SURFACE DRAINAGE SCHEMES IN THE PUNJAB.

By AMAR NATH NANDA, Rai Sahib,
Personal Assistant to the Sanitary Engineer to Government, Punjab.

Scope of the Paper.

The scope of the paper, as its name implies, is a restricted one, as it does not cover the wider field which a paper dealing with sewerage schemes of large populated areas would have done. In this paper an attempt has only been made to describe the salient points of design, construction, and maintenance of drainage works for the disposal of sullage from urban areas.

Although in its chemical composition crude sullage— a putrescible liquid—is not different from sewage, still the fact that human fæces are excluded from the former, affects the question of its disposal to a material extent. It is a truism to say that the habits of the people are largely the outcome of climatic conditions operating in conjunction with social and economic causes, but it is worth noting that out of a total of a hundred and eighty-nine municipalities and notified areas in the Punjab, as many as a hundred and forty-nine have populations under 10,000 while twenty-two are between 10,000 and 20,000, so that the province as a whole is largely rural in its general aspect. That being so, it may be asserted without fear of contradiction that, for a considerable time to come, the conservancy system, as distinct from the water carriage system, will offer the best possible solution for problems relating to urban sanitary reform. This system is well adapted to the wants of sparsely populated districts, and works well in towns where an adequate supply of water can only be obtained at excessive cost.

Introduction of Western Methods.

On the other hand it must be admitted that as a result of a general sanitary awakening which has followed in the wake of the gradual spread of education, and the stress of altered economic conditions—due to which difficulty is experienced in enlisting a cheap and willing conservancy staff to do the work of private and public scavenging—the necessity has been felt for initiating large sewerage schemes on western up-to-date lines in

the two premier cities in the province, viz., Lahore and Amritsar. In the latter, two congested mohallas—Dhab Khatikan and Bazar Sant Singh—with a total population of about fifteen thousand and an area of seventy-seven acres, have already been provided with an underground system of drainage, and the cement slab pavements and cement section drains have been much appreciated by the people, while, according to the testimony of the Municipal Engineer, the underground sewers have satisfactorily stood the ordeal of test flows during the last monsoon. Similarly a comprehensive sewerage scheme has been prepared for Lahore, the completion of which in due course will, it is hoped, mark the beginning of an era of great sanitary improvement in the capital of the province.

General Outlines of a Sullage Disposal Scheme.

The sullage of the intramural area is caught and carried in surface drains, which are usually laid down the sides of bazars and *gallies*. These drains discharge their contents at the town outlets into a system of intercepting drains, which more or less encircle the town and lead into an outfall channel which terminates in the disposal works. These works may either take the form of land treatment, viz., collecting tanks and a sewage farm, or of a free discharge into a nullah or river, according as the scheme is a pumping or a gravitation one.

Salient Features of the General Lay-out of Punjab Towns.

The lay-out of the majority of the old towns in the Punjab is very irregular, the nucleus of the present day town having been a small patch of habitation, originally built within a walled enclosure or a rampart located more or less on an eminence. The growth of these towns appears to have followed the theory of cell formation in organic growth; i.e., one cell is already existing and the next comes into being, nestling against the first one, and so on. The main outstanding features from a sanitary point of view of these towns are as noted below :—

1. The lie and extent of the drainage blocks are always most irregular, so that it becomes a matter of difficulty to command the drainage summits from a single point of vantage for drain flushing purposes.

2. The meanderings in the streets and lanes tend to retard the flow of sullage in the drains.

3. Conservancy arrangements are difficult, owing to want of easy access to the central parts of the town.

As for the new colony towns which have sprung into existence during the last twenty-five years or so, either a system of rectangular, or a combination of rectangular, diagonal, and concentric lay-outs has been attempted in these places. This is best illustrated by the examples of Sargodha and Lyallpur. The chief defects in the planning of these new towns are as follows:—

1. Contours, compactness and convenience in the majority of cases have been sacrificed to geometrical symmetry.
2. In some cases the widths of bazars, streets and lanes, and the extent of the town are so great that not only is it impossible to build upon the whole town area, but the provision of pavements and drains also becomes difficult. This is the condition of new Dera Ghazi Khan, which is nearly a mile long and a mile broad, and the widths of the main bazars and streets are a hundred feet and sixty feet respectively.
3. Most of the towns are situated on absolutely flat areas, as a result of which the intercepting and the outfall drains get into very deep cutting, and this adds considerably both to the initial cost and the maintenance charges.

Intensity of Population.

