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A Case for Single Stack System of Plumbing

The adoption of the single stack system of plumbing which is more economical than the conventional systems is advocated particularly in view of the need for conserving building materials and the optimum utilization of vast outlays earmarked for construction projects in the coming years. Guidance for installation of plumbing systems in buildings for drainage purposes has been provided by ISI in the 'Code of practice for drainage in buildings (IS : 1742-1960)' as well as in the draft 'Code of practice for plumbing in multi-storey buildings'. The points made in the paper may help in the further improvement of these codes—Ed.

Internal plumbing forms an important service in buildings. Its cost varies from 5 to 12·5 percent of the total cost in residential buildings. In office buildings, it is about 5 percent while in hostels and hospitals it can be as high as 15 to 17·5 percent[1]. The cost can be broadly divided into two parts, namely, cost of appliances and cost of pipes along with specials. The cost of the latter is about 40-50 percent of total cost. Since it is not possible to reduce the expenditure on appliances, their cost being almost fixed, any economy that can be effected can only be in pipes and specials.

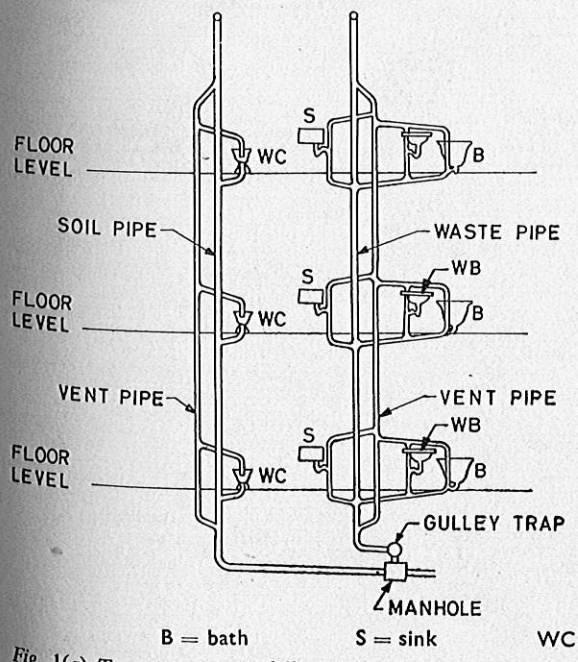
The increasing tendency towards vertical development of buildings has further complicated the problem of plumbing. In tall buildings, conventional methods of plumbing become more complicated due to the large number of pipe lines. The conventional two-pipe system is the only method that seems to be enjoying a general acceptance with the local authorities in India[2]. Only recently, the one-pipe system of plumbing has been adopted in some residential and public buildings at New Delhi[2]. The adoption of single stack system appears to be still a long way off, the main obstacles being the local authorities and lack of knowledge about the system. This paper reviews the various systems of piping that have been in use in plumbing, and makes out a case for the adoption of single stack system.

PLUMBING SYSTEMS IN BUILDINGS

Though plumbing is as old as civilization, interior drainage piping systems came into use since 1845 and venting of traps was proposed in a conference at New York in 1874[3]. The earliest of the piping systems was the two-pipe system. This system was mostly used in England until 1932 when the one-pipe system was introduced from America[4,5].

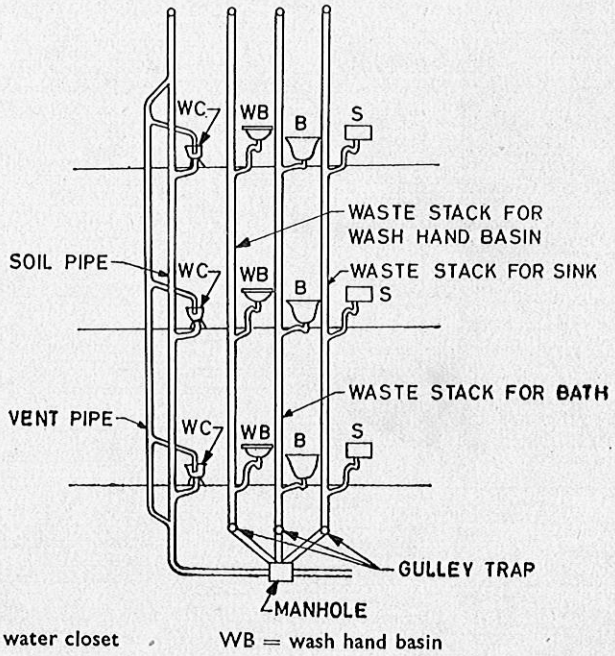
Two-Pipe System

This system consists of separate pipes for soil and waste. This is the more orthodox system, normally used in all large buildings. It consists of separate soil and waste pipes both ventilated independently [*see* Fig. 1(a)]



