Modified Single Stack System of Plumbing for High-rise Buildings

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ABSTRACT

The sanitary plumbing in high-rise buildings forms an important part of building services and costs 12-15 per cent of total building cost. This paper describes the recent development in building sanitary services to provide economy in labour and material without effecting performance requirements. The functional requirement of any sanitary plumbing system is it should protect against any water seal loss in traps. It is established that a permissible pressure limit of ±40mm (W.G.) in side stack safe guards seal loss of traps.

Investigations were carried out to increase the hydraulic load carrying capacity of normal drainage stack by introducing special fittings at the junctions. These fittings were designed and fabricated at CBRI Roorkee based on the Sovent System of Switzerland. The tests were conducted in a 5-Storeyed mock-up incorporating special fittings. The results revealed that the limiting capacity of 100 mm diameter stack is 400 litres per minute with fittings and 250 liters per minute without fittings. Hence use of special fittings increases hydraulic load carrying capacity of stack quite considerably.

Introduction

The tendency towards concentration of the population in big cities, has resulted in problem of shortage of space and has led to the practice of vertical expansion. In India too, 25 storeyed buildings have already come up. The high and continuously increasing costs of construction and servicing in high rise buildings are causing serious concern. It has been estimated that the cost of sanitary services and underground drainage account for 12 to 15 per cent of the total cost of building. Modified techniques in the design of sanitary services for buildings are thus necessary so as to achieve an overall cost reduction without effecting efficiency.

Present Status

The traditional method of having vent pipe with one or two pipe system consume much material and labour. Instead, a single stack system in which all sanitary appliances discharge into a main stack which itself serves as vent has established its utility and is widely adopted in developed countries. For a number of years, the Central Building Research Institute, has been engaged in the problem of evaluating the performance and merits of single stack system under Indian conditions. The extensive experimentation carried out has revealed that for the design of a single stack system, the ratio of hydraulic discharge load (litres per minutes) and the diameter of the stack (mm) should not exceed 2.5. The above recommendation is however, valid only when a seal depth of 40 mm in all floor traps is maintained.

Development of a Modified Single Stack System

The analysis of the flow from the appliances to the stack revealed that the column of water coming to the stack through a horizontal branch is momentarily halted at the junction due to change of direction of flow. Depending upon the rate of discharge and the size of the branch, a plug of water is formed immediately at the junction. The formation of this water plug prevents free flow of air from the top of the stack and develops a negative pressure immediately below the plug. It gives rise to unequal pressures at the seals for lower storeys which may result in breaking of seals in the traps of appliances.

The building up of excessive negative pressure inside the stack can be prevented adopting either of the following measures :

(i) Oversizing the stack
(ii) Increasing the seal depth
(iii) Venting of the horizontal branches
(iv) Providing special fitting at the junction point.

The first three solutions lead to substantial addition to cost, therefore, investigations were made for deve-