The old towns in the province are more or less congested with an average intensity of population ranging from 150 to 250 people per acre of inhabited area. In the new colony towns, which have wide streets and lanes and a liberal lay-out, the intensity of population varies from 40 to 100 per acre.

Sullage and Storm Water Run-off.

In towns not having a water supply system, the allowance for sullage and storm water found adequate from many years' practical experience, is as given below:—

Intramural Drains:—For flush and sullage flow 1-30th cusec = 1/30" rainfall per hour, or equivalent to four gallons per head per hour (intensity of population being 250 persons per acre).

Intercepting Drains.—1-30th cusec or 1/30" rainfall per hour in the cunette section and $\frac{1}{4}$ cusec or $\frac{1}{4}$" rainfall per hour in the full section ; everything above to overflow.

Outfall Drains.—Gravitation—same as intercepting drains. Pumping—1/30" to collecting tanks ; rest to overflow at most convenient points.

In towns having regular water supply systems, the provision for run-off of sullage and storm water is as follows :—

Intramural Drains.—1/10th cusec or 1/10" rainfall per hour.

Intercepting Drains.—1/10" rainfall per hour in the cunette section and $\frac{1}{4}$" in the full section.

Outfall Drains.—Gravitation—same as intercepting drains. Pumping—1/10" to collecting tanks ; the rest to overflow.

As regards storm water, it is either allowed to escape at intervals along the length of the extramural drains into adjoining ponds and depressions, or is run into artificial kutcha channels, which are made to discharge into a natural drainage cut of the country.

Type Sections of Drains.

An improved set of type designs for street drains was issued in 1902, by the late Mr. Du Cane Smithe, the first Sanitary Engineer, Punjab, in supersession of those published in 1900. Plate No. I illustrates these type designs. Leaving out the single invert brick drain marked No. I, the basic type is No. II, which consists of an invert and a curb brick. The invert has a radius of four inches, and the angle subtended at the centre is 136°, so that the side splay of the cunette forms a tangent of 22°, which may be expressed fractionally as 4/10. The further manipulation of the types follows the tangential splay given above, and is achieved by the interposition of ordinary bricks placed as stretchers between the invert and the curb brick.

Mr. Goument, who succeeded Mr. Du Cane Smithe as Sanitary Engineer, issued a revised set of types in 1907, as experience had dictated the following alterations:—

1. The concrete at the back of the cunette having been found insufficient, its thickness was increased from four to six inches, according to the size of the type drain.

2. The concrete backing, instead of being put in a horizontal layer, was laid parallel to the side wall of the cunette.
3. The thickness of the cunette at the sides was reduced from $4\frac{1}{2}$" to 3".

The set of type drains revised as above, and illustrated on Plate No. 2, is still in use in the province. This sheet also shows a covered drain which has proved a failure. These drains are never cleaned out, with the result that after working some time, they become so foul, and full of rubbish and silt, that it is impossible for any one to venture into them to clean them. There is, moreover, great difficulty in getting repairs done to such drains and once they are built, the inside is never seen again by the engineer. For these reasons covered drains should not be introduced into surface drainage schemes except as a last resort.

Minimum Velocity of Flow.

Owing to a general lack of sufficient fall in the lie of township areas in the province, the minimum velocities found feasible both on the score of cost and efficiency of working are $1\frac{1}{2}$ feet to 2 feet per second in the case of intramural drains and 2 feet to $2\frac{1}{2}$ feet with extramural.

As for the question of a self-cleansing velocity, standard works dealing with the conditions obtaining in the West lay down $2\frac{1}{2}$ feet per second as the minimum, but the Author's experience had been, that the self-cleansing velocity in India is higher, because a lot of street garbage, shop sweepings, also rotten fruit, fruit skins and in fact every conceivable kind of rubbish is allowed to find its way into the surface drains, so that the self-cleansing velocity is probably 3 to $3\frac{1}{2}$ feet per second, which, even with the help of flush water, drains are incapable of developing.

Formulæ advocated for working out Velocities and Discharges in Surface Drains.

In the statement of the discharges and velocities in the type drains, which was issued from the Sanitary Engineer's Office in 1906, the velocity in feet per second (V) has been worked out from Kutter's formula with $N = \cdot 015$. The different values of the rugosity co-efficient for brickwork assumed in the above formula are as given below :—

$N = \cdot 012$ for new brickwork.
$N = \cdot 013$ for good brickwork and ashlar.
$N = \cdot 015$ for rough faced brickwork.
$N = \cdot 017$ for brickwork and stonework in inferior condition.

