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# AN AUTOMATIC PORTABLE PRESSURE TESTING RIG TO DETERMINE THE PERFORMANCE OF THE GRE COMPOSITE PIPES UNDER VARIOUS STRESS RATIOS



## PRODUCT DESCRIPTION

This product is a novel automated pressure test rig to perform Ultimate Elastic Wall Stress (UEWS) test. It is fabricated using Rotex make solenoid valves controlled using NI DAQ and Labview interface. The test rig is designed to conduct pressure testing of GRE pipes in accordance with ISO 14692 through ASTM D2992 document. The test rig is capable of automatically testing under five stress ratios by a combination of internal pressure and axial loadings through inclusion of indigenous design of pressure intensifier. [Pure axial (0H : 1A), hoop to axial (1H : 1A), pure hydrostatic (2H : 1A), quad hoop to axial loading (4H : 1A) and pure hoop (1H : 0A)]. The test rig also allows for short term tests such as UEWS test where the strain response can be measured and analyzed offline to determine the initial failure of the pipe. The tubes are further tested until the weepage failure occurs. The failure envelope for different stress ratios are mapped and provides a design limits for engineers to design the composite pipes.

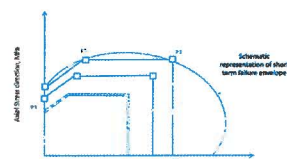
The results are associated with ASTM D2992 type of regression testing for the determination of long term strength of composite pipes.



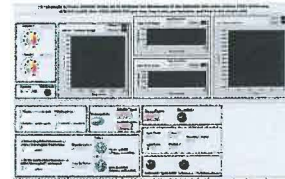
Automated UEWS pressure test rig setup



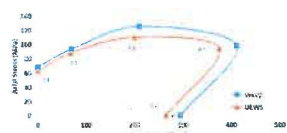
Weepage failure in composite pipe at high pressure



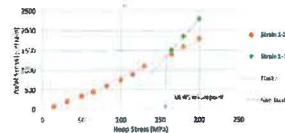
Failure envelope according to ISO 14692



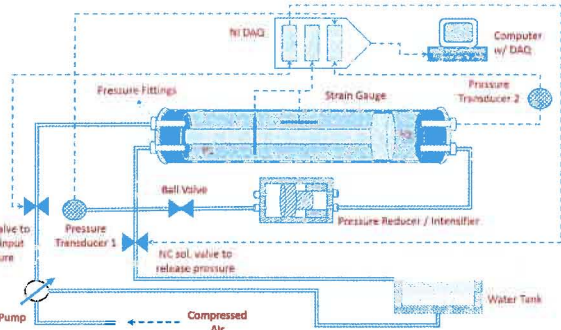
Labview interface for static and cyclic UEWS test



UEWS and weepage failure envelope



Determination of UEWS failure point from the stress strain relationship



Schematic diagram of the automated multi-axial pressure test rig

## PROBLEM STATEMENT

- The international standards for the qualification of composite pipes under pressure conditions are described in ISO14692 through ASTM 2992.
- The current testing procedures take 10000 hours (≈14 months) to determine the long term performance of the composite pipes which is not cost or time effective.

## INDUSTRY COLLABORATION

- SIRIM Advanced Materials Research Centre (AMREC), Kulim, Malaysia.
- NI Southeast Asia Sdn. Bhd., Malaysia.

**PUBLICATIONS**

- Pranesh Krishnan, M.S. Abdul Majid, M. Afendi, M.N.F. Mohd Kazim, (2014). Short-term test of ±55° filament wound GRE composite pipes under multi-axial stress ratios, World Virtual Conference on Advanced Research in Mechanical and Materials Engineering, 18-22 March 2014.
- Abdul Majid, M. S., Afendi, M., Daud, R., Gibson, A. G., Assaleh, T. A., Hale, J. M., & Hekman, M. (2014). Acoustic emission monitoring of multi-axial ultimate elastic wall stress tests of glass fibre-reinforced epoxy composite pipes. *Advanced Composite Materials*, 1-17. doi: 10.1080/09243046.2013.871175.
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- Majid, M. S., Afendi, M., Daud, R., Amin, N. A. M., Mohamad, A., Cheng, E. M., & Gibson, A. G. (2013). *Modelling of multi-axial ultimate elastic wall stress (UEWS) test for glass fibre reinforced epoxy (GRE) composite pipes*. *Applied Mechanics and Materials*, 367, 113-117.
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- Gibson, A. G., Abdul Majid, M. S., Assaleh, T. A., Hale, J. M., Fahrer, A., Rookus, C. A. P., & Hekman, M. (2011). *Qualification and lifetime modelling of fibreglass pipe*. *Plastics, Rubber and Composites*, 40(2), 80-85.

## COMMERCIAL POTENTIAL

- The test rig is mobile and portable, suitable to test the pipe specimens under five different stress ratios automatically.
- The industries need a short term test to determine the performance of the pipes under multi-axial stress ratios to determine the maximum working pressure of the composite pipes under various stress ratios.

## NOVELTY

- The test rig is a novel attempt to control the UEWS pressure test procedure automatically using solenoid valves through Labview interface.
- The test rig is capable of short term cyclic and static UEWS tests under various stress ratios to determine the long term performance of the GRE composite pipes.