

Qenos

Cracking Failures in Polyethylene Rotomouldings



September 2022

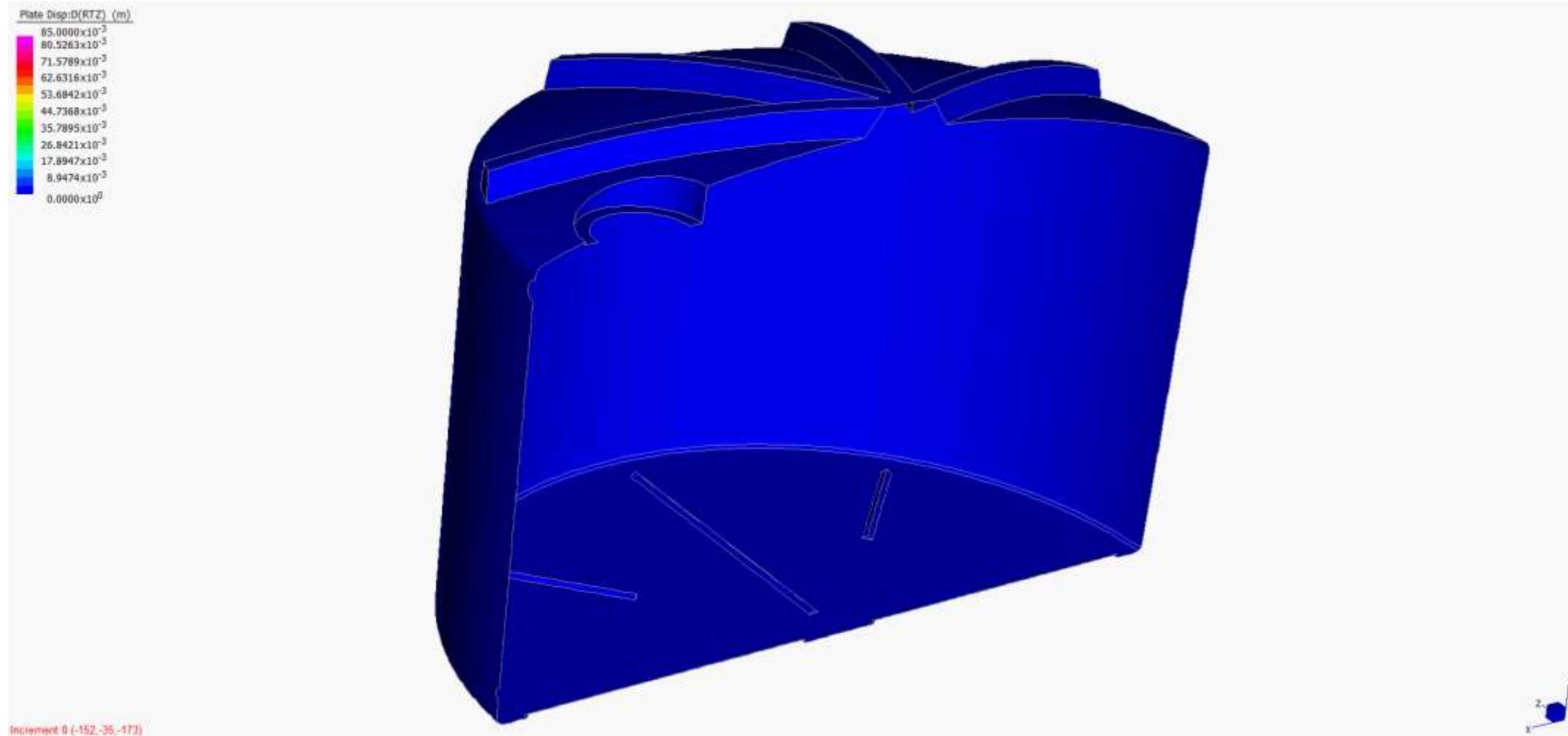
Rotational Mouldings can fail in different ways

- Burst
- Bend or sag
- Bulge
- Crack

What underpins a good rotationally moulded product that lasts?



Engineers can design against Bursting, Sagging and Bulging problems by keeping stress below critical levels



Catastrophic Failure can occur in badly designed or poorly moulded plastic parts



Eastern Courier Matt Bowen



Ductile failures (bulging and sagging) can happen due to uneven thickness or at elevated temperatures



Rotomoulded pipe after long exposure to stress exhibiting ductile (bulging) failure

Good product design and moulding process are important to ensuring catastrophic and ductile failures during service are averted

Slow Crack Growth failure can sometimes happen in apparently well designed and properly moulded rotomoulded products



Cracking develops over a period of time in an area where there is no discernable defect, bulging or stretching of the product wall