SURFACE DRAINAGE IN THE PUNJAB.

Discharges and Velocities in Type Drains.

Type No.	Depth of flow in inches.	Area of flow in square feet.	Hydraulic mean depth in feet.	Slopes. 1—50 V	1—50 D	1—100 V	1—100 D	1—150 V	1—150 D	1—200 V	1—200 D	1—250 V	1—250 D	1—300 V	1—300 D	1—350 V	1—350 D	1—400 V	1—400 D	1—450 V	1—450 D	1—500 V	1—500 D	1—600 V	1—600 D
I	1	·025	·05	1·3	·034	1·0	·026	8	·021	·7	017	·6	·016	·6	015	·5	·013	·5	·012	·4	·011	·4	·010		
	1½	·046	·08	2·0	·096	1·4	·064	1·1	·050	1 0	·046	·9	·041	·8	·037	·8	·035	·7	·032	·7	030	·6	·027		
	2	·068	·10	2·5	·17	1·8	·12	1·5	·10	1·2	·08	1·1	·07	1·0	·07	·9	·06	·9	·06	·8	·05	·7	·04		
	2½	·093	·12	2·9	·27	2·0	·19	1·7	·16	1·4	·13	1 3	·12	1 2	·11	1·1	·10	1·0	·09	·9	·08	·8	·07		
	3	·120	·14	3·2	·38	2·3	·28	1 9	·23	1·6	·19	1·4	·17	1 3	·16	1·2	·14	1·1	·13	1·0	·12	·9	·11		
II	3½	·147	·16	3·6	·53	2·5	·37	2·1	·31	1·8	·27	1·6	24	1 5	22	1·4	·21	1·3	·19	1·2	·18	1·1	·16		
	4½	·207	·18	3·9	·81	2·8	·58	2·3	·48	2·0	·41	1·8	37	1·6	·33	1·5	·31	1·4	·29	1·3	·27	1·2	·25	1·0	·21
	5½	·272	·21	4·3	1·17	3·1	·84	2·6	·71	2·2	·60	2·0	·54	1 8	·49	1 7	·46	1·6	·44	1·5	·41	1·4	·38	1·2	·33
III	6½	·343	·23	4·7	1·61	3·4	1·17	2·8	·96	2·4	82	2·2	·75	2 0	·69	1·8	·62	1·7	·58	1·6	·55	1·5	·51	1·3	·45
	7½	·419	·25	5·1	2·14	3·6	1·51	3·0	1·26	2·6	1·09	2·3	·96	2 1	·88	2·0	·84	1·8	·75	1·7	·71	1·6	·67	1·4	·59
	8½	·501	·27	5·4	2·70	3·9	1·95	3·1	1·55	2·7	1 35	2·4	1 20	2·2	1 10	2 1	1·05	1·9	·95	1·8	·90	1·7	·85	1·5	·75
IV	9½	·589	·29	5·7	3·36	4·1	2·41	3·3	1·94	2·9	1·71	2·6	1 53	2·4	1·41	2·2	1·30	2·0	1·17	1·9	1·12	1·8	1·06	1·6	·94
	10½	·682	·31	5·9	4·01	4·3	2·92	3·5	2·38	3·0	2 05	2 7	1 84	2·5	1 71	2·3	1·57	2·1	1 43	2·0	1·36	1·9	1·30	1·7	1·16
	11½	·781	·33	6·2	4·84	4·4	3·43	3·7	2·89	3·1	2·42	2·8	2·19	2 6	2 03	2 4	1·87	2·2	1·72	2·1	1·64	2·0	1·56	1·8	1·41
V	12½	·885	·34	6·5	5·75	4·6	4·07	3·8	3·36	3·2	2 83	2·9	2·57	2·7	2 39	2·5	2 21	2·3	2·04	2·2	1·95	2 0	1·77	1·8	1·59
	13½	·994	·36	6·7	6·66	4·8	4·77	3 9	3·88	3·3	3·28	3·0	3 00	2 8	2·79	2 6	2·59	2 4	2·39	2·3	2·29	2·1	2·09	1·9	1·99
	14½	1·109	·37	6 9	7·66	4·9	5·44	4·0	4 44	3·4	3·77	3·1	3·44	2 8	3·11	2 6	2·88	2·4	2 66	2·3	2 55	2 2	2·44	2·0	2·22
VI	15½	1·230	·39	7·1	8·95	5·1	6·27	4·1	5·04	3·5	4·30	3·2	3·94	2·9	3·57	2·7	3·32	2·5	3·08	2·4	2·95	2·2	2·71	2·0	2·46
	16½	1·356	·41	7·3	9·90	5·3	7·19	4·3	5·83	3·7	5 02	3·3	4·47	3·0	4 07	2·8	3·80	2·6	3 52	2·5	3·39	2 3	3·12	2·1	2 85
	17·2	1·45	·42	7·5	10·88	5·4	7·83	4·4	6·38	3·8	5·51	3·5	5 07	3·1	4·50	2 9	4·20	2·7	3·91	2·5	3·62	2·4	3·48	2·2	3·19