B = bath S = sink

Fig. 1(a) Two-pipe system fully ventilated



WC = water closet WB = wash hand basin

Fig. 1(b) Two-pipe system with separate waste stacks

and is known as 'Two-pipe system fully ventilated'. The soil stack is connected direct to sewer while the waste stack is connected through a trapped gulley. The vent pipe of the soil stack, and the air-break at the gulley trap in the waste stack, provides necessary protection against the entry of sewer gases. As such, this system does not rely entirely upon the water seals incorporated in the appliances. Shallow water seals 38 mm (1·5 in) for traps of less than 60 mm (2·5 in) diameter and 50 mm (2 in) deep for traps of 60 mm (2·5 in) diameter and above are provided to check the entry of foul gases from the piping.

In situations where the waste appliances are widely separated as in hotels and hospitals each of these are provided with a separate waste stack [*see* Fig. 1(b)]. Only one appliance is connected to a stack at every floor level, the vent pipes for the waste stacks are omitted. This system known as 'Two-pipe system with separate waste stacks' becomes costlier as the saving from omission of vent pipes is more than offset by the extra stacks of pipes.

The 'Two-pipe fully ventilated system' is fool-proof and does not call for any special skill and knowledge on the part of the designer. But with the four stacks of pipes and the numerous connections on the exterior of the building, it is unsightly and uneconomical especially when adopted in large blocks of buildings. The need for economy paved the way for the one-pipe system which with suitable precautions was considered safe enough.

One-Pipe System

In this system [*see* Fig. 2(a)], the soil and waste pipes are combined into one with a common vent pipe. The main reliance against entry of sewer gas is placed on the water seals at the appliances which are fully ventilated. As such, deeper water seals, namely, 75 mm (3 in), as against the 38 mm (1·5 in) to 50 mm (2 in) adopted in the two-pipe system are used. This system is economical as compared to the two-pipe system as the number of stacks are reduced from four to two and gulleys are omitted.

Further developments and simplifications of the one-pipe system led to 'Modified one-pipe system' [*see* Fig. 2(b)] and 'Modified one-pipe vented stack system' [*see* Fig. 2(c)]. In the former, the water closets only are ventilated direct to the main vent pipe. The lengths and angles of fall of the pipes serving the waste appliances are subject to certain restrictions to ensure adequate ventilation through the main soil stack. All fittings except water closets are connected to the main stack through 75 mm (3 in) deep seal traps.

In the second system which is adopted in tall buildings a common vent pipe runs close to the soil stack for the full height of the building. The waste appliances are connected to soil stack through 75 mm (3 in) deep seal traps and none of the appliances are directly ventilated. Necessary ventilation is provided by connecting the soil and vent stack by short lengths of 50 mm (2 in) dia pipe at alternate floors.

EVOLUTION OF THE SINGLE STACK SYSTEM

In all the above systems, great emphasis was placed on trap venting and the water seals in the appliances as it was thought that sewer gas was harmful to human health. Modern investigations in bacteriology have proved that sewer gas does not generally convey any pathogenic bacteria considered harmful from disease transmission point of view. But exposure to concentrated sewer gas for a considerable period may cause some harmful physiological effects as nausea, giddiness, etc[6]. An occasional reduction in the seals is, therefore, not going to be harmful for health although proper seals should be maintained for checking the entry of any foul odour.

In recent years, researches by the Building Research Station, UK and certain plumbing contractors in England have led to the conclusion that water seals in traps, under certain conditions, do not require ventilating pipes[4]. These have led to the evolution of the single stack plumbing system which dispenses with the use of ventilating pipes. The soil and the waste are carried through only one stack. In this system, since there is no separate vent pipe, the main object has been to

