COMPARATIVE AIR FLOW ASSESSMENT OF WEEP HOLE VENTILATION INSERTS AND DRAINAGE ASSESSMENT

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1. Executive Summary

This report outlines the work and findings related to the consultancy work performed for Weepa (P/L) on a range of provided weephole inserts. An investigation into airflow restriction from the use of inserts was examined for Weepa 2007 [3] and for water ingress in 2009[4]. Weepa (P/L) have provided additional inserts to Griffith University to undertake additional air flow restriction studies under similar conditions as well as to examine the drainage capability of the samples. Samples were tested and their performance evaluated in comparison with standard weephole apertures.

Results showed that all bar one of the supplied weephole inserts had no significant restriction of the airflow under normal and extreme operating conditions at typical or even high gust weather conditions. There was considerable air-flow restrictions clearly found with the sample GR07 weephole insert. The Weepa inserts were then tested under extreme laboratory conditions (over 100x typical air flow rates). Under these conditions measurable restriction to the flow is shown to vary considerably across the supplied weephole insert design.

Drainage tests showed that all samples were able to drain water either through the inserts or around the insert.

2. Background

Weepa Products is an Australian company producing inserts for domestic and commercial buildings for the local and international markets. Their products are designed to provide a covering for weepholes to prevent entry by vermin, insects (eg. bees and wasps) or as protection from bushfires, whilst still ventilating the wall cavity via the weephole.

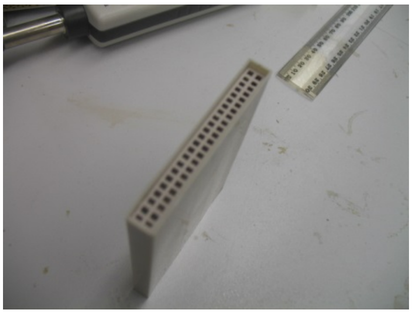
The Centre for Wireless Monitoring and Applications, School of Engineering at Griffith University has again been engaged to test the flow restriction that a sample of weephole products might have on airflow. The Centre for Wireless Monitoring and Applications has previously developed sensors for extreme environments and applications. Previous research within the centre has included research and development of miniature anemometers (air flow, agricultural soil and gas sensors). This has involved simulation and practical wind tunnels testing in the field of thermo-fluid dynamics.

3. Experimental

A number of inserts were provided for testing, identified by a unique code as shown in Table 1. Using expected flow rates [3] the conditions were evaluated for air flow in the cavity operation as in free flowing or restricted flow using standard equations. A custom test rig was used to test each insert experimentally. With no measurable difference obtained at standard operating conditions, tests were undertaken at higher air flow rates. The rig used forced flow and monitored pressure differences on either side of the weep hole to determine airflow restriction.

3.1. Description of problem

Five weephole inserts were provided for testing by Weepa for restriction of airflow and drainage testing. These were are identified as-

Weephole	Description
GR01 (insert)	Vermin Grate 
GR04 (insert)	Black Insert, 2 foldable grills 

GR05 (insert)	Wide Aluminium (75mm), drilled holes 
GR06 (insert)	Narrow Aluminium (50mm), drilled holes 

GR07 (flush mount)	White Flush Mount, micro holes externally mounted 

Table 1: Weephole inserts tested

Typical air flow rates were provided previously by Weepa together with the relevant building codes information [3] to ensure validity across application ranges. The Reynolds number for the Weepa weephole insert was calculated to be approximately 10,000 [3], which is defined as turbulent or free flowing flow. The inserts were also to be tested for drainage properties.

3.2. Equipment

A test rig to simulate and control airflow across the test weep hole inserts was designed, constructed and operated under laboratory conditions. Measurements of airflow and restriction allowed individual inserts to be evaluated under controlled conditions.

Differential pressure across an area of restriction is commonly used to quantify air flow restriction. This set-up allowed for the differential pressure to be measured as a dependency of the flow rate of the air through the weephole insert.

The equipment (Figure 1 and Figure 2) consisted of:

- A wind tunnel of sufficient size and separation of air flows;
- Ability to fit and replace weephole inserts easily;
- A tubular manometer used for differential pressure measurements;
- A hand held anemometer for the calculating airflow speed and volume; and

- A variable airflow source.