Kutter's formula with N = ·015. V = Velocity in feet per second.
D = Discharge in cusecs.

In this province the drain cunette is usually built of special moulded bricks laid in lime, and the joints are either cement pointed or the whole cunette face is cement plastered. In assuming, therefore, ·015 as the value of N for the above class of work, an error has presumably been made on the side of safety. The co-efficient $N = ·013$ would have been more suitable to the actual conditions. Another acknowledged expert in the science of hydraulics who may be bracketed with Kutter is M. Bazin, and in regard to the practical value of the formulæ evolved by these two authorities, it has been found by actual experiments that for smooth channels of small hydraulic radius Kutter's co-efficients give results which are too low. On the other hand, facts point to the greater accuracy of Bazin's co-efficients for small and smooth channels. M. Bazin, it is said, some years ago, reviewed the whole question of flow of water in channels, and after considering all the best known experiments, finally arrived at a new set of co-efficients corresponding to certain values of μ which is analogous to Kutter's N. The kinds of channels corresponding to Bazin's μ are as follows :—

μ = ·109 for cement and planed wood.

μ = ·290 for planks, bricks and cut stone.

μ = ·833 for rubble masonry.

μ = 2·35 for ordinary earth, etc., etc.

The value of μ = ·290 is the one which is analogous to Kutter's value N = ·013, and adopting these values it is interesting to compare the velocities as obtained from the formulæ of Kutter and Bazin.

Taking Type 111 drain, and assuming it to run full, the velocity according to the two formulæ mentioned above will be as under :—

	Kutter	*Bazin*
1 in 100	V = 4·26 ft.	= 5·0 ft.
1 in 200	V = 2·98 ft.	= 3·5 ft.
1 in 300	V = 2·43 ft.	= 2·85 ft.
1 in 400	V = 2·13 ft.	= 2·5 ft.

Thus the values of V as obtained by Bazin's co-efficient are 17½ per cent. higher than those obtained by Kutter's. If

however, we assume $N = \cdot 015$, then the values of V for the above slopes will be as shown below :—

1 in 100 V = 3·6 feet per second
1 in 200 V = 2·5 feet ditto.
1 in 300 V = 2·1 feet ditto.
1 in 400 V = 1·8 feet ditto.

It is thus obvious that the particular formula, and co-efficient for brickwork, employed in the preparation of the table of velocities and discharges, are such that they give the value of V thirty-nine per cent. lower than that obtained by the use of a formula and a rugosity co-efficient, which are acknowledged to give accurate results for small and smooth channels such as our type drains. That being so, it seems extravagant to have designed drain types thirty-nine per cent. larger than required to pass the requisite discharge, through under-estimating the discharging capacity by assuming low velocities of flow in the drains.

Discussing the matter last year with the Sanitary Engineer, Mr. Montgomery agreed that, while perfectly correct in theory, in practice he had found that our street drains were none too large, possibly due to the surface of the cunette bricks, and the general rough style of the joints and work, leaving much to be desired. He, therefore, preferred for the present to adhere to the tables and calculations already in use.

While agreeing that this is the prudent and safe course, the Author is strongly of opinion that experiments should be put in hand to determine practically what co-efficients will best suit our drains, and with the approval and co-operation of the Sanitary Engineer it is hoped to undertake these experiments this year if it is possible to obtain funds from the Sanitary Board for the purpose.

Pavements as an Essential Adjunct to a Drainage System.

In this province it is usual to have the streets and lanes paved, and the main bazars and roads metalled. Brick pavement is both cheap and suitable from a sanitary point of view, and usually consists of burnt brick set on edge in first class lime mortar and laid on two inches of rammed ballast.

Where funds permit, such pavements are cement pointed, and prove neat and enduring in foot traffic lanes. In Amritsar, on the other hand, some cement concrete slab pavement has been laid in two mohallas. This sort of pavement, although initially costing fifty-seven per cent. more than brick on edge, is so decidedly superior both from a sanitary point of view and on account

of its probably having a longer lease of life that it fully warrants the extra cost involved.