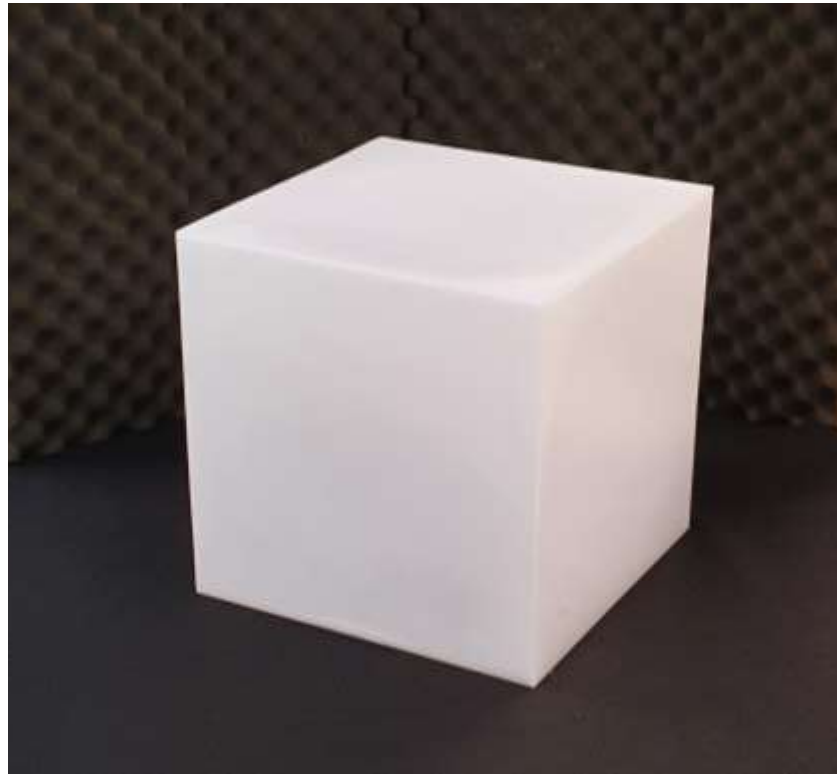
Rotational Mouldings can be tested to determine how well they are cooked

- Impact Testing
- Checking for internal Bubbles

However these tests don't necessarily tell us whether the moulding can withstand failure from slow crack growth



In order to explore the factors that affect Slow Crack Growth in rotomoulding, a series of 12mm thick mouldings were moulded from Alkatuff LL711UV



Oven temperature 250°C

Cook times 42 – 56 Minutes



The ARM Impact strength of the mouldings were assessed at - 40°C

| Cook Time (Mins) | 42 | 46 | 50 | 54 | 56 |
|------------------|----|----|----|----|----|
| 135 J Impact | P | P | P | P | P |
| 203 J Impact | F | P | P | P | P |

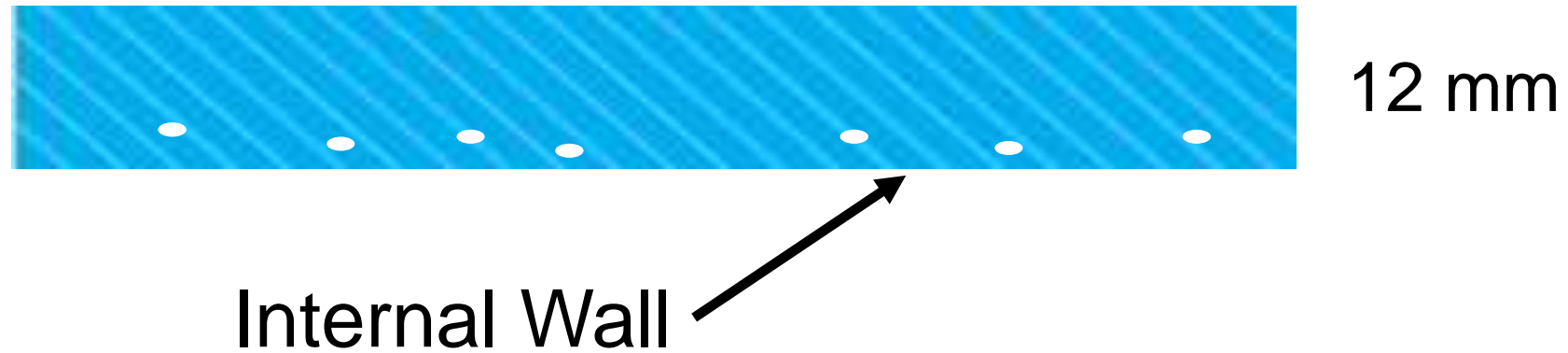
Impact Energy = Height (m) x weight (kg x acceleration due to gravity)

