NT Conradie

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MEng Safety Report

Tensile and Compression Testing of Hyperelastic Materials

Date: January 2020

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Student: Mr NT Conradie

Laboratory Technician: Mr N Macallister

EMERGENCY CONTACTS:

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Pressure Vessels or Pipes: No pressure vessel or pipe with a pressure in excess of 50 kPa is involved in this project.

Laboratory Technician (Mr N Macallister)

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OVERVIEW OF TESTING

Tensile and compressive testing of Ecoflex 0030, Mold Star 15 and Smooth-Sil 950 is to be performed according to ISO 37 and ISO 7743 standards respectively.

Specimens of each of the materials are prepared in the laboratory by mixing the required two constituent components in accurately measured appropriate amounts. The materials are poured into cleaned and prepared moulds. The filled moulds are inserted in the degasser to remove any air bubbles formed during mixing and pouring. Once this is completed, any excess material is removed from the filled moulds. The filled moulds are left to set overnight. The workstation and equipment are cleaned appropriately for further use.

Once the specimens have set, they are removed from the moulds. The moulds are cleaned appropriately for further use. The specimens are then sprayed with spray paint to produce an appropriately distributed speckled pattern on the specimen surface for the DIC test.

For tensile testing, the MTS crosshead and load cell are set up appropriately, as is the workstation according to the instruction booklet. Tensile grips are fixed to the MTS frame. The specimen is placed in the grips and the extensometer is fixed to the specimen. The DIC equipment is set up so that the specimen is appropriately lit and in focus. Testing is commenced and the extensometer removed when appropriate. Once the specimen has failed, it is removed from the grips. All data recorded is backed up appropriately.

The procedure for compressive testing is much the same as detailed above, barring that compressive grips are fixed to the frame and the test is set up for compressive testing.

Once a testing session is completed, all relevant equipment is carefully stowed away as needed.

The equipment that will be used is detailed in the table below.

Equipment
Degasser
MTS tension/compression load frame fitted with load cell
MTS standard tensile grips
MTS standard compressive grips
MTS extensometer
DIC adjustable tripod frame
DIC processor
2 DIC cameras
2 DIC constant light sources
Spray paint canister

Samples to be tested are detailed in the table below.

Material	**Test**	**Number of samples**	**Thickness (mm)**
Ecoflex 0030	Tensile	15	2
Ecoflex 0030	Compressive	15	12
Mold Star 15	Tensile	15	2
Mold Star 15	Compressive	15	12
Smooth-Sil 950	Tensile	15	2
Smooth-Sil 950	Compressive	15	12

Tensile and compressive test specimen examples are shown in the figures below.

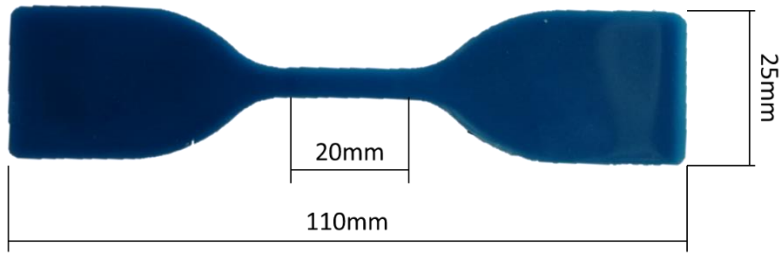

Figure 1 - Tensile Test Specimen

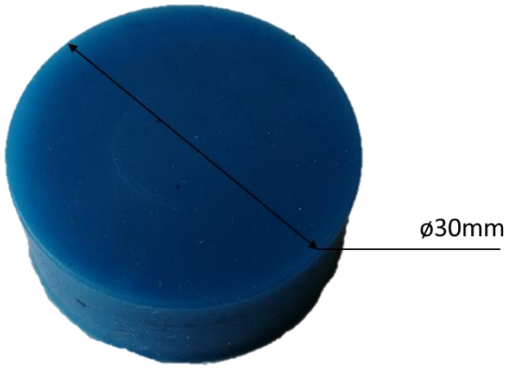

Figure 2 - Compressive Test Specimen

The estimated maximum loads are detailed in the table below.

Test	Estimated maximum load (N)
Tensile	15
Compressive	100

GENERAL LAB SAFETY

- Laboratory induction is required before any testing may take place
- Obtain and work through the safety instructions for any laboratory setup before using it, or compile new ones if it does not exist
- An approved safety report is required to work in the laboratory and must be visible and accessible at all times during testing
- Always ensure at least one other person is within earshot when working in the laboratory
- Unsupervised testing after working hours is not allowed without proper approval
- Closed shoes are required to be worn at all times in the laboratory area
- No loose clothing may be worn in the laboratory area
- No earphones or headsets are allowed when working in the laboratory area so that any alarms may be heard properly
- No food or drinks are permitted within the laboratory area
- Cellphones may not be used when working with laboratory equipment
- No unauthorised persons are allowed within the laboratory area
- General good working practices should be held to

- Extra caution should be taken when working in the DIC laboratory and with DIC equipment, as the equipment is highly sensitive and may not be violently disturbed
- Help should be requested if uncertain, it will be willingly provided
- Report any safety risks observed to the lab technician or a relevant member of staff, or campus security if observed after hours
- Report any incident in which a significant injury has occurred immediately to the lab technician or a relevant member of staff
- If a fatal or potentially fatal injury has occurred, the law specifies that the site must not be disturbed
- In case of loadshedding occurring during testing:
    - Treat all electrical outlets as live
    - Ensure all plugs are switched off
    - Unplug equipment as necessary

FIRE SAFETY

There is no direct fire risk associated with the work as detailed in this report.