Disposal Works.

The disposal works for a Punjab town usually take the form of land treatment; that is to say the sullage, flush and such storm water as finds its way into the outfall channel, discharge into collecting tanks, which are invariably in duplicate, and from which the liquid is raised by mechanical means, and thence by means of main and subsidiary carriers is finally utilized on a sewage farm. Biological treatment of sullage has only been attempted on a systematic scale in Simla, where, on the advice of the late Mr. Santo Crimp, a start was made in 1900 with an installation consisting of a macerating tank and ordinary contact beds of stone. As, however, the percentage of purification never exceeded fifty, and the effluent was never satisfactory, a Ducat filter was started a year later, but this too proved a failure. Mr. Santo Crimp's macerating tank was then converted into a three chamber septic tank, and in place of the Ducat filter a continuous filter was put in. The latter was treated with the effluent from the septic tank, which was distributed over its surface by means of tipping troughs and this method of sewage treatment is being worked in Simla up to the present day. It is, however, worth noting that last year, when the Author inspected two out of the five Simla installations, he was unfavourably impressed with their value as a means of purifying and rendering harmless the sewage that was, after treatment, discharged into the valley ravines. The dilution of the daily flow of sullage at a certain proportion ; regulating the flow through the septic tanks so as to ensure the requisite amount of septic treatment ; working the continuous filter without allowing it to become clogged; and finally, ærating the effluent by running it over the hill side ; involved technical details of working, which required the attention of a more highly trained person than the sweepers in immediate charge of these installations.

The question of treating the town sullage before utilizing it on land was raised, sometime ago, in Lyallpur by Mr. Barnes, Principal of the Agricultural College. His idea was that, after screening the sullage in a detritus pit for primary treatment, a contact bed on the Dibdin principle should be used, which would ensure liquefaction and the reduction of organic impurities, and that, for secondary treatment, open filters should be provided to allow of free oxidation of this reduced liquid, which, mixed with irrigation water, could be applied to land. Mr. Barnes attributed

previous failures in the use of septic tanks to the want of requisite bacteriological data to show at what rate the liquid should be passed, under the varying temperature conditions obtaining in this country. This is probably correct, but there is also the question of how to provide the expensive and trained agency which alone can work these scientific devices with some measure of success. In Mr. Barnes' opinion, a man with a fair general education would require at least two or three years' training in the necessary technique, and in the practical working of contact and oxidizing beds by bacterial and chemical analysis of the effluent. The pay during training would be Rs. 80 to Rs. 100 a month and afterwards Rs. 150. Not only would a scientifically managed farm solve the problem of the disposal of a city's sullage, without creating a public nuisance, but it would add very considerably to the health and comfort of the inhabitants. The farm would, moreover, be a profitable investment. All this sounds very attractive, but the financial means of the majority of the local bodies in the Province are so limited, that it would be impossible for them to entertain such a highly paid staff for working a sewage farm, even if ways and means were found to train such a body of scientific farmers to act as managers of disposal works.

Means of lifting Sullage.

Some of the small municipalities and notified areas with systems of surface drains have " persian-wheels " set up at their disposal works for raising the sullage, but a persian-wheel besides being liable to frequent breakdowns, is a very inefficient means of dealing expeditiously with the daily flow. Its lifting capacity under normal conditions of working being about 1,500 to 2,000 gallons an hour, it would need to be worked ten to twelve hours every day, in order to deal with the daily flow from a town having a population of ten thousand. On the other hand, pumping plant consisting of a centrifugal pump, belt coupled to an oil engine of a robust make, such as the semi-Diesel type, constitutes an effective means of dealing with the daily sullage outflow in from three to six hours. Pumping plants for lifting sullage are working successfully in Lahore, Amritsar, Rawalpindi, Lyallpur, Amballa, and several other places.

Sewage Farm.