P = Pass F = Fail

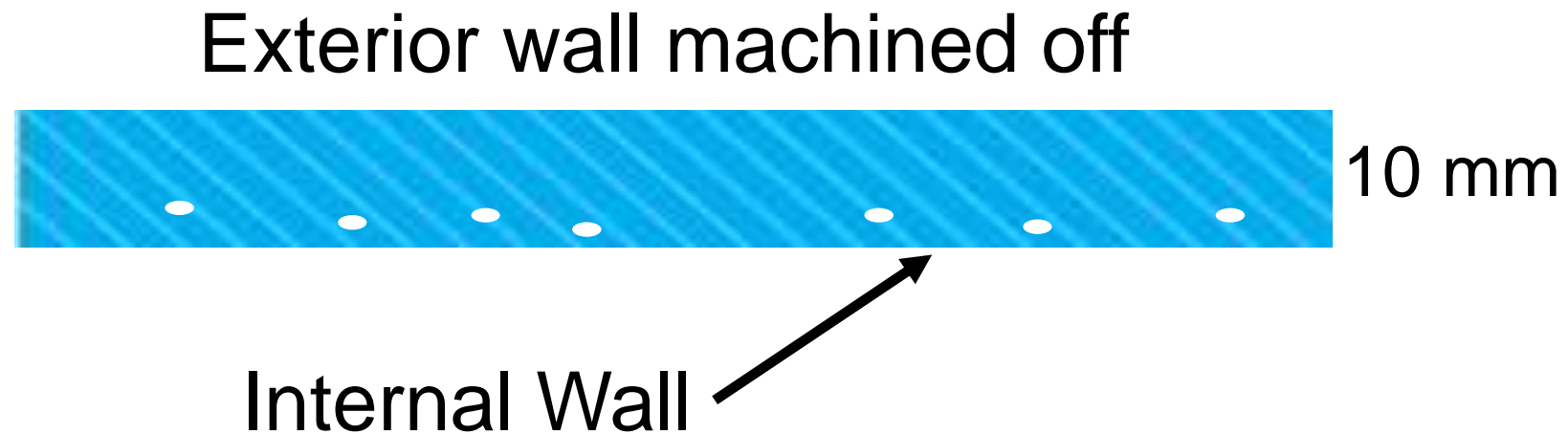
The impact strength results infer a wide processing window for producing well cured mouldings



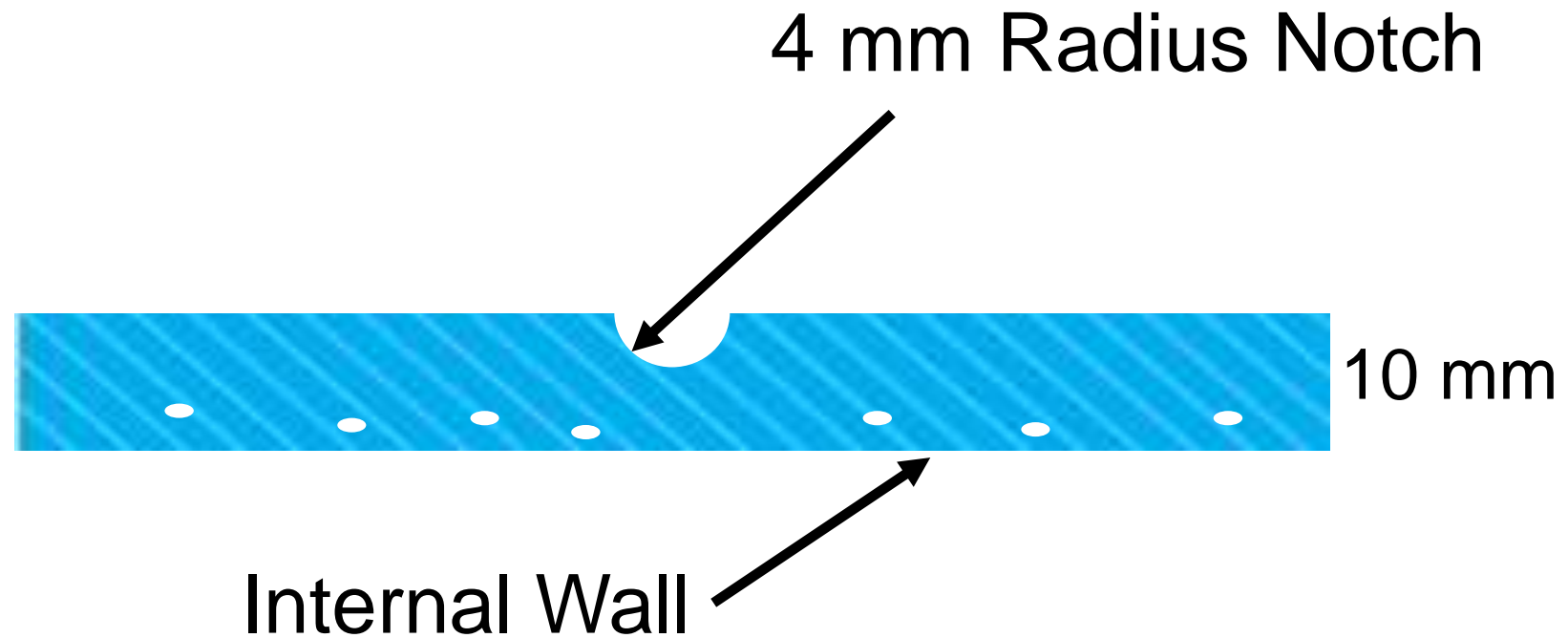
In order to critically assess the slow crack growth resistance we developed an in-house test method based on rotomoulded parts



