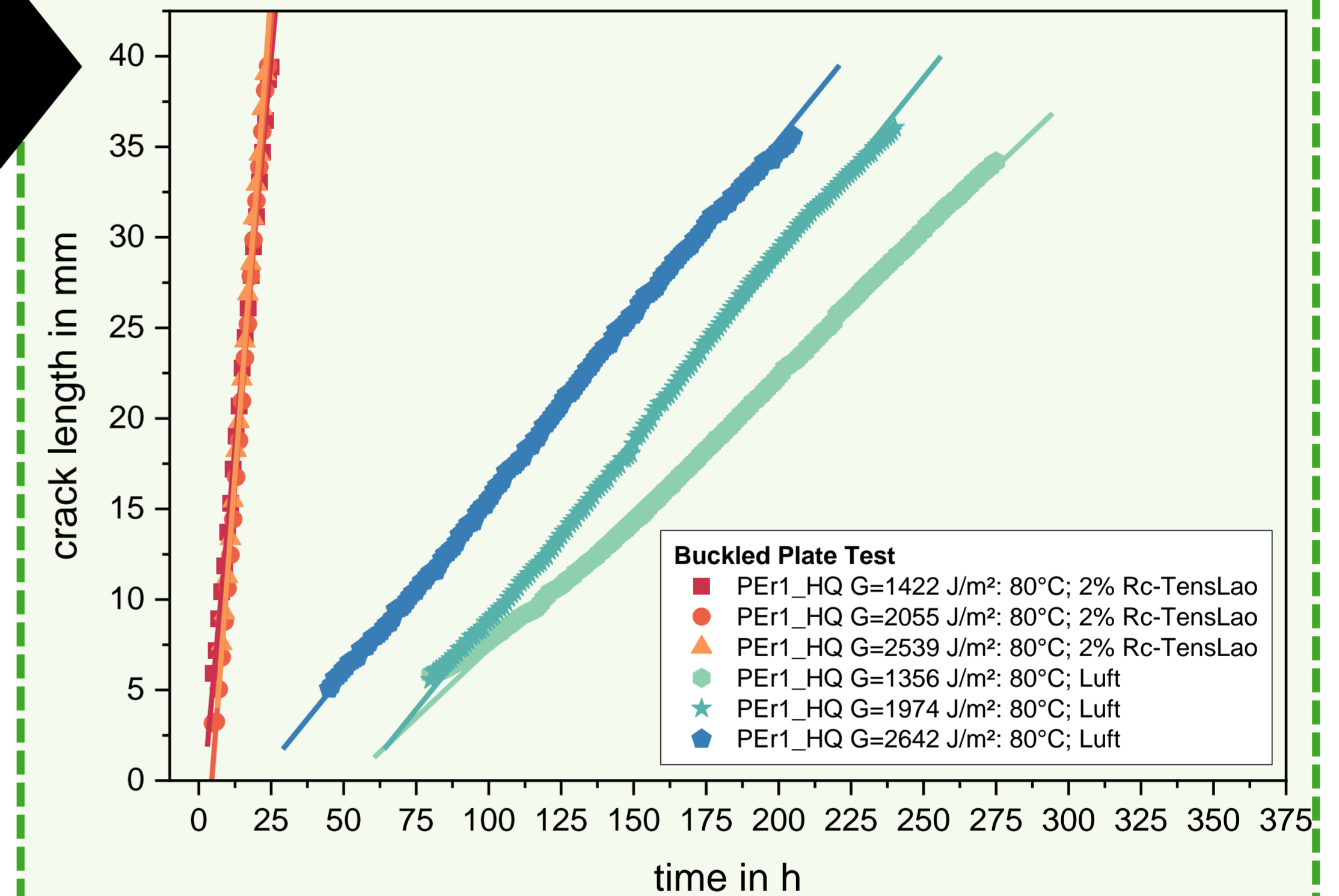
CORRELATION BETWEEN FRACTURE MECHANICS AND ENVIRONMENTAL STRESS CRACKING METHODS



INFLUENCE OF TEMPERATURE & MEDIA



Increased Temperature: significantly reduces PE resistance against ESC.