A sewage farm is laid out in quarter to one acre plots with the main sullage carrier, which is built in brick or masonry

TYPE SECTIONS OF DRAINS

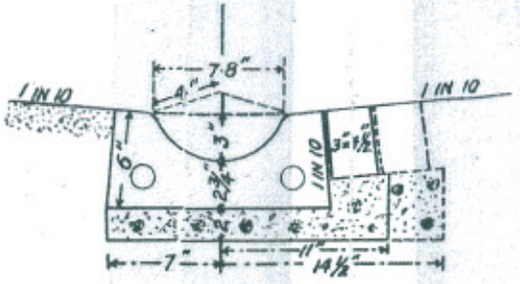
DESIGNED BY THE LATE Mr E. DUCANE SMITHE

AND

ISSUED IN 1902

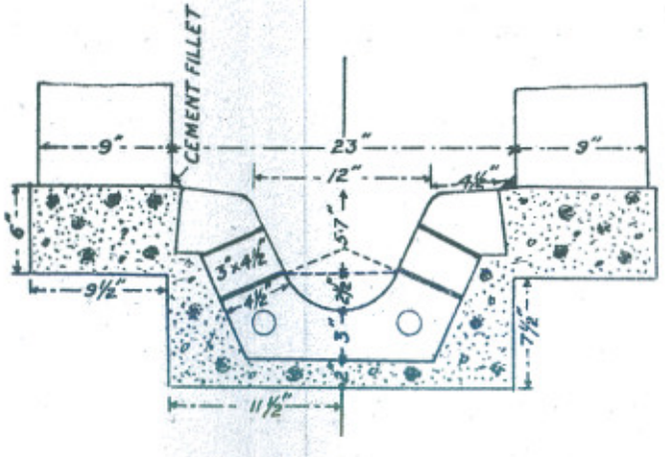
SCALE 1/12

TYPE I.



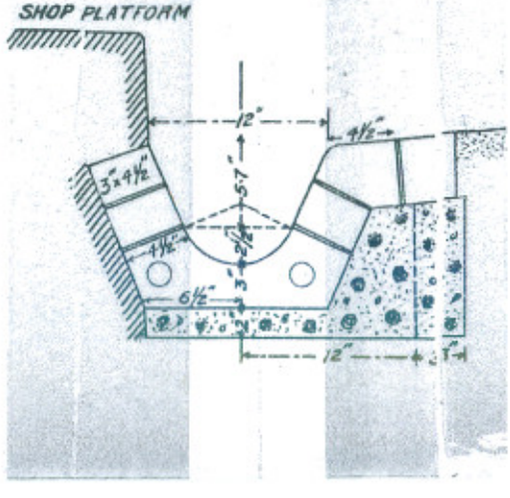
TYPE III.

FOR AN INTERCEPTING DRAIN IN OPEN COUNTRY

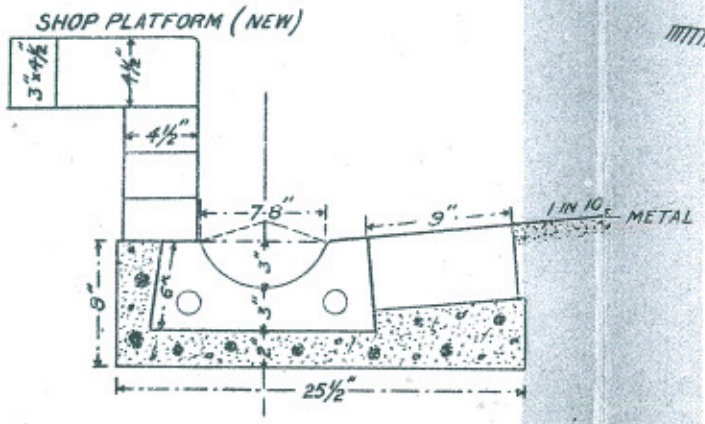


TYPE IIIa.

FOR A SIDE STREET DRAIN

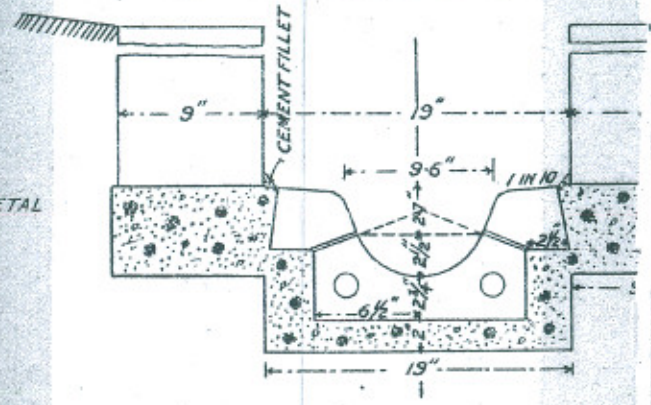


TYPE Ia.