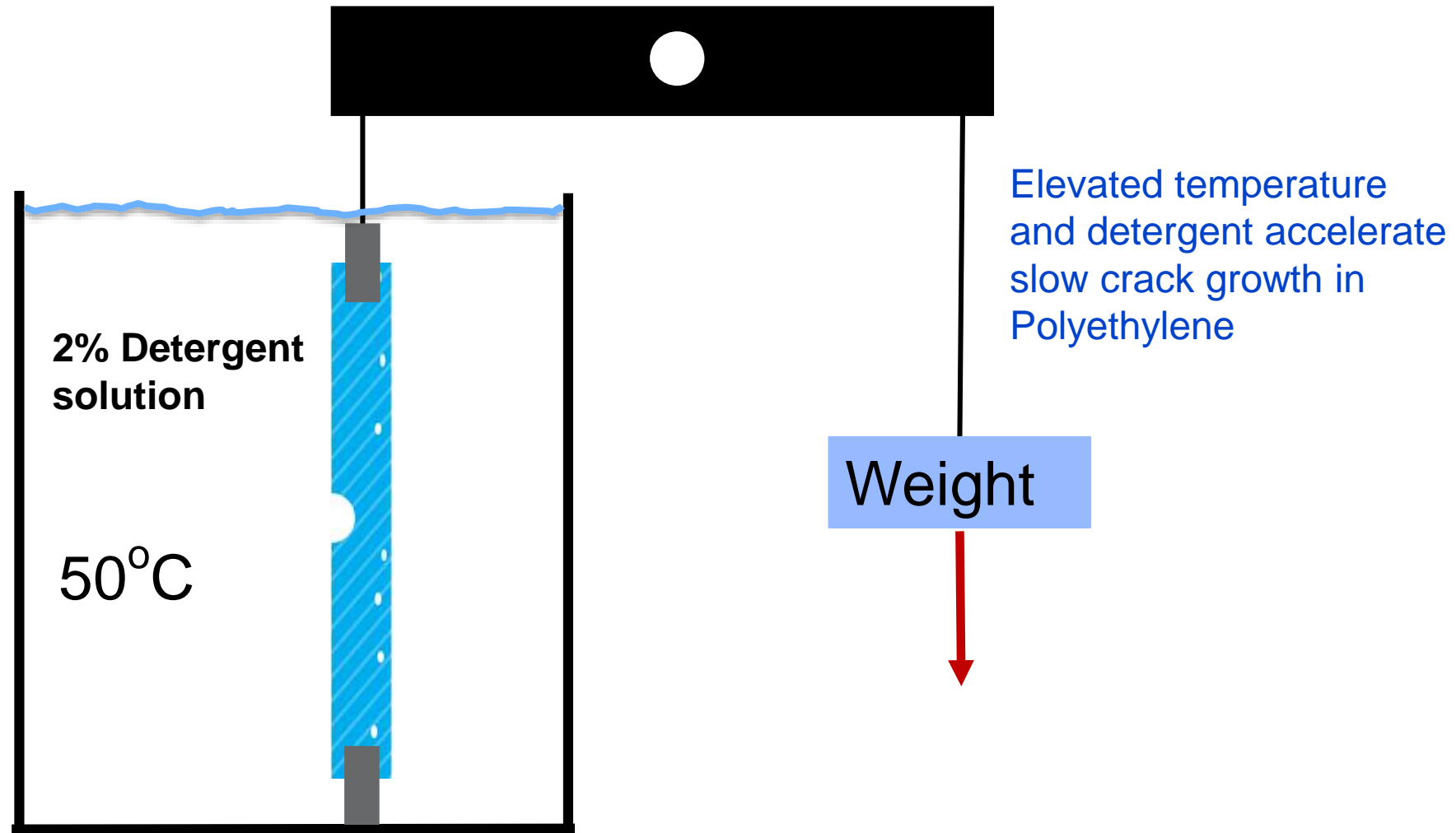
Samples were prepared to overcome wall thickness variation and apply stress to a constant area