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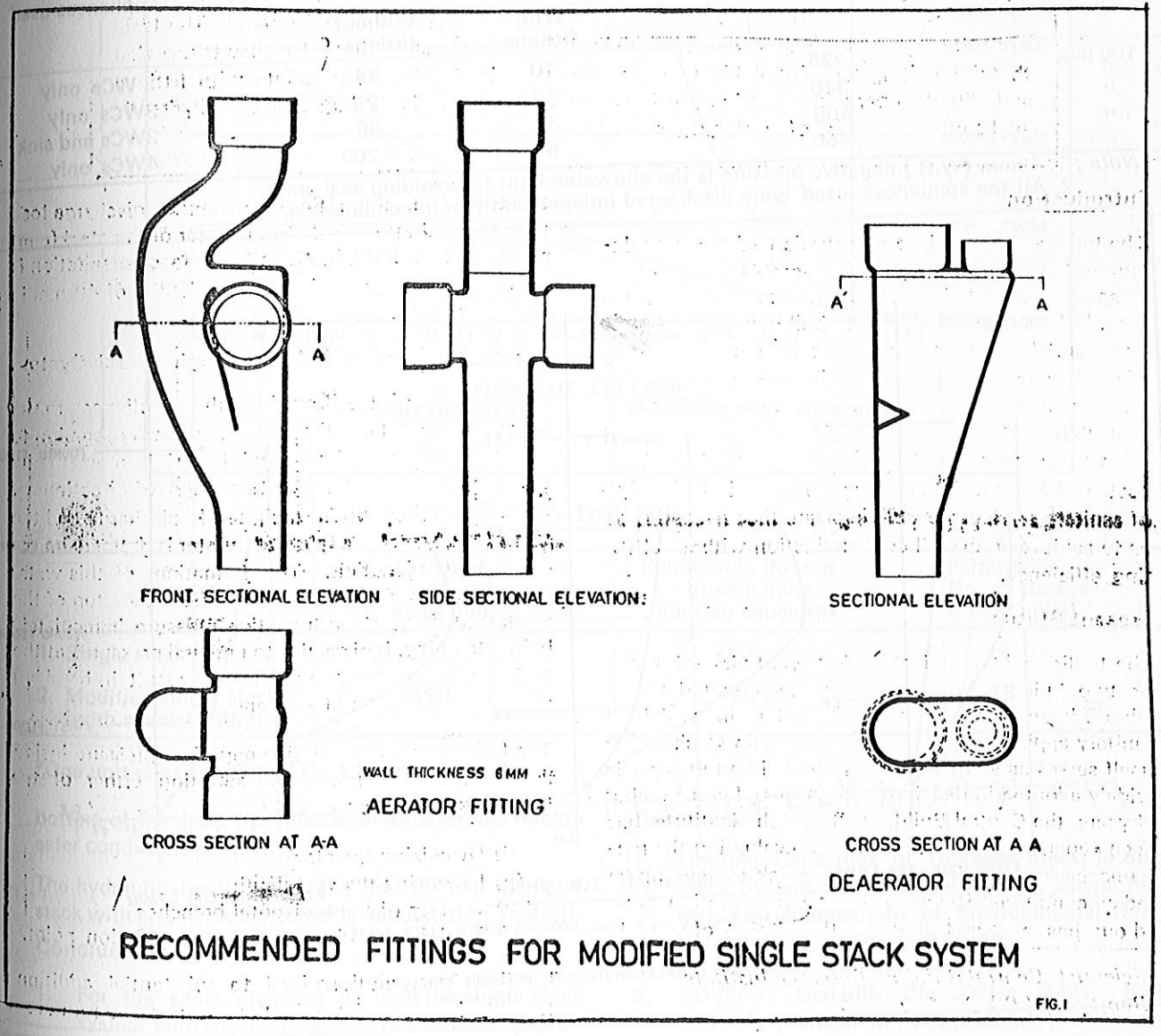
lopiog special fittings at the junctions based on *Sovent System*. (2) Two types of fittings namely (a) V-notch rings, and (b) Aerator and Deaerator fittings were developed and tested.

(a) V-Notch Rings

Water flows in the form of an annular ring and forms distinct air and water columns in the stack. The mass of water compresses the air below it in the stack. In the lower part of the stack, air being lighter will try to go up and hence gradually a negative pressure will start developing. Thus the negative pressure would depend upon the density of the water mass. If water could be mixed with air so that it would become too light to develop negative pressure. The density of water mass could be reduced if the proportion of air in water is increased. This could be achieved by introducing hinderance in the path of mass of water travelling down. V-notch rings were introduced at the joints in the stack. But the results revealed that the reduction in negative pressure was not significant. Hence not recommened for use.

(b) Aerator Fittings

This fitting is introduced to the stack at each floor level. The flow from top storeys is diverted and not allowed to obstruct the flow from branches. It also allows additional air to circulate freely from upper part of the stack. This effects mixing of air with water which brings down the specific gravity of the falling mass of water so that it would become too light to develop negative pressure. The advantage of CBRI developed fittings is that it has two branch inlets which may serve twin units of service group in each floor. Details of fittings has been shown in fig. 1A.



RECOMMENDED FITTINGS FOR MODIFIED SINGLE STACK SYSTEM

FIG.1

Deaerator Fitting

This fitting is introduced at the foot of the stack. In a normal single stack system the air and water mass is slowed down by the sudden change of direction at the foot of the stack. The air water mixture does not escape out easily and hence a positive pressure is built up creating nuisance to the ground floor appliances. The use of deaerator fitting seperates air from water and avoids formation of positive pressure at the foot of the stack. Details of fittings is shown in Fig. 1B.