The path of the airflow through the tunnel was completely blocked apart from the opening of the replicated weephole with insert. The airflow source and exit was arranged so that direct jetting through the inserts was avoided.

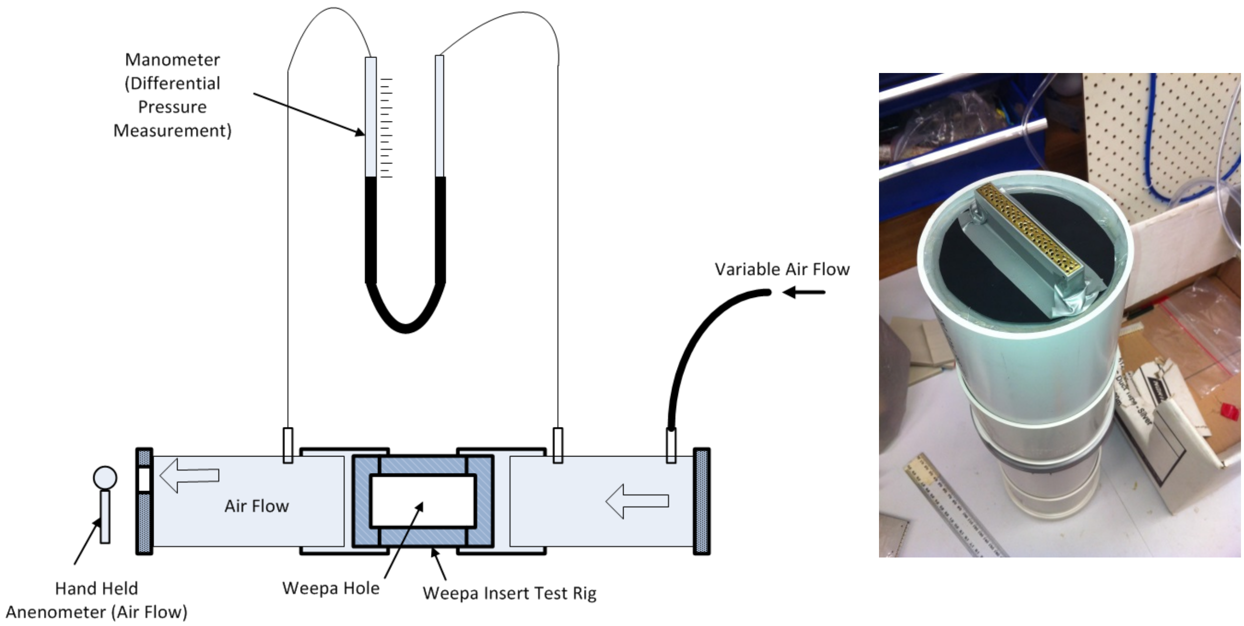


Figure 1. (a)Airflow Test Rig Setup (b) **Weep Hole Insert Test Rig**

The variable airflow source depicted in Figure 1(a) was used to simulate the airflow generated through a weephole. Pressure variation measurements were recorded using a blue dye water filled manometer. The Bernoulli effect (pressure of moving air) was accounted for by two manometer measurement insertion points (before and after the insert) with measurement points at regions having a similar airflow characteristics. The end of the wind tunnel was restricted by providing a 50mm flow exit. This is equivalent to increasing the wind speed by a factor of 4.

The range of the pressures tested far exceeds the pressure and flow rates possible in normal or even extreme weather conditions by several orders of magnitude. This extended test range was used to compare the weephole insert characteristics.

Drainage through hydrostatic resistance was tested using the apparatus in Figure 2. In this apparatus the hydrostatic pressure required to allow water to drain was investigated, water flow rate was not considered to be an important aspect of the test as weepholes are designed to allow a building to breathe and 'weep' water by way of drainage.