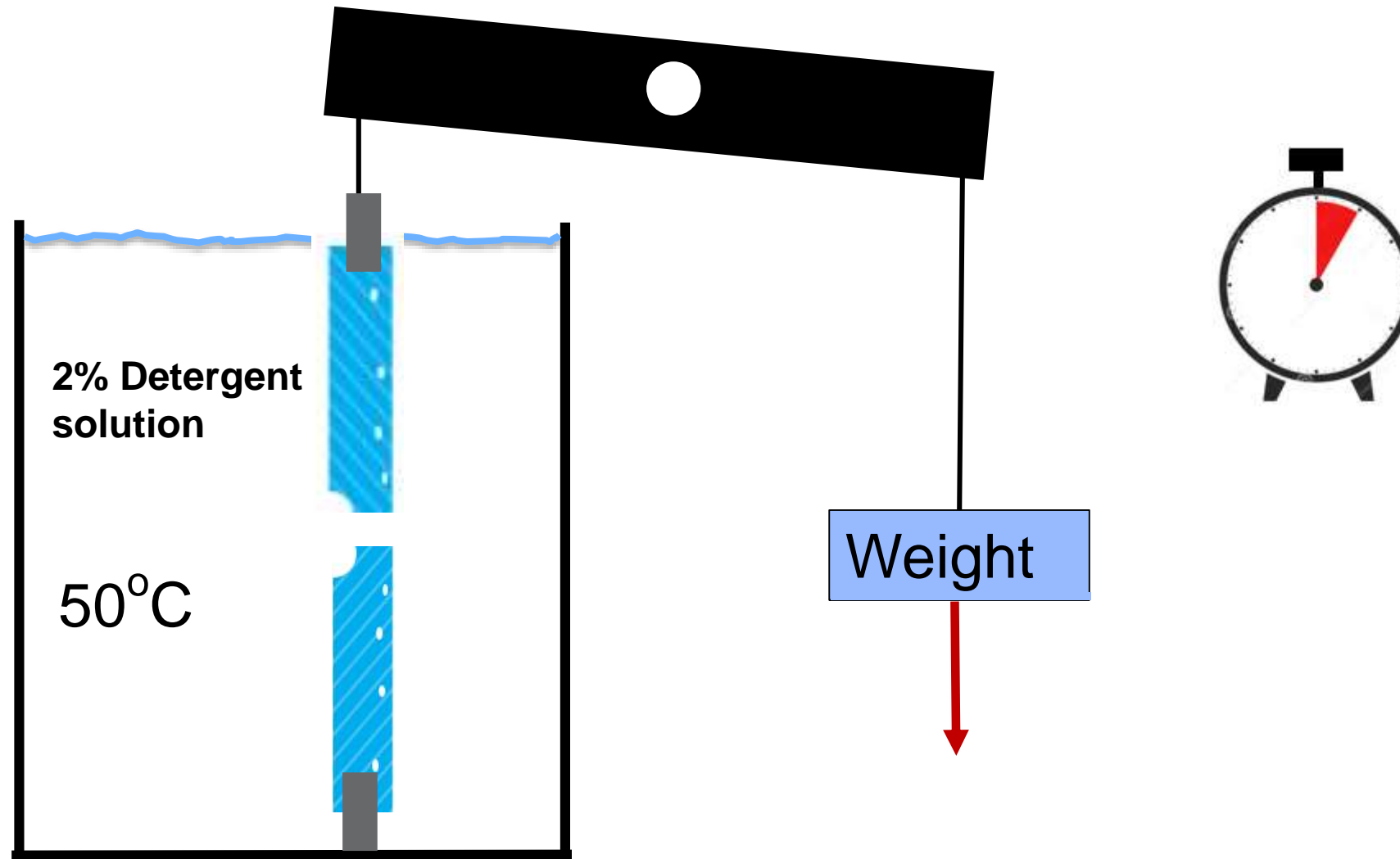
The specimen was notched on the outside wall where damage or intrusion is likely during service