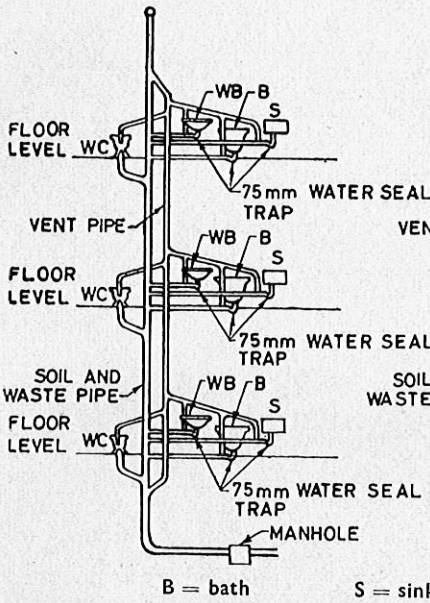


Fig. 2(a) One-pipe system fully ventilated (all appliances ventilated directly)

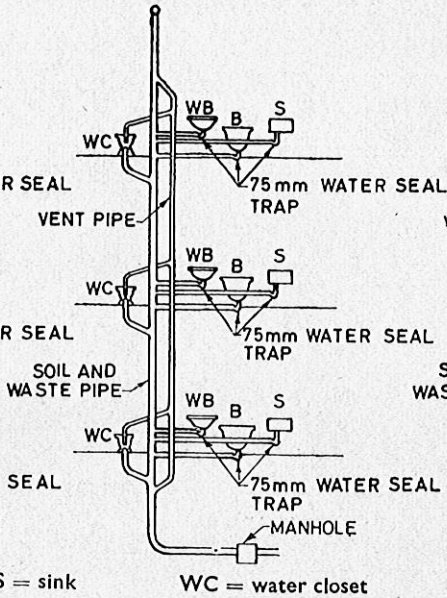


Fig. 2(b) Modified one-pipe system (only WC ventilated directly)

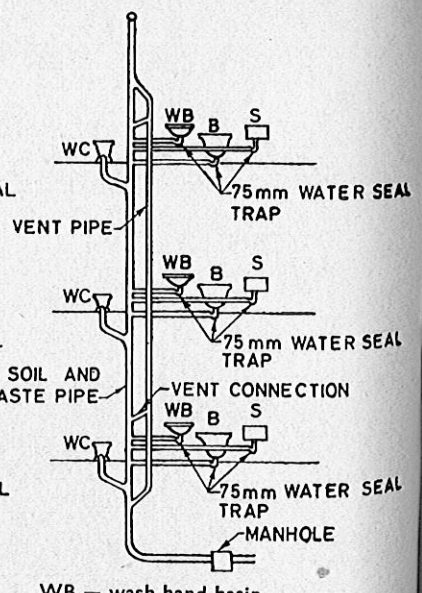


Fig. 2(c) Modified one-pipe vent stack system (appliances not ventilated directly but soil and vent stack connected at alternate floors)

prevent loss of seal due to self siphonage, induced siphonage and back pressure. The shape of the appliances and length, slope and bore of the branch pipes play an important part in preventing self siphonage. The induced siphonage and back pressure at the foot of the stack are governed by the height of the stack, its diameter and the amount of water flowing in. As such, certain restrictions have been imposed for the depth of seal, the length and slopes of the branch pipes. The design recommendations[7] for branches and fittings and vents required for various loading conditions are given in the British Code of Practice B.S. CP 304 : 1953[8]. This system has also been described briefly in IS : 1742-1960[9]. The recommendations given in both the codes are for plumbing systems wherein the appliances are directly connected to the stack (*see* Fig. 3.)

In the plumbing system that is generally followed in India, the appliances, namely, wash hand basin and sink are often not connected directly to the stack, but the waste pipes of these appliances are led to a floor trap and the latter is connected to the stack. Under these circumstances, the restrictions that have been given in the above codes as regards depth of seal, location of appliance and slopes of branch pipes are not directly applicable. Hence it is not necessary to provide deep seals for the wash basin and sinks but the same becomes necessary only for the floor trap. Further there is no necessity of restricting the length of waste pipe from the appliances because of the provision of the floor trap and as such there is a greater flexibility of locating the appliances anywhere inside a building. As regards WC, the same normal seals 38 to 50 mm (1·5 to 2 in) deep and branch pipes 100 mm (4 in) diameter and 1·5 m (5 feet) long are recommended. Thus it is seen that single stack system can be adopted for Indian conditions without going in for special fittings, such as deeper seals and special connections between the branch pipe and the stack as has been stipulated in the code. An illustrative example of the installation of single stack system suitable to our requirements is given in Fig. 4, and salient features of the design recommendations are summarized in Table 1.

