AIRFLOW ASSESSMENT OF NOVEL VENTILATION AND MOISTURE DRAINAGE HOLES

FINAL REPORT

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Daniel James, Richard Adamec
Centre for Wireless Monitoring and Applications
Griffith University

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1. Executive Summary

This report outlines the work and findings related to a research consultancy performed for Weepa (P/L) on a range of weephole inserts. The possibility of airflow restriction from use of inserts was a concern to Weepa and they approached Griffith University to assess this. Theoretical and experimental tests evaluated the performance of the weephole inserts in terms of their restriction of airflow. Three models of supplied inserts were tested and their performance evaluated in comparison with standard weephole apertures.

Result showed all of the supplied inserts had no significant restriction of the airflow under typical normal and extreme operating conditions through any of the supplied weepholes. Inserts were then tested under extreme laboratory conditions (over 100x typical flow rates). Under these conditions, the measurable restriction of the most restrictive insert, the Louvered grate, was four times that of a standard weephole. The restriction correlated to a pressure differential of 1.1% atmospheres which is not considered restrictive. Expressed as an equivalent device it was found to be equivalent to a 2/3 size weephole. There was some variation across individual insert designs.

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, and protection from bushfires, whilst still ventilating the wall cavity via the weephole.

The Centre for Wireless Monitoring and Applications at Griffith University has been engaged to test the flow restriction these weephole products might have on airflow. The Centre for Wireless Monitoring and Applications specializes in the development, application of and testing of sensors for extreme environments and applications. Previous research within the centre has included research and development of miniature anemometers (air flow 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 and identified by a unique code. Using expected flow rates (supplied by Weepa) the conditions were evaluated for air flow in the cavity operation as in free flowing or restricted flow using standard equations. Following this, custom apparatus were designed and constructed to test each insert experimentally. With no measurable difference obtained at standard operating conditions tests were undertaken at higher flow rates

3.1. Description of Problem

Three weephole inserts were provided for testing by Weepa products for restriction of airflow. These were identified by sample number given in Table 1.

WEEPA Insert	Description
GR01	Standard Weepa Vermin Grate
GR02	Bushfire Weepa
GR03	Louvred Weepa

Table 1: Weepa inserts tested

Tests were undertaken at typical and extreme flow rates. Typical flow rates through weepholes in standard deployment were provided by Weepa as being up to 8 l/min with excursions up to 14 l/min.

3.2. Theoretical Validation

Flow rates typical to the problem need to be identified as free flowing (Turbulent), Transitional or Restricted (Laminar). Turbulent airflows are regions where the viscous forces of the fluid (gas) are less than the inertial forces, where the momentum of the moving gas is high enough that motions of the molecules of the gas are determined by the momentum of the gas and not by the viscous internal forces.

For laminar flows, the viscosity of the gas is dominant and therefore the momentum of the molecules are not enough disrupt the flow.

Laminar flow is only possible with sufficient restriction of the airflow to channel the air and create distinct boundary layers around surfaces. Without this restriction the air is able to freely move as is travels and therefore not create smooth layers of flow, but rather unpredictable eddies and swirls in the fluid.

‘Reynolds number’ is often used to describe flow. Using this explanation, a passage with a high Reynolds number (turbulent flow) may be considered free flowing, while a passage with a low Reynolds number (laminar flow) may be considered restricted. The Reynolds number is effectively the ratio of the inertial forces to the viscous forces of the gas. [1]

The Reynolds Number (Re) defines states of fluid flow as :

Laminar	(Re < 2000)
Transitional	(2000<Re<3000)
Turbulent	(Re>3000)

The Reynold equation is given as:

$$R_e = \frac{\rho \upsilon D}{\mu}$$

Where

Re – Reynolds number

μ - Air viscosity

ρ - Air density

D - characteristic diameter

The Renolds number for the Weepa weephole insert was calculated at approximately 10,000, clearly defining turbulent or free flowing flow.

3.3. Apparatus

An apparatus to simulate and control airflows across the Weepa inserts was designed and operated under laboratory conditions. Measurements of airflow and restriction allowed individual inserts to be evaluated under controlled conditions.