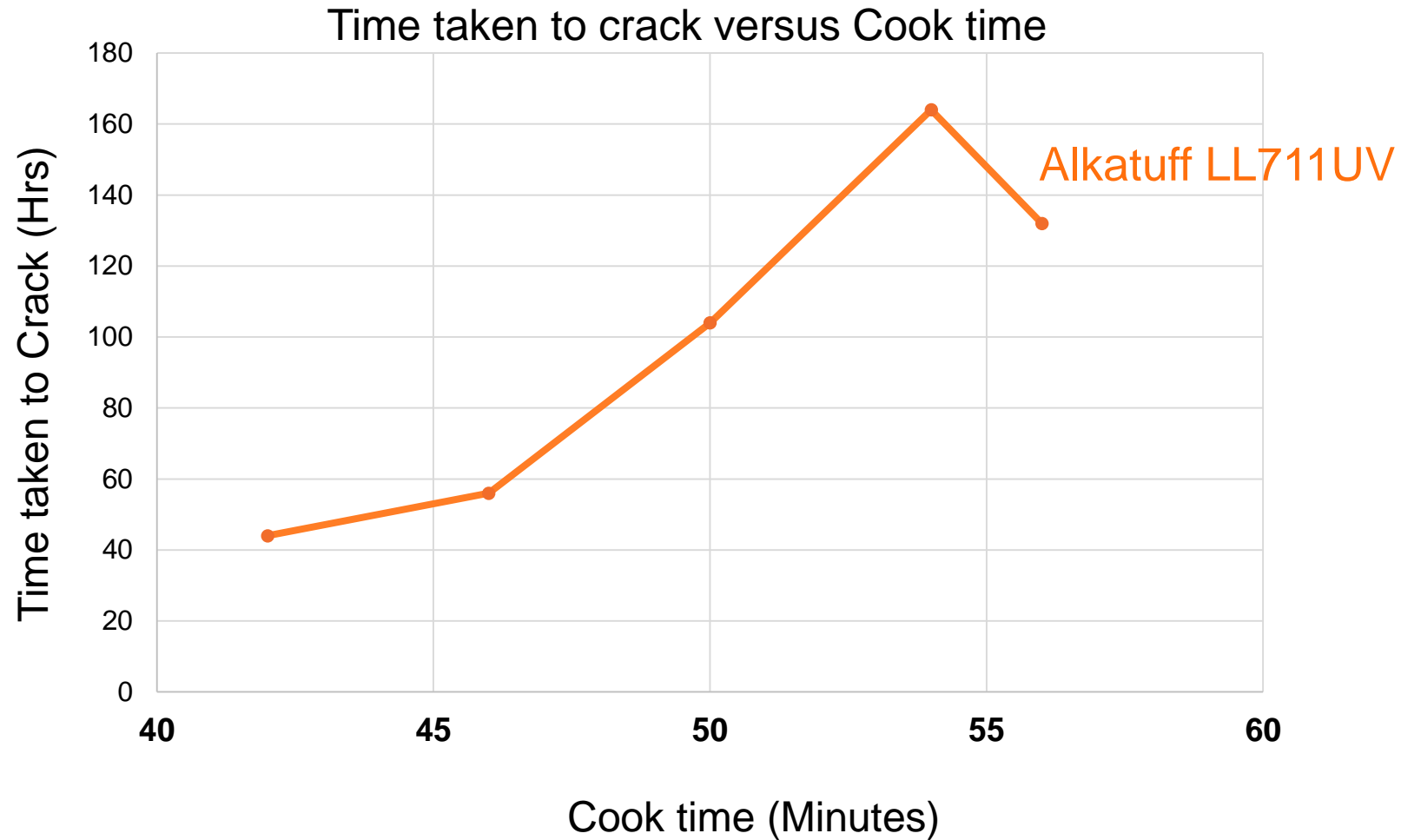
The samples were immersed in 2% detergent solution at 50°C and a stress of 3.5 MPa applied



The testing rig have timers attached so that the time to failure can be accurately recorded

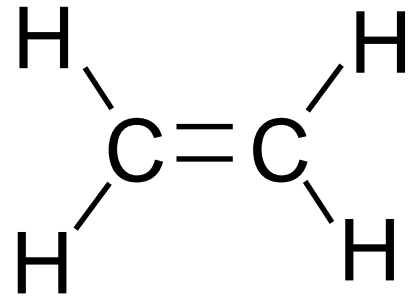


The test results showed that the slow crack resistance of 12 mm thick Alkatuff LL711UV mouldings improved dramatically as the cook time increased from 46 minutes

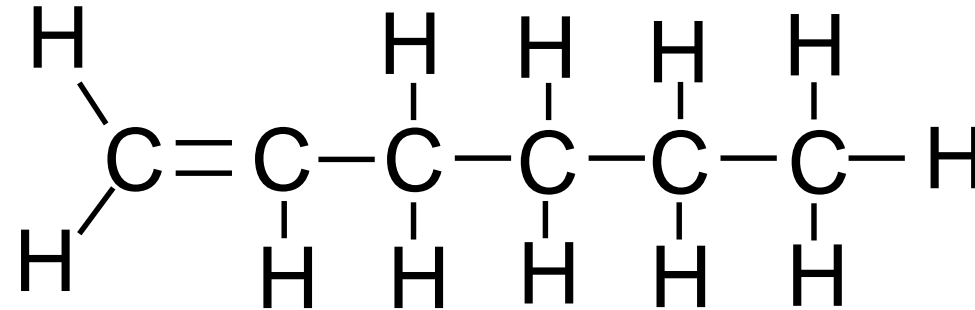


Alkatuff LL711UV possesses excellent crack resistance

Qenos roto polymer grades are designed for high performance using Hexene co-monomer



ETHYLENE



HEXENE

The Hexene comonomer is applied effectively to make Alkatuff LL711UV very resilient and resistant to slow crack growth