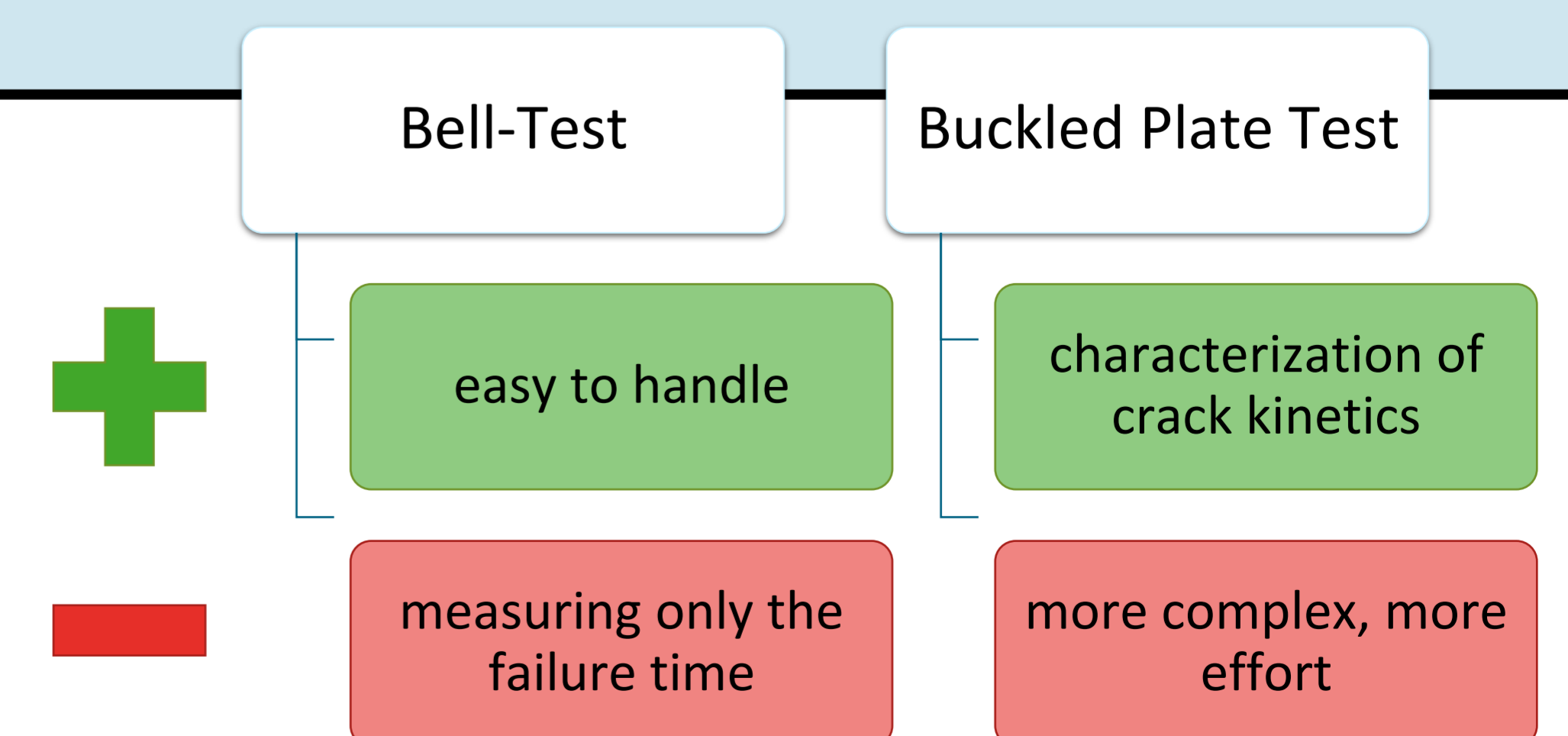
Active Agent: accelerates ESC in all PE by faster crack initiation and propagation.

Mechanism: Active agent reduces secondary attraction forces leading to higher chain mobility during crack growth.

Recyclate Vulnerability: PE recyclates are especially affected, showing lower resistances compared to virgins.

CONCLUSION & OUTLOOK

- Bell Test:** A straightforward method effective for assessing ESC resistance, providing a quick evaluation. Adoption by many companies easily possible.
- Buckled Plate Test:** Offers detailed insights into crack propagation kinetics, allowing a deeper understanding of ESC behavior under stress. Higher test complexity.
- Limitations of Recycled PE:** Results emphasize that recycled PE may have limited suitability for high-stress applications due to significantly lower ESC resistance.
- Future Research Direction:** Aim to develop methods to enhance recyclate selection processes for demanding applications, supporting increased recycled content in consumer goods without sacrificing durability.



- Recyclates have worst ESC resistance
- Strong influence of active reagent on ESC resistance
- Strong influence of temperature on ESC resistance

