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Performance Study of Horizontal Branch in Building Drainage System

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Self-siphonage of traps of sanitary appliances caused by full-bore water discharge affects the performance of horizontal branches in building drainage systems. Relationships have been established correlating flow, diameter and slope of branch pipes connected to main drainage stack for permissible loss of water seal with recourse to an experimental investigation in the laboratory on a range of wash-basins, as is usual in office buildings, with a view to developing a performance oriented design procedure. A measure has also been suggested to control development of negative pressure caused by self-siphonage.

1. INTRODUCTION

SELF-SIPHONAGE plays the most vulnerable role in the system performance of horizontal branch. It is the phenomenon by which the sanitary appliances remove their own trap seals when they discharge. It occurs when the branch discharge runs full bore. The smaller the branch diameter the greater is the chance of its flowing full causing loss of seal due to self-siphonage. It is, therefore, predominant in waste pipes of smaller diameters.

Baths and sinks normally do not give trouble from self-siphonage. Their shapes are such as to cause a considerable slowing down of flow and the formation of vortex as they empty, giving a long trailing flow from the flat bottom after the bulk discharge. As a result whatever seal is lost due to siphonage is eventually replenished by the long trail flow. Water closets can also be self-siphoned but it does not occur in normal installations because the relatively large branch runs directly to stack with only one or two bends and the full bore flow necessary to cause self-siphonage does not develop. But the situation is different with small bowl-shaped appliances in which a fairly high rate of discharge is maintained throughout and little trailing water remains at the end. Wash-basins in particular give this type of discharge and may lose all their seals by self-siphonage in extreme cases.

Main objective of the present study is to carry out experimentation on the performance of horizontal branch connecting a range of wash basins under varying conditions of discharge, diameter, length and slope of the branch pipe so as to develop design relationships for the aforementioned parameters.

2. LITERATURE REVIEW

Substantial information now exists on self-siphonage of branches from the comprehensive studies made, to determine the conditions under which fixture drains will be safe against excessive self-siphonage, at the National Bureau of Standards[1, 2] and the Building Research Establishment[3, 4]. Safe maximum lengths for nominally horizontal unvented wastes from fixtures connected to a stack have been put forward by Hunter[2]. The complexity of the self-siphonage process can be realised when French and Eaton[1] rightly described that loss of trap seal from this cause is affected by the rate of discharge; the length l, diameter d and slope of fixture drain s; the dimensions of trap, particularly of the depth of trap seal and the internal diameter of the trap, the type of stack fitting, and the amount and duration of trail flow. French found that the results of his self-siphonage tests on lavatories with drain laid at different slopes could be simplified in certain instances if trap seal losses are plotted against the dimensionless variable (sl/d) and in other cases against $(s^{1/2}l/d)$. When a 1.25 in. trap and drain were used in the lavatory, French found that the relationship with $(s^{1/2}l/d)$ yielded better result. Hanslin[5] in his recent experimentation found that vertical drop following the trap and connecting the drain affects its performance considerably. By increasing the branch diameter, adjusting the elbow radius and reducing the flow rate, self-siphonage can be avoided.

The Building Research Establishment has forwarded recommendations for both residential and office buildings[6, 7], where appliances are installed either individually or in ranges, in order to limit the effects of suction within the combined branches serving such ranges. Branch pipes serving ranges of WCs are normally 100 mm diameter and do not run full. This has been checked in the laboratory for up to eight WCs in a range with a straight branch at an angle of 2.5°; it is likely that this number of WCs could be exceeded. Field studies have shown that this angle is also not critical. From a general performance stand point, it is an advantage for the WC connections to the common branch to be swept in the direction of flow. In case of lavatory basins in ranges with the discharge rates that

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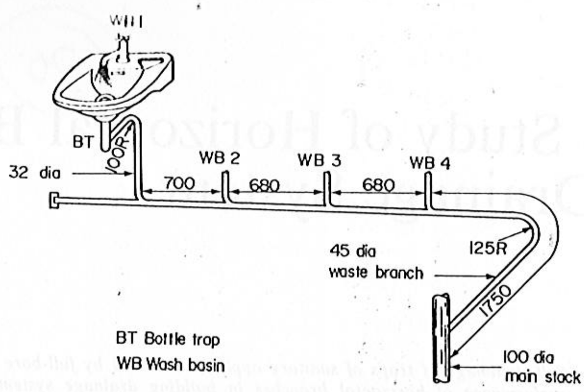