In the case of an emergency, the evacuation route for the laboratory may be found in Appendix A.

- Avoid the internal combustion engine laboratory if the fire alarm has sounded, as the automatic fire extinguishers may lead to suffocation.
- If you are the last to leave an area, close the door behind you and tie something to the handle.

ACTIVITY BASED RISK ASSESSMENT

Activity	Risk	Risk type	Classification of risk severity	Mitigating steps
Entering the lab	Injuring yourself due to improper use of the door	P	Acceptable Risk	Be cautious and aware of your surroundings
Moving around the laboratory	Tripping and falling over equipment	P&E	Possible risk	Be cautious and aware of your surroundings
Switching on lights	Shocking yourself	P	Acceptable Risk	Inspect the switch before using it for signs of damage
Setting up for the mixing process	Injuring yourself	P	Acceptable Risk	Be cautious and aware of your surroundings
	Dropping materials and equipment	E	Acceptable Risk	Be careful when handling materials and equipment
Preparing specimens	Improper procedures resulting in contaminated or unusable specimens	E	Possible risk	Make sure to exactly follow preparation instructions and be careful
Degassing specimens	Improper use of the degasser	P&E	Substantial risk	Inspect the degasser before use and make sure to exactly follow instructions for use
	Equipment failure	P&E	Possible risk	Inspect the degasser for any signs of damage before use

Moving DIC equipment from storage to the appropriate position	Damaging equipment	E	Acceptable Risk	Be careful when moving equipment
Turning on equipment	Electrical shock	P	Possible risk	Check all cabling before plugging in or switching on to ensure the insulation is intact
Turning on DIC lights	Eye injuries	P	Acceptable Risk	Make sure to not look directly at the lights when switching them on or while they are on
Creating new test methods	Overwriting the test method templates	E	Acceptable Risk	Follow instructions carefully and be aware when saving the new test methods
Manually adjusting the crosshead height	Injuring yourself	P	Substantial risk	Keep clear of the crush zone between the crosshead and load frame when making adjustments
	Compressing the load cell above its limits	E	Substantial risk	Always check that the hard-limits are set correctly before commencing testing, and turn off the handset to avoid accidental adjustment
Changing grips	Hand injuries from tool misuse	P	Substantial risk	Correctly use tools, do not use excessive force and be cautious
	Dropping a grip	P&E	Substantial risk	Always wear closed shoes in the laboratory, hold grips firmly and carefully, and be cautious
Fitting the sample	Finger injuries	P	Substantial risk	Use fine adjustment and be cautious
	Overtightening the grips	E	Substantial risk	Do not force the grips once they are tightened appropriately
Fitting the extensometer	Dropping the extensometer	P	Acceptable Risk	Be careful and attach the extensometer to the MTS frame to prevent it from falling to the ground
Applying a tensile load to the sample	Compressing the load cell	E	Possible risk	Verify the crosshead direction is correct before commencing testing
	Overloading the load cell and grips	E	Possible risk	Ensure the load limits are set to +25000N and -400N before commencing testing
Capturing relevant data	Overextending the extensometer	E	Substantial risk	Remove the extensometer before its maximum extension has been reached
	Extensometer failure due to sample failure	E	Substantial risk	Remove the extensometer before sample failure
	Failing to capture data	E	Acceptable Risk	Check that all recording equipment is properly set up before commencing testing

Removing the extensometer	Dropping the extensometer	E	Possible risk	Be careful and place the extensometer on a safe area
Removing the specimen	Finger injuries	P	Substantial risk	Ensure the crosshead is stationary and will not be activated before removing the specimen
Returning the crosshead	Bodily injuries	P	Substantial risk	Be careful and ensure you are standing away from the MTS frame when returning the crosshead
Removing the grips	Hand injuries from tool misuse	P	Substantial risk	Correctly use tools, do not use excessive force and be cautious
	Dropping a grip	P&E	Substantial risk	Always wear closed shoes in the laboratory, hold grips firmly and carefully, and be cautious
Backing up recorded data	Loss of data	P&E	Possible risk	Store data according to guidelines and keep sufficient independent backups
Turning off equipment	Electrical shock	P	Possible risk	Check all cabling before switching off or plugging out to ensure insulation is intact
Tidying the workstation	Tripping and falling over equipment	P&E	Possible risk	Be cautious and aware of your surroundings
Locking the laboratory	Injuring yourself due to improper use of the door	P	Acceptable Risk	Be cautious and aware of your surroundings
Returning the key	Losing the key	E	Possible risk	Be careful when handling the key and be conscious of its whereabouts until it has been handed over to the appropriate personnel

APPENDIX A – EMERGENCY EVACUATION PLAN