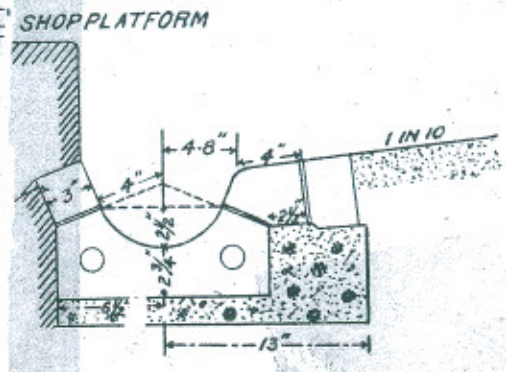
TYPE II.

FOR AN INTERCEPTING DRAIN IN OPEN GRO



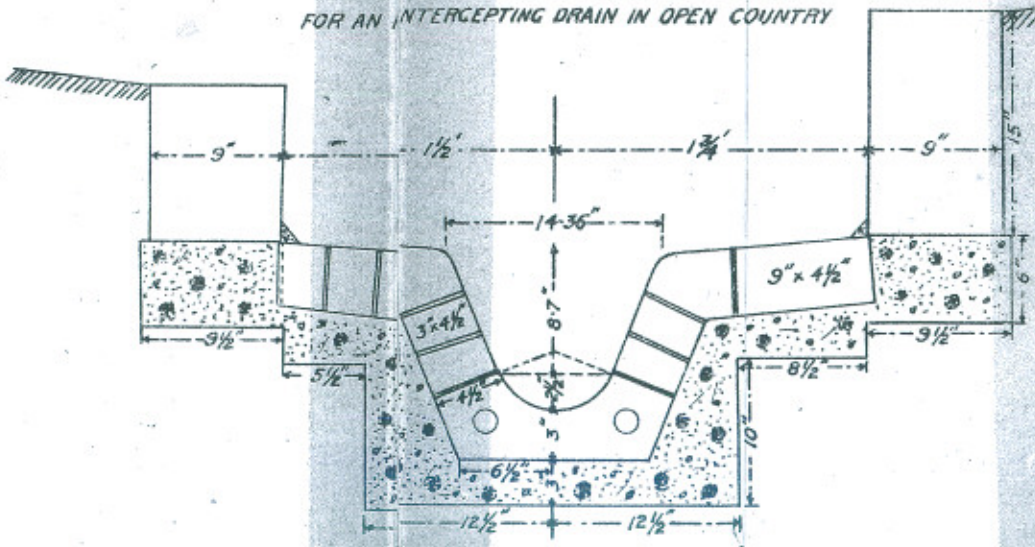
TYPE IIa.

SAME SIZE DRAIN ADAPTED FOR SIDE OF A STREET WITH SHOPS



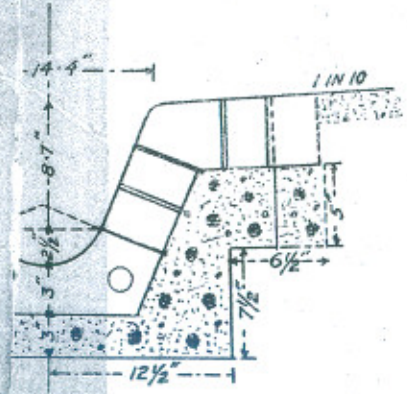
TYPE IV.

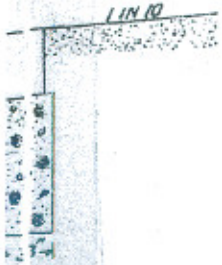
FOR AN INTERCEPTING DRAIN IN OPEN COUNTRY



TYPE IVa.

DRAIN ALONG A SIDE STREET





the formation of cesspools. It is highly desirable to use pressed bricks, because these present a much harder and smoother surface to the flow of sullage than an ordinary hand-moulded brick. Failing this the inside of the drains should be cement plastered.

6. Annual repairs to drains, pavements, culverts, flushing tanks, pipes, sullage tanks, etc., are neglected owing to which deterioration of the drainage system as a whole sets in. With every new scheme now prepared in the Sanitary Engineer's office an annual repair estimate is furnished to the local body concerned.

7. The conservancy staff in the employ of local bodies, headed by an old darogha, is generally an inefficient one. In this connection it is worth noting that the scheme for replacing daroghas by qualified sanitary inspectors, which came into existence three years ago, constitutes a real step forward.

8. There is a general lack of municipal appreciation and interest in sanitary matters which is largely responsible for the defective working and maintenance of surface drainage systems in the province.