Fig. 1. Diagrammatic view of test range of wash-basins.

commonly occur when the appliances are emptied and with the sizes of branched waste normally used, full bore flow and hence a suction effect in the branch is more likely than with the WC ranges. In addition to discharge rate or pipe size, the occurrence of full bore flow depends upon factors such as the length and slope of branch and the shape of tee connections. Full bore flow is unlikely if washing is done under a running tap. As this is common in offices, the BRE recommendation [7] based on a study with filled basins gives a safety margin.

3. EXPERIMENTAL SET-UP AND SCHEDULE OF EXPERIMENTS

Experimental set-up consists of 4 wash-basins, conforming to Indian Standard: 2556 (Part IV), 1972, connected in a range to a horizontal branch of perspex pipe as shown in Fig. 1. Each wash-basin is fitted with a flat-bottom screen waste connection, having seven openings of 6 mm diameter, followed by a 32 mm diameter 50 mm seal bottle trap, the arm of which is connected to the horizontal branch via a long sweep vertical bend of radius 100 mm.

The study was conducted for the group of appliances discharging independently or in combination for connections to stack: (1) with intermediate floor trap, as is widely practised in India and (2) without floor trap. The observations were made for filled basin discharges. Slope has been varied from 1:20 to 1:60 for all the discharge combinations. Horizontal branch diameter of 45 mm was tried for the aforementioned trial runs. Wash-basins were filled up to overflow level and discharged by removing the plug. Trap seal losses caused by self siphonage were determined by measuring the residual seals with piezometers fabricated from glass tubing with attached graduated scales. Each flow condition was repeated for a minimum of six observations and the consistent maximum seal-loss considered.

To accommodate for installations in residential buildings, study was also conducted for a single wash basin having a large radius horizontal bend after the trap. In a bid to prevent the seal loss due to self-siphonage from lavatory traps an enlarged section of 40 mm diameter and 150 mm length was introduced in the branch pipe at varying distances from the stack and the effect studied for various slopes.

4. RESULTS AND DISCUSSIONS

Wash-basins connected to stack through floor trap showed better performance as compared to those directly connected since the loss of seal due to self-siphonage was replenished by the subsequent trail flow.

Relationship between slope s and length l to diameter d ratio derived for a single wash-basin with a large radius horizontal bend following the trap has been depicted in Fig. 2. Separate curves have been drawn for different magnitudes of seal loss. It is interesting to note that for a particular (l/d) ratio, two different slopes produce the same seal loss.

For a range of wash-basins connected to 45 mm internal diameter perspex pipe, as shown in Fig. 1, relationships were established for water seal loss at varying conditions of flow Q, length l and slope s. Figure 3 presents the relationship for $Q.(l/d)$ ratio at different slopes and Fig. 4 illustrates the relationship with $s.(l/d)$ ratio for various discharges.

Experimentation on a single wash-basin with the enlarged section near the trap end revealed enormous decrease in trap seal loss due to self-siphonage.

5. CONCLUDING REMARKS

The afore-mentioned study on the performance of horizontal branch comprising of single or multiple number of wash-basins has enabled us to reach the following conclusions.

Connection of wash-basins to stack through floor trap reduces the effect of self-siphonage since the loss of water is replenished by the trail flow. It also dictates in eliminating the individual traps of the appliances since the purpose is safeguarded by the floor trap. However, proper size of the floor trap is to be selected such that flooding of floors does not occur.