Experimental Work

A five storeyed mock up construction was installed with a 100 mm diameter A.C. Pipe. The aerator fittings were provided at each floor level and the deaerator fitting at the foot of stack. To produce various hydraulic load effects the appliances were discharged from the top most floor. Discharge of 225, 340, 400 and 450 litre per minute were produced in the stack.

Observations with each discharge were repeated 3 times and corresponding negative pressures at each floor junction were noted. The maximum of these values was taken as negative pressure at junction. The ovservations were made for single stack system with and without special fittings. The results are given in Table—I.

TABLE I

Stack Dia	Discharge litre/minute	Maximum negative pressure developed in the single stack, mm		Appliances used
		With fittings	Without fittings	
100 mm	225	10	36	2 WCs only
"	340	30	78	3WCs only
"	400	32	98	3WCs and sink
"	450	60	200	4WCs only

Note : 1. 40mm (W.G.) negative pressure is the allowable limit for avoiding seal crack.
2. All the appliances used were discharged independently or in combination.

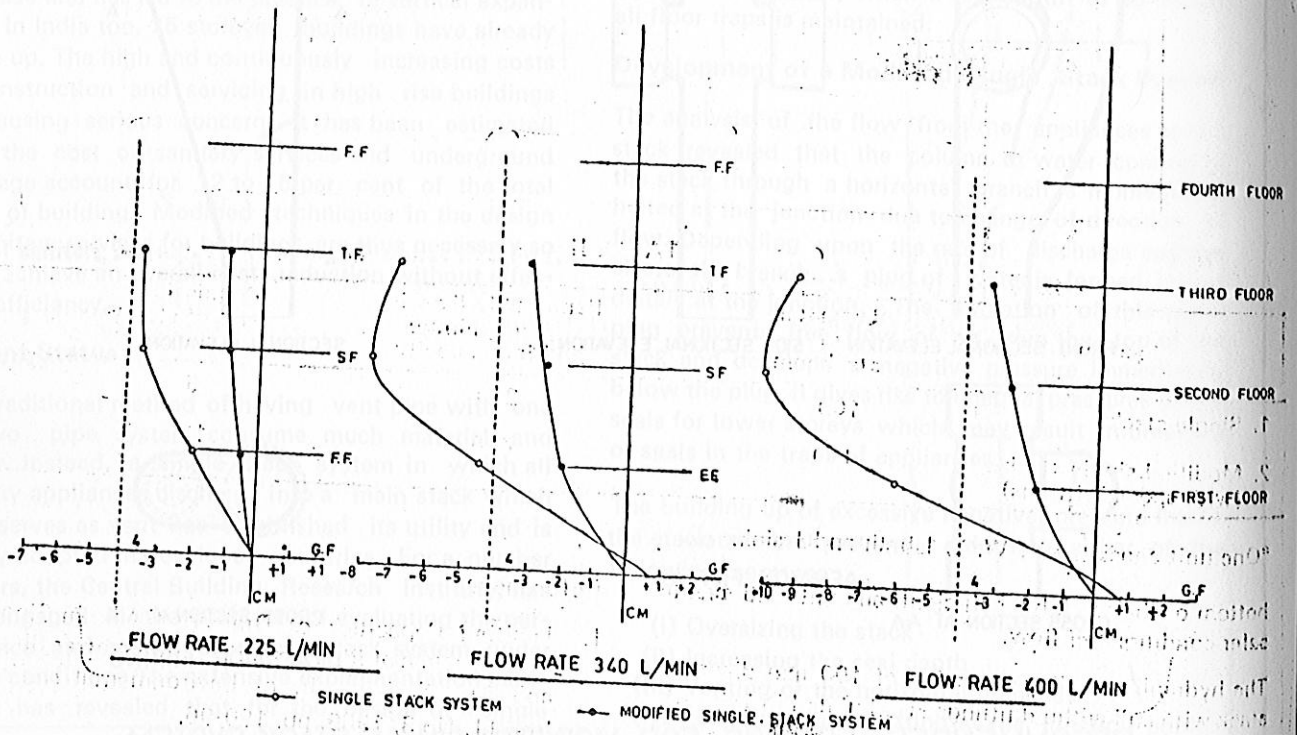


FIG. 2 FLOW RATE (LITRES/MINUTES) Vs PRESSURE DEVELOPED (CM)