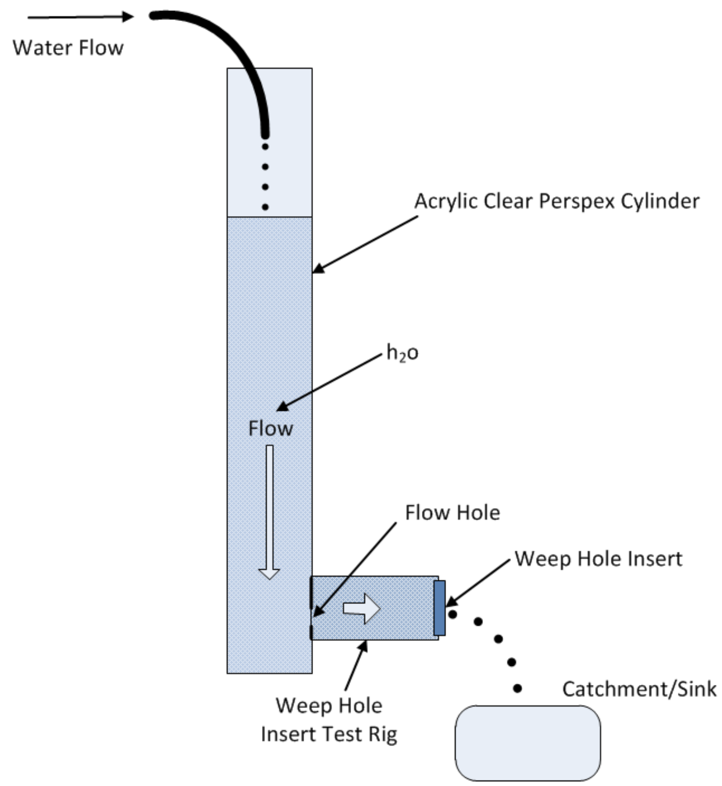


Figure 2. Airflow (water/drainage) Test Rig Setup

4. Results

4.3. Airflow tests

Airflow (l/min) Insert (code)	Normal (5 l/min)	Gust (14 l/min)	10x Nml (50 l/min)	100x Nml (500 l/min)
No insert	<0.01%	<0.01%	<0.01%	0.05%
GR01	<0.01%	<0.01%	<0.01%	0.26%
GR04	<0.01%	<0.01%	<0.01%	0.17%
GR05	<0.01%	<0.01%	<0.01%	0.35%
GR06	<0.01%	<0.01%	<0.01%	0.48%
GR07	<0.01%	<0.01%	0.16%	2.49%

Table 2: Pressure differential across inserts for a range of wind conditions (percentage of atmospheric pressure)

As shown in Figure 3, three benchmark flows were included using the standard GR01 weephole insert. These benchmarks are the pressure drops for flow through cavities that have No Restriction, 1/3 blockage, 2/3 blockage.

The pressure values shown in Figure 3 are given in Pascals (100,000 Pa ~ atmospheric pressure) while flow rates are in Litres/min. Tests were performed on a single insert at a time with the pressure difference gradually increased. A typical house will have typically upwards of 20 of these inserts, thus giving a 20 times improvement on the flow rates seen here.