Differential pressure across a site 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 apparatus (Figure 1) consisted of:

- A wind tunnel of sufficient size and separation of flows
- Capability to fit Weepa weephole inserts
- A manometer used for differential pressure measurements
- An anemometer for the calculating airflow speed and volume.
- A variable airflow source

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

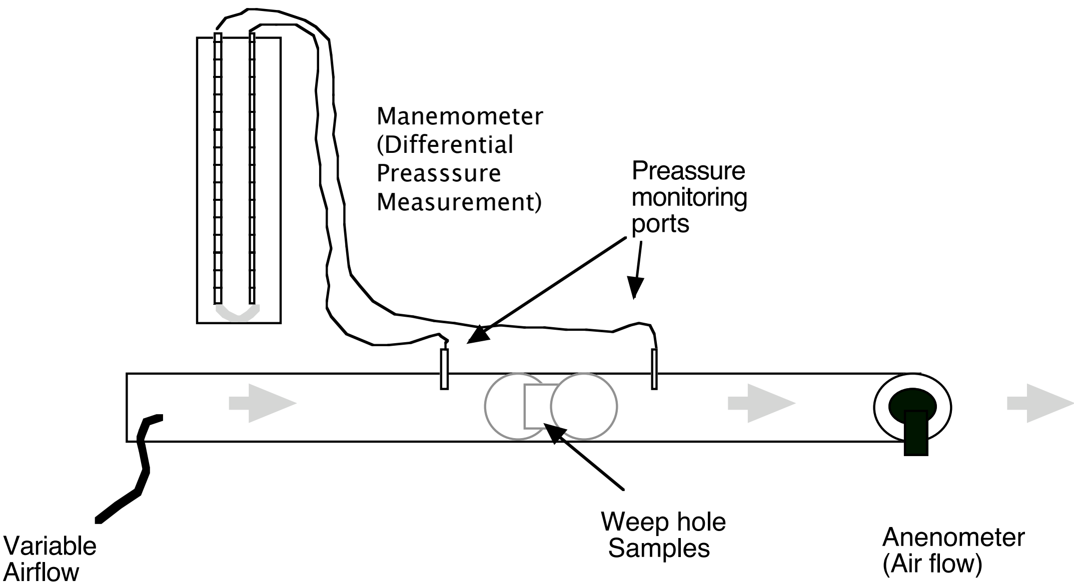

Figure 1. Test apparatus

The variable airflow source depicted in Figure 1 was used to simulate the airflow generated through a weephole. A water Manometer was used for the pressure variation measurements. The Bernoulli effect (pressure of moving air) was accounted for by the two manometer measurement points (before and after the insert) by having the measurement points at regions with similar airflow characteristics.

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 insert characteristics.

4. Results

Table 2 shows the performance under normal operating, gusting conditions 10x and 100x normal required flow rates. All inserts performed equivalently to a standard weephole (no insert) with only small divergences at extreme laboratory conditions.

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%	0.26%
GR01	<0.01%	<0.01%	0.01%	0.6%
GR02	<0.01%	<0.01%	0.015%	0.85%
GR03	<0.01%	<0.01%	0.015%	1.1%

Table 2: Pressure differential across inserts for a range if wind conditions (Atmospheric variation, expressed as a percentage)

In Figure 2 we display the performance of the weepholes when compared to smaller sized apertures (weepholes). Three benchmark flows are included in the data of Figure 2. These benchmarks are the pressure drops for flow through cavities that have No Restriction, 1/3 sized insert, 2/3 sized insert.

The pressures are expressed in Atmospheres, and the flow rates in Litres/min. As a guideline typical atmospheric weather conditions may cause pressure fluctuations of the order of 2% of normal atmospheric pressure.

These tests were performed on a single insert at a time, whereas a typical domestic deployment will have typically upwards of 20 of these inserts, thus reducing actual flow requirements somewhat.