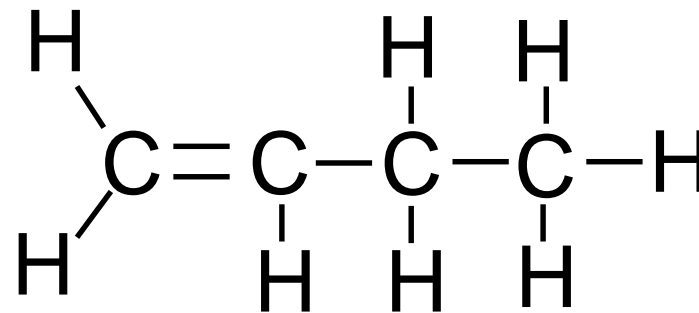


The testing was repeated using LLDPE tank grade with similar MI and density but with Butene as co-monomer instead of Hexene

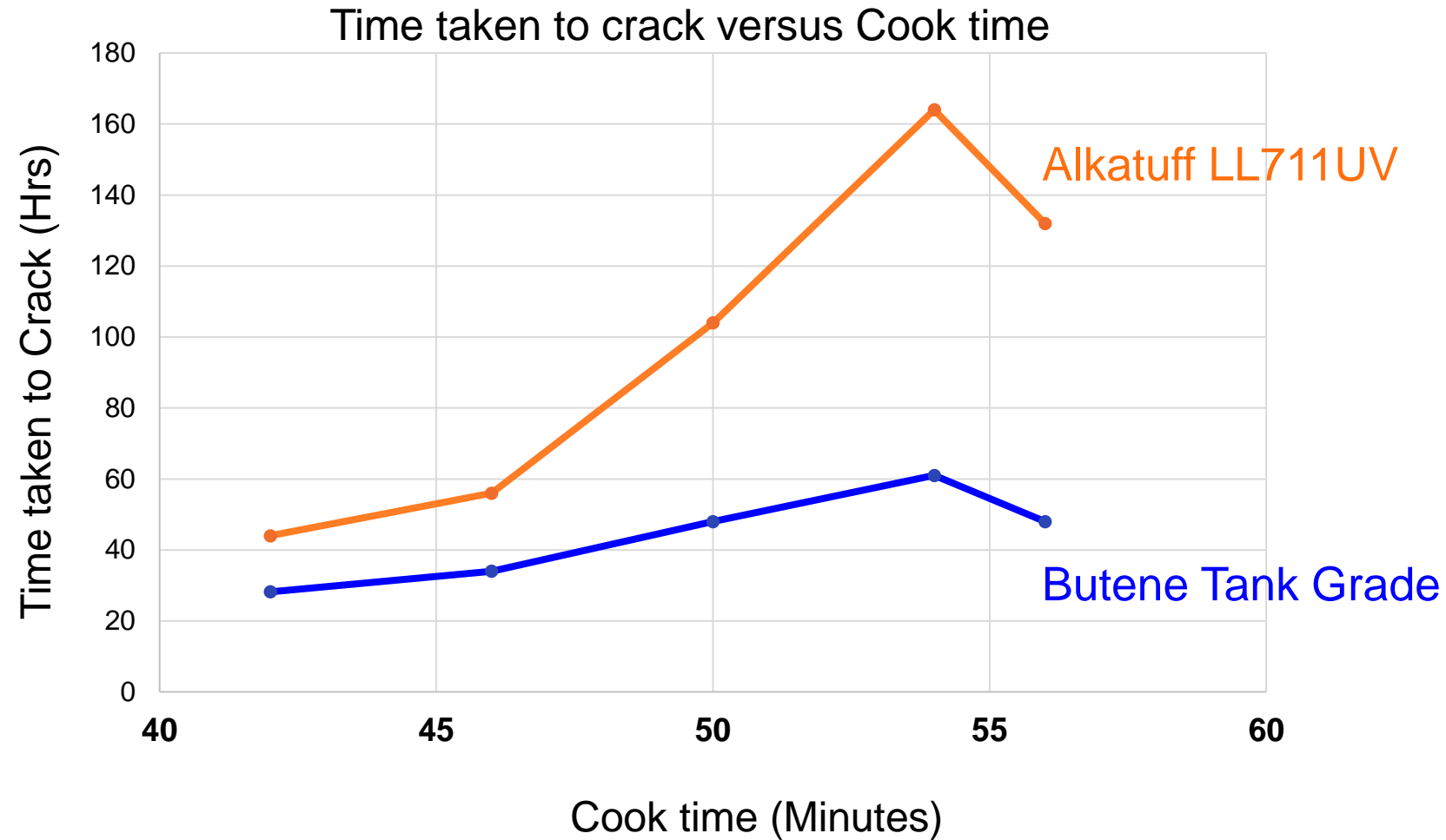
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Butene Tank Grade