TABLE 1 DESIGN OF SINGLE BRANCHES AND FITTINGS

Component	Action to be Guarded Against	Design Recommendations
Bend at foot of stack	Back pressure at lowest branch	Bend to be of large radius or two numbers 135° bends to be used. Vertical distance between lowest branch connection and invert of drain to be at least 75 cm (2·5 ft) for multi-storeys. For 2 storey houses with 100 mm (4 in) stack, only 45 cm (1·5 ft) is sufficient.
Soil branch connection to stack	Induced siphonage in the lower stack when WC is discharged	WC connections should be swept in the direction of flow. Cast iron fittings to be to B.S. 416-1957[10]. Fittings of other materials should have the same sweep as cast iron fittings. WC branch shall be up to 1·5 m (5 ft) long.
Floor trap 75 mm (3 in) dia and 75 mm (3 in) dia branch pipes	self siphonage	50 mm (2 in) seal trap to be used up to double storey construction and for multistorey construction 75 mm (3 in) seal trap to be used. Slope of branch pipe may vary from 1 in 48 to 1 in 12.

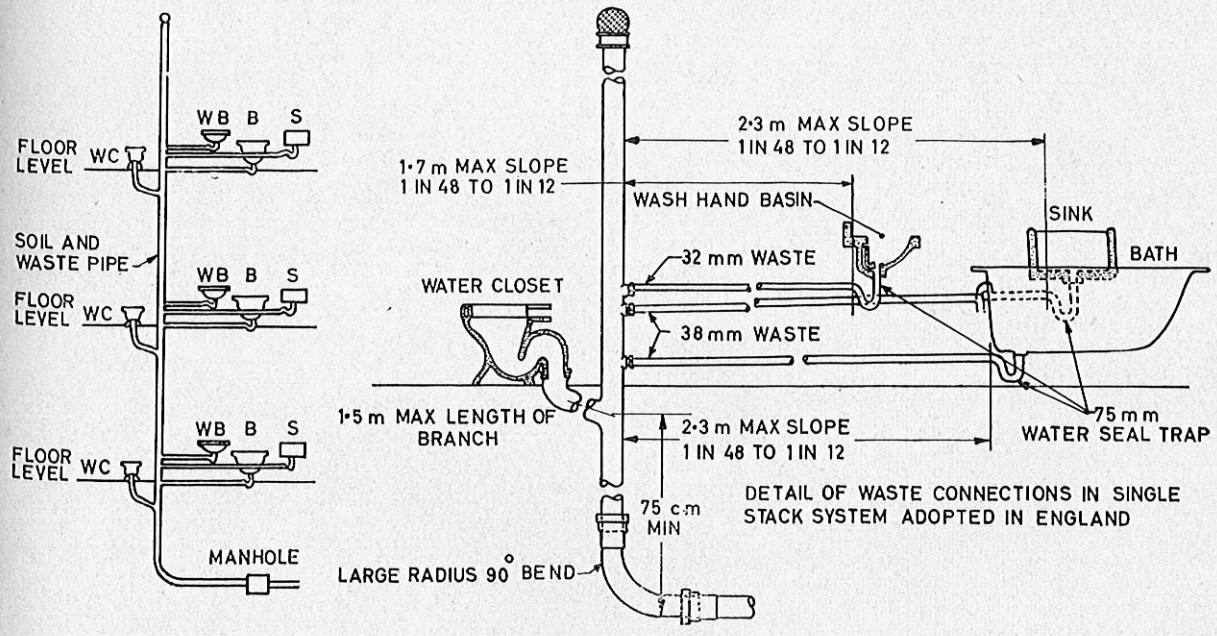


Fig. 3 Single stack system

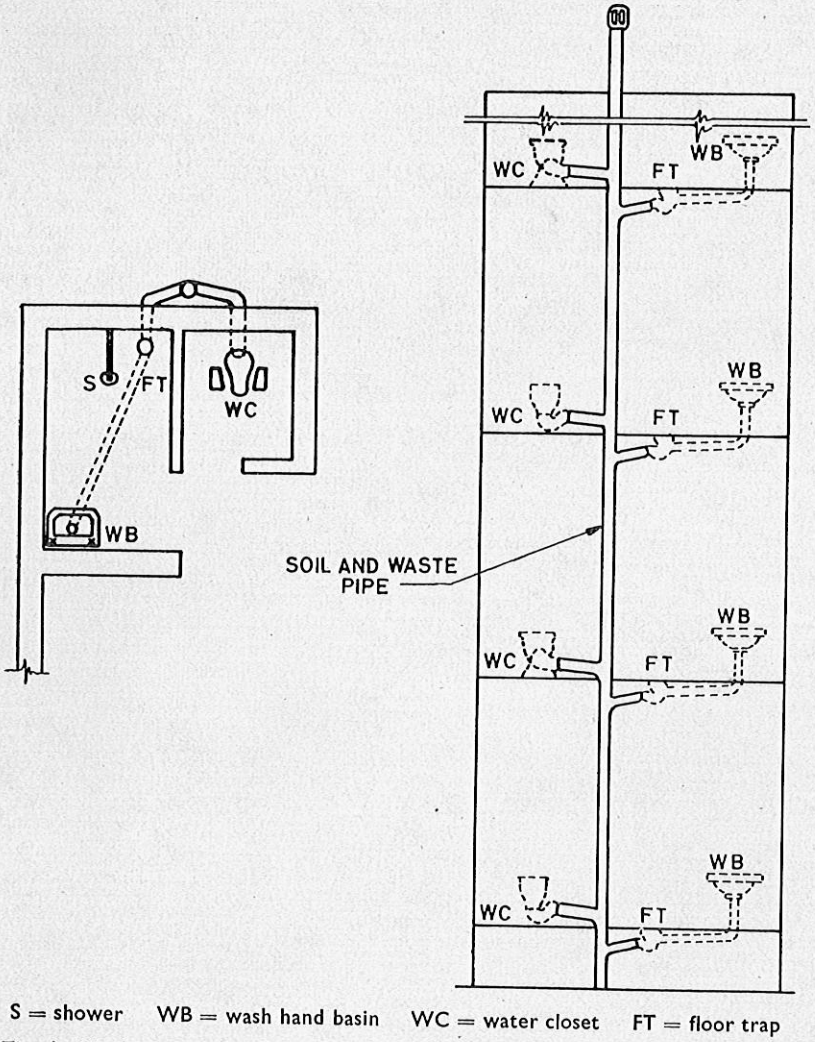


Fig. 4 Single stack system suitable to our requirements

Although, no experimental work has been carried out in this country but work done at Building Research Station, UK indicates that up to four storeys a 100 mm (4 in) dia stack is sufficient. For more than four storeys, a stack of 150 mm (6 in) dia is satisfactory up to 15 storeys.

PRECAUTIONS IN SINGLE STACK SYSTEM

The floor traps should be so located that the branches connecting to the stack are short, as short branches do not flow full bore and thereby avoid self siphonage. Offsets within the bore below the connection should be avoided in the main stack. In tall buildings it is essential to minimize the pressure at the foot of the stack by