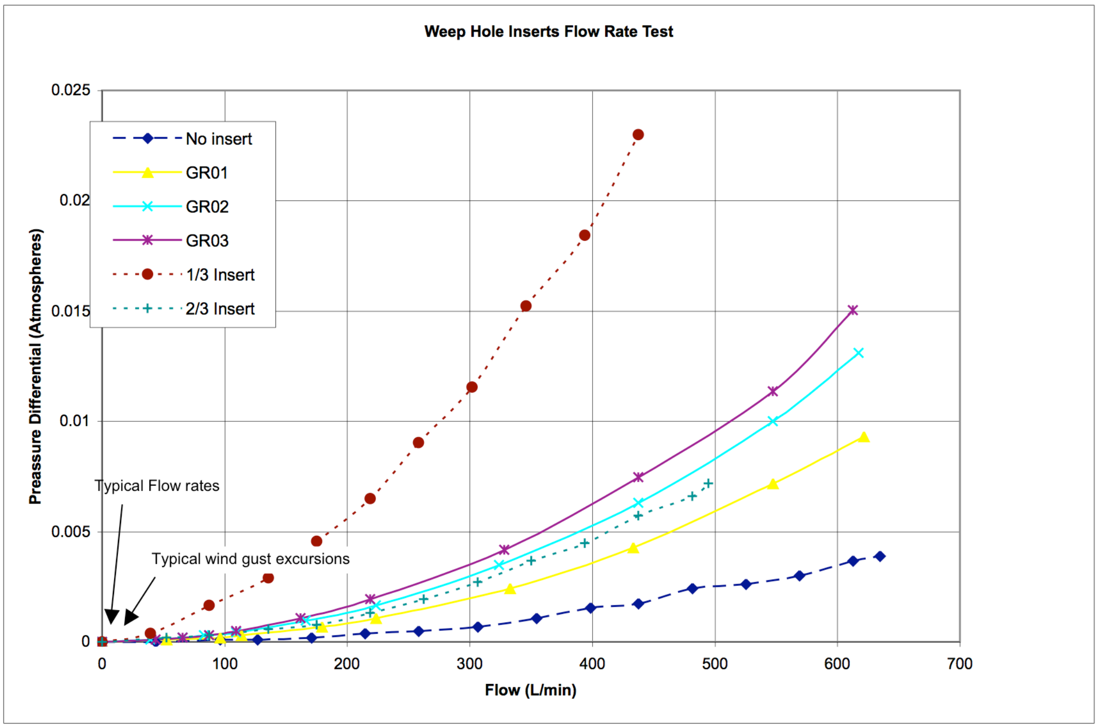

Figure 2 Pressure Differential across different weep hole inserts

Of the inserts provided, the least restriction was seen from GR01 (the standard insert) while the greatest restriction was seen from GR03 (Louvred insert) but only well beyond typical operating conditions.

The performance differences seen here were only detectable at flow rates generated in the laboratory and would not be detectable under normal weather conditions. Under normal weather conditions the inserts present no significant flow restriction.

5. Conclusions

The weephole inserts as provided by Weepa P/L have been tested and evaluated in terms of restriction to airflow through building weepholes. The results seen from these tests have shown no practical restriction to airflow at quoted typical flow rates that represent typical operating conditions (steady and gusts).

Under extreme laboratory conditions, differences in performance were observed though these do not constitute restricted flow. Where measurable differences exist the inserts performed equivalently to a reduced size insert.

In the case of the Louvered insert it was found to behave approximately like a 2/3 normal sized weep hole, where a pressure differential of 1.1% was observed across the insert. In this case, airflow through the insert was found to be 4x more restrictive than a standard weephole.

Variation in results between the models of inserts supplied has shown differences only under extreme laboratory test conditions and demonstrating the newer design of the bushfire rated inserts has improved the performance (lessened the restriction) of the insert over the previous design.

6. Biographies

Daniel A. James received his Ph.D. degree from Griffith University, Brisbane, Australia, in 1998. He is currently a Senior Research Fellow with the Centre for Wireless Monitoring and Applications at Griffith University, engaged on a number of pure research and industry related projects. His principle area of research is in the application of microtechnology to geophysical, sporting and biomedical applications. This has lead to several international patents and pre-commercial products in daily use at the Australian Institute of Sport and the Queensland Academy of Sport.

Richard J. Adamec received his Ph.D. degree from Griffith University, Brisbane, in 2007 on the design of novel airflow sensors for agricultural applications. He is currently a Lecturer with the Griffith School of Engineering. His research include environmental monitoring, performance automobile applications, he holds an international patent for sensor use in precision agriculture.

7. References

[1] - D. J. Tritton, *Physical Fluid Dynamics*, 2nd ed., Oxford University Press

[2] Richard J. Adamec, "MEMS Anemometer", Ph.D. Thesis, Griffith University, 2007