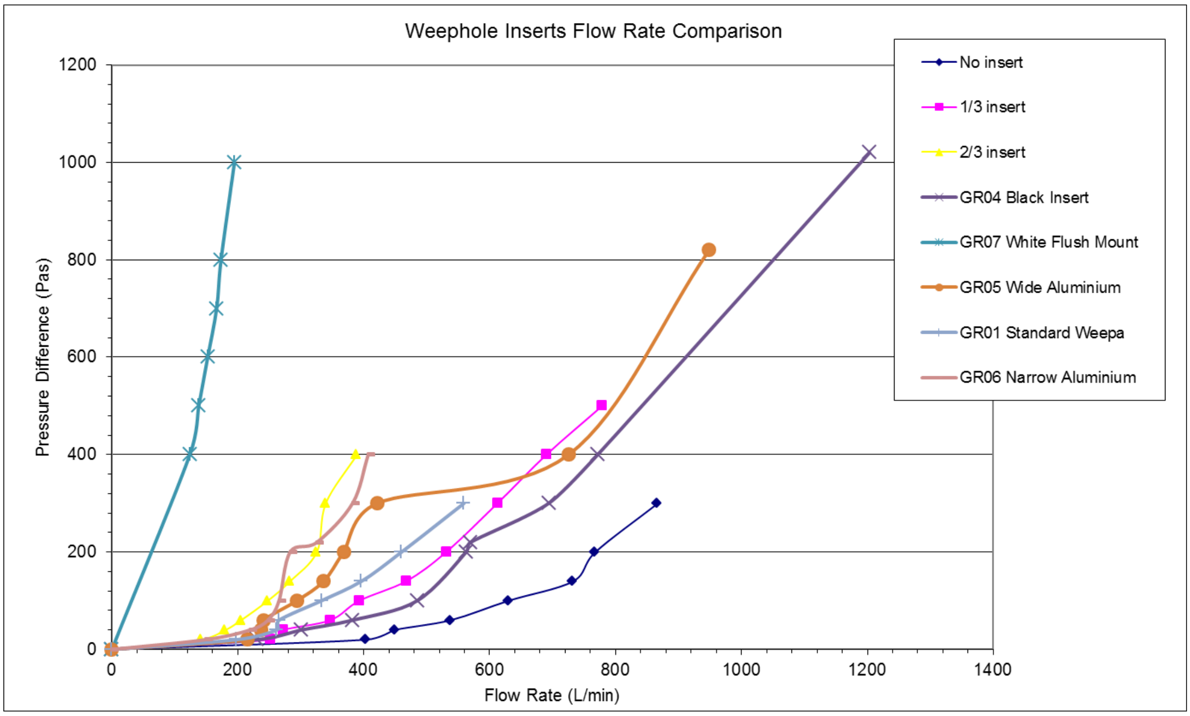


Figure 3: Pressure Differential across supplied weephole inserts. 1/3 and 2/3 covered inserts include for cross comparison

Of the inserts provided, the best performance (least restriction) at very high flow rates was seen from GR04 (Black Insert), which is expected given the less physical obstruction, while the poorest performance (greatest restriction) was seen from GR07 (White Flush Mount). Excluding GR07, these performance differences (shown in Figure 3) were only detectable at very high flow rates generated in the laboratory and under normal weather conditions present no significant flow restriction.

Flow rates rates below 100 L/m were at the limit of equipment sensitivity.

4.4. Water flow tests

In these tests water passed freely through all inserts with some leakage through the insert casing.

Insert (code)	Flow head (mm H20)	Observations
No insert	<1mm	Water passed freely through the grate
GR01	<1mm	Water passed freely through the grate
GR04	<1mm	Water passed freely through the grate
GR05	<1mm	Water passed freely through the grate
GR06	<1mm	Water passed freely through the grate
GR07	<1mm	After a wetting up period ~1s water passed freely through the grate. Water flowed equally around the grate

5. Conclusion

The weephole inserts as provided by Weepa P/L have been tested and evaluated in terms of restriction to airflow from normal to extremes. The results seen from these tests have shown no practical restriction to airflow under typical operating conditions (ie normal air flows). Under extreme laboratory conditions, differences in performance were seen. Differences between the supplied weephole inserts were observed when flow rates greater than 200 L/min were recorded. However, this flow rates is categorised under extreme laboratory conditions and will rarely be met on a typical structure. Significant differences were shown with the sample weephole insert GR07 at flow rates below 100 L/min which occurs between calculated normal and gusting wind conditions.

The weepholes were assessed for drainage of accumulated moisture, all inserts were considered to be able to drain water freely.

6. Biographies

Daniel A. James received his Ph.D. degree from Griffith University, Brisbane, Australia, in 1998. He is currently an Associate Professor and Principal Research Fellow with the School of Engineering at Griffith University, engaged on a number of pure research and industry related projects. This includes a soil moisture and ammonia sensor in addition to micro sensors for wind speed and humidity. His principle area of research is in the application of micro technology to geophysical, sporting and biomedical applications. This has lead to several international patents and commercial products.

James A. Kirkup has extensive private and Government industry experience in engineering. He has contributed to a number of varied research projects including classified and restricted research projects with the Defence Science and Technology Organisation (DSTO), Department of Defence in Canberra. James is currently undertaking his Ph.D. degree at Griffith University.

7. References

[1] - D. J. Tritton, “Physical Fluid Dynamics”, 2^{nd} ed., Oxford University Press

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