Results and discussions

The observations were then plotted, the study of the pressure diagrams shown in Fig. 2 reveals that in all cases, the peak negative pressure occurs somewhere one floor (3 meters) below the point of inlet of discharge load. The aerator fittings helped to direct the column of water coming from the branch in the main stack in the direction of flow. It thus prevented the formation of water plug. The flow of air from the top of the stack was uninterrupted. It is clear from the curves that fittings bring down the maximum negative pressure in the stack as well as positive pressure at the bottom of the stack by sufficient amount and create safer conditions of flow.

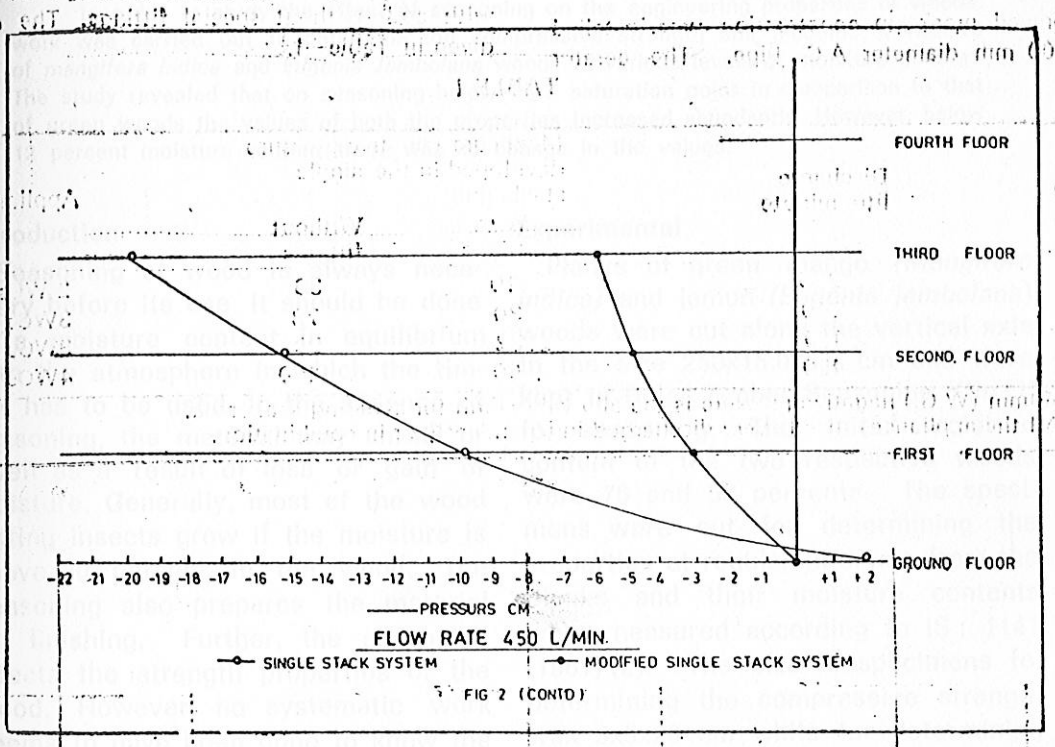


FIG 2 (CONTD)

The hydraulic loading capacity of 100 mm diameter stack with and without fittings is tabulated in Table-II.

TABLE II

System	Diameter of stack mm	Permissible flow in litres/minute limiting capacity	Permissible No. of storeys (*twin units)
1. Single stack	100	250	5
2. Modified single stack (with special fittings)	100	400	15

*One unit consists of 1 W.C., 1 bath and 1 sink.

Conclusion

1. For the same diameter of pipe the single stack system with special fittings provides much greater capacity than single stack system without fittings.
2. The single stack system with special fittings can provide considerable economy in plumbing for high rise buildings.

Acknowledgement

The investigation forms part of the normal programme of research at the Central Building Research Institute, Roorkee and the paper is published with the permission of the Director.

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