providing large radius bends. The ground floor fittings, in buildings taller than five storeys should be connected direct to the manhole or drainage system. In low buildings (3 to 4 storeys), this will not be necessary but the lowest connection should not be less than 75 cm (2·5 ft) above the invert of the drain.

CBRI EXPERIENCE

An opportunity to instal the single stack system of plumbing was availed on some of the staff quarters at the Central Building Research Institute (CBRI), Roorkee. A set of 10 double storey quarters was selected for the installation. A 100 mm (4 in) dia stack was used with other conventional fittings and appliances. The floor traps with normal water seals 38 mm (1·5 in) were used as against the specified 75 mm (3 in) seals. The branch pipes connecting the traps to the stacks were of 75 mm (3 in) dia. Tests were carried out to check the loss in depth of water seals of the appliances and it was found that there was no loss.

The satisfactory performance of the 38 mm (1·5 in) seal in the floor traps may be due to the provision of 75 mm (3 in) dia branch pipe which avoids the risk of self or induced siphonage as it does not run full bore. Therefore, for double storey buildings it will not be even necessary to use floor traps with deeper seals. Whether this would be applicable for multi-storey buildings has to be investigated.

CONCLUSION

The single stack system offers compact layout. It avoids gulley traps, and is thus free from insect nuisance, odours, obstructions, etc.

It saves 60 percent in materials and 45 percent in overall cost of piping as compared to the conventional two-pipe system in a four storey building.

Floor traps with 75 mm (3 in) seal and large radius bends at foot of stack should be manufactured.

ACKNOWLEDGEMENT

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