Before concluding, it is well to record that recently Mr. V. Stainton, while Sanitary Engineer, wrote a comprehensive note on the defective working and maintenance of surface drainage schemes by local bodies in the Punjab, and submitted it to Government. This has been circulated amongst the Commissioners and Deputy Commissioners of the Province, and it is hoped that this will result in a decided improvement manifesting itself in the working and maintenance of existing sanitary installations.

DISCUSSION.

RAI SAHIB AMAR NATH, in introducing his paper, said he had only touched briefly on some points gleaned from his experience in the preparation and working of surface drainage schemes in the province, where the question of sanitary reform as a whole was of paramount importance ; and although instances were legion where the necessity for a wholesome drinking water supply and a proper means of drainage disposal were imperative, yet if the question of ways and means made it necessary to choose between the two, priority must be given to drainage disposal.

A water carriage system could not and would not meet the exigencies of the drainage requirements of the bulk of the province, which, as mentioned in his paper, was largely rural in its general aspect, but the system of surface drains, as at present designed, was susceptible of modification in several directions, on account of the habits of the people and the peculiar characteristics of the sullage. The practice of throwing all kinds of rubbish into the open street and bazar drains made it necessary to avoid giving a constricted section to these drains, while the necessity for a self-cleansing velocity and flow rendered it essential to have a certain depth and flow for a certain value of R. Complaints are made that the cunette portion of the standard type drains, even when laid at good slopes, present too constricted a waterway for the passage of the solids which form an integral part of the Indian bazar sullage ; and further, that a piece of sugarcane or a twig is sufficient to block the drains. Moreover, where type drains had got revetments on either side, as in Type *IIa*, the tops of the curb bricks offer ledges for the deposit of silt as soon as the flow of sullage and rain water rises above the cunette section. To meet these objections it had become necessary to consider the question of modifying still further the present drain type.

There was also another important point worth considering, namely, that the general lack of education and the consequent absence of intelligent interest in sanitary matters, were factors which contributed largely to the defective working and maintenance of drainage systems in this province. The result was that drainage schemes designed and built on modern, up-to-date lines, instead of doing good to the extent expected, accentuated the insanitary conditions in certain respects, owing to the way in which the installations were neglected.

The way out of the difficulty lay along the path of initiating strenuous measures for gradually removing the above defects. There was no doubt but that the problem of ameliorating the environment of the people from a sanitary point of view was a knotty one, both on the score of a general lack of sanitary awakening, and on account of the paucity of funds ; still it was a source for satisfaction that the prospect, dark as it was, was not without its silver lining. Government was ready to help the local bodies with grants-in-aid, and there were indications that the general mass of the people was slowly awakening to a sense of their sanitary responsibility. In support of this he would like to quote the instance of the Kotli Loharan drainage, which according to the figures supplied by the Deputy Commissioner, Sialkote, had cost nearly Rs. 26,000. In the course of an inspection he learnt that the money had been raised in equal amounts by voluntary subscription from the inhabitants, a grant-in-aid from the District Board, and a further grant-in-aid from the Sanitary Board.

Going through the bazars, lanes, and streets, he was very favourably impressed with their state of cleanliness, and the villagers gave him to understand that before the work of draining and paving had been taken in hand, almost all the bazars suffered from chronic waterlogging, and as for the streets and the lanes, these had been more or less slushy morasses. Kotli Loharan thus furnished an instance of a large village, of which there were numbers in the province, which was too small to have a separate organisation of its own under the Municipal Act, but in which certain very desirable measures of sanitary reform were actually carried out on a contributory basis. This constituted a practical step forward on the path of rural sanitation, and while on the one hand it testified in a large measure to the sanitary awakening of the people, on the other hand it spoke volumes for the tactfulness and power of initiative of the district authorities concerned.

After seeing Kotli Loharan he felt, that giving due consideration to local circumstances, it might often be advisable to deal with the sanitary problems of a particular locality on the principle that good could not be the enemy of the best. This dictum was particularly applicable to rural areas, where to attempt the very best would often be prohibitive on the score of cost. In such circumstances the best should not prove the enemy of the good, by depriving people of the immense advantage which simple paving and draining an intramural area, even

without the desirable adjunct of an extramural system of drainage, was bound to bring in its wake.

COLONEL CRA'STER in thanking the author for the paper said that as there were no criticisms offered, the paper was apparently perfect (Laughter) and therefore beyond criticism. He would like to emphasise the importance of sanitation and an efficient staff to maintain it. The sweeper and the bhisty were all very well in their own way, but they required constant watching and supervision, for they never thought of anything for themselves beyond drawing their pay.