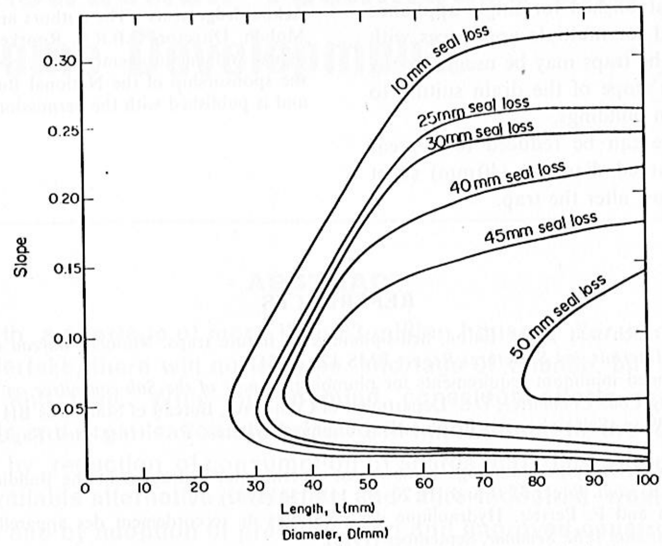

Fig. 2. Relationship between slope and *l/d* ratio for single wash-basin.

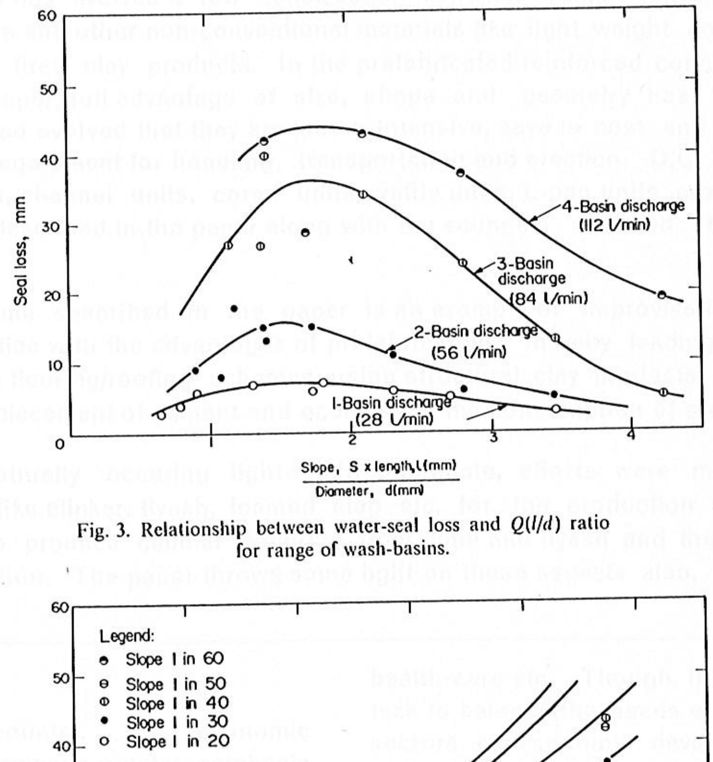

Fig. 3. Relationship between water-seal loss and *Q*(*l/d*) ratio for range of wash-basins.

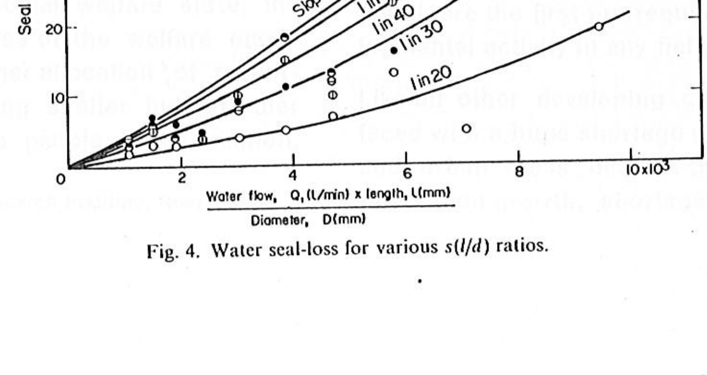

Fig. 4. Water seal-loss for various *s*(*l/d*) ratios.

Design relationships established for single appliance with horizontal bend and for multiple appliances with vertical drops following the traps may be useful for the designers in selecting the slope of the drain suiting to the actual requirements in buildings.

Effect of self-siphonage can be reduced to a great extent providing an enlarged diameter (40 mm) short length (150 mm) of pipe just after the trap.

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