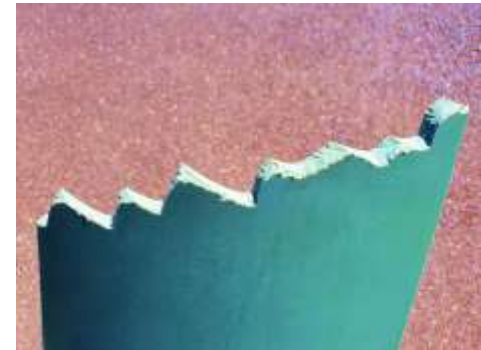
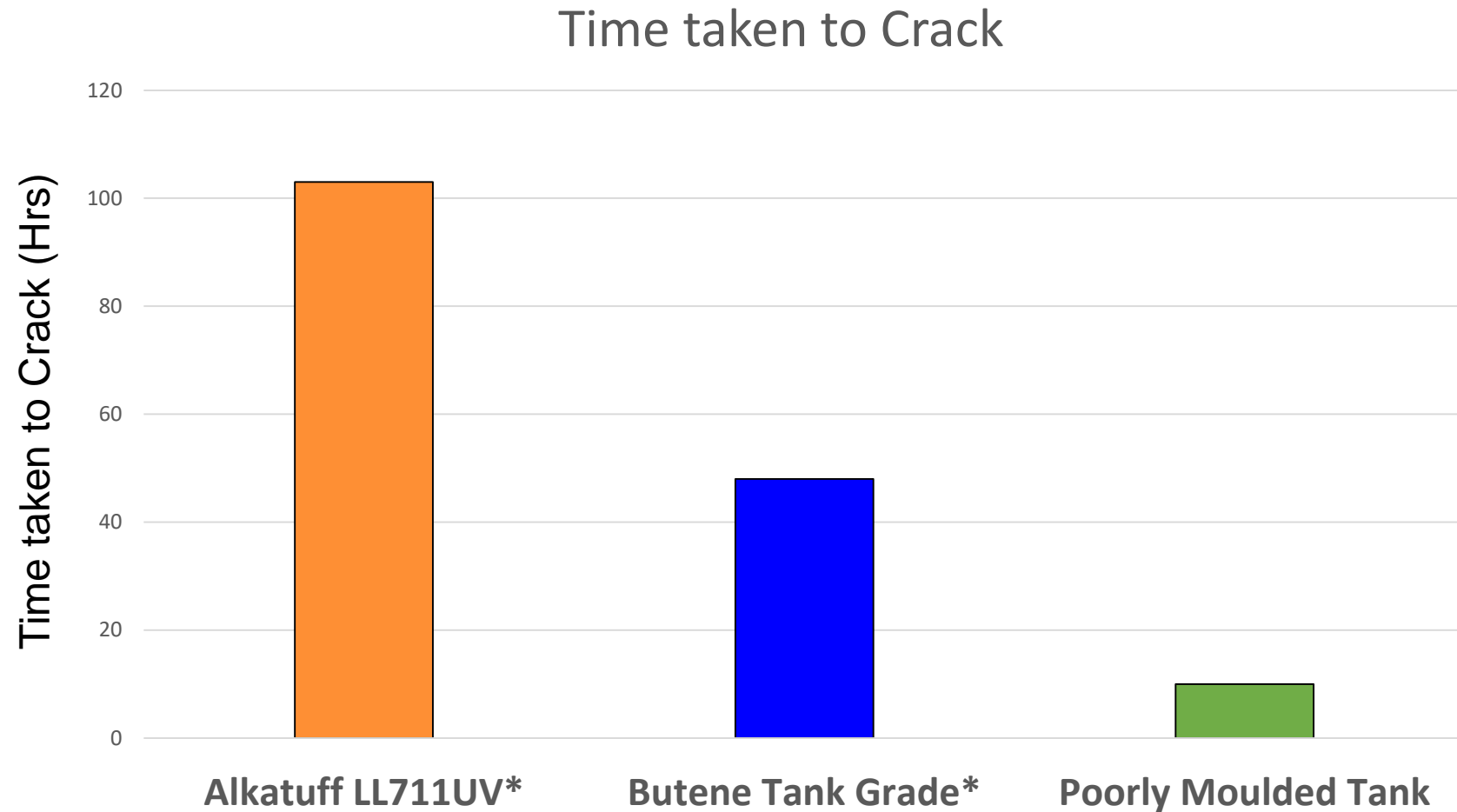
BUTENE



The Butene LLDPE tank grade showed inferior crack resistance regardless of what cook time was used



An 1800L tank which suffered catastrophic failure in service exhibited very poor slow crack resistance



*50 mins Cook time



The 1800 litre tank was produced from poor quality powder which was also undercooked



Internal Surface



Cross Section



Key deductions from our evaluation of slow crack growth resistance of Rotational Mouldings

- Good product design and quality powder are important underpinnings
- Mouldings with good impact strength may still have poor crack resistance, so optimising cook time with this in mind is necessary
- The inherent resilience built into the base polymer grade is critical to the ultimate crack resistance of the moulding



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Questions??

