IRRIGATION AND DRAINAGE PAPER **28**

drainage testing

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INTRODUCTION

Several of the Irrigation and Drainage Papers issued so far deal with farm drainage methods and practices. The present paper, however, is the first to contain explicit guidelines on how to test the functioning and adequacy of single drain lines and drainage systems.

As the acreage of irrigated land increases, so does the need for drainage. This is particularly true of the Near East Region where large-scale reclamation and drainage projects are presently being planned and implemented. Governments are increasingly recognizing that on most of the low-lying irrigated lands drainage is indispensable if soil degradation through waterlogging and salinity is to be avoided. Drainage, in this sense, does not only refer to major structures and canals but also to the smaller ditches and pipe drains on the farms. Without this farm system resalinization is likely to occur and will cause crop production to remain low.

Farm drainage is, unfortunately, still a relatively new field of activity in many countries. There is little experience to lean on and little time available for intensive experimentation prior to the execution of field projects. Nevertheless, it is of great importance to determine the characteristics of the drainage systems and of each single drain line that will give optimum hydrologic and economic performance. For this purpose, carefully designed and controlled tests are needed that yield design information at short notice and that serve to make a confident choice between practical alternatives.

The possibilities of transferring knowledge from one area or country to another appear limited due to differences and inadequacies in the applied investigation's methodology. Researchers and field engineers have therefore increasingly felt the need of guidelines for standardized testing procedures. With this in mind the Water Resources, Development and Management Service organized an Expert Consultation in Rome in 1974. This Consultation was to establish guidelines for the testing of the performance of drainage pipe lines and materials in relation to soils and hydrologic conditions. Its participants, listed below, were experienced drainage scientists from countries in the Near East as well as from those with a long drainage tradition. The authors gratefully acknowledge their advice during the Consultation and in later stages of preparation of this paper.

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Part I of this paper is based on the Consultation's views and recommended guidelines for the testing of single drain lines. It also contains a discussion of a few related items which the authors hope will further contribute to the usefulness of the paper.

The Consultation has not dealt with sophisticated laboratory methods of collecting information on flow patterns around pipe drains. It has considered that the procedures should refer to testing under practical field conditions and should be geared to obtaining information that would be applicable immediately.

Drainage trials are seldom undertaken for the sole purpose of single drain line testing. There are usually also urgent questions to be solved regarding the required intensity of the system, primarily the depth and the spacing of the drains. The plots for the testing of single drains lend themselves easily to obtaining the needed information and it will be only practical and efficient to use them for that purpose. A condition, of course, is that the arrangement of the drains as well as their depth and spacing are geared to the requirements for the testing of systems. Part II of this paper has therefore been added to explain how the same basic set-up and instrumentation can be used in a simple manner to maximize the information for system design.

It is hoped that this publication will help put the design of farm drains on a sound footing and so contribute to the effective preservation of our land resources. The Water Resources, Development and Management Service will welcome any comments or suggestions that may lead to further improvement of the proposed guidelines.

PART I

TESTING OF SINGLE DRAIN LINES

TABLE OF CONTENTS

LIST OF FIGURES

1. SELECTION OF DRAINAGE MATERIALS AND TECHNIQUES: WHAT WE KNOW AND DO NOT KNOW

1.1 INTRODUCTION

One of the real problems which the drainage designer faces is that soils are an extremely variable and sometimes unpredictable material. As the soil is the most important factor in the performance of a drainage system we shall not be able to predict the performance of any specific design with complete confidence until we have a better understanding of the soil behaviour under all conditions. From laboratory work we can predict the relative performance of, say, different drainage pipes and examples of this are given in Annex 1. However, in the field they often appear to perform better than expected and occasionally far worse. For example, a simple clayware drain is theoretically not particularly good in terms of water intake; however in field use the results are often indistinguishable from those of, say, corrugated plastics of a gravel covered clayware drain. The reason is that the laboratory tests were performed in homogeneous conditions but in the field the pipe is installed in a trench. Under some conditions the backfilled earth will be as efficient at transmitting water as a gravel surround - hence no difference between drains. In other cases, particularly under wet conditions, a soil/water slurry is formed which can effectively seal the pipe. We know broadly the conditions likely to lead to these results but not in an adequately defined way. To avoid slurry one is advised to avoid wet conditions, but how wet is wet? What soils are not subject to slurry? What is the danger point in a specific soil? These are arguably the most important points in drainage research today. The answer should be obtainable via soil physics and soil mechanics but unfortunately little progress has been made in the last 10 years.

It is instructive to review briefly the present state of knowledge in the following paragraphs.

1.2 PIPES

The performance of pipes under standard conditions is adequately known as is shown in Annex 1, in the FAO publication "Drainage Materials" and in the reported proceedings of the ASAE symposium on drainage materials held in Chicago in December 1971. There is some dispute on the effect of slot sizes in plastic pipes but in general there seems little need for further research on drainage pipes themselves. The problem is predicting the interaction with soil under all conditions. Annex 1 provides a simple method for estimating, on a theoretical basis, the effect of using different types of pipes.

1.3 PIPE ENVELOPES

There is a great deal of confusion on terminology and hence for the purposes of this paper the following terms will be used:

Envelope - this will be used as a generic term to mean any material other than the natural earth, except perhaps topsoil,, placed on or around drains. The material may or may not completely surround the drain. In general it is preferable to use a more specific term such as "filter" or "surround" which implies the purpose for which the envelope is used.

Filter - an envelope placed around the drain with the express purpose of preventing the fine particles of soil entering the drain. A filter will almost always completely surround the drain and have a thickness of 5 cm or so if granular material is used. In the situation where the instability is confined to the trench, it may suffice to have the material only partially surrounding the drain (see Annex 2). Fig. 1-1 illustrates the normal situation.

Surround - an envelope placed on or perhaps around the drain to improve the drain water entrance characteristics. A permeable surround of at least 5 cm thick will convert all practical drains into ideal drains. A partial surround is acceptable with some small loss in efficiency (see Annex 3). Surround material will usually be coarser than for a filter (see Fig. 1-1).

Note that an envelope is not composed of two types of materials, one for the filter and the other for the surround function. The material to be selected should serve the need of both, or either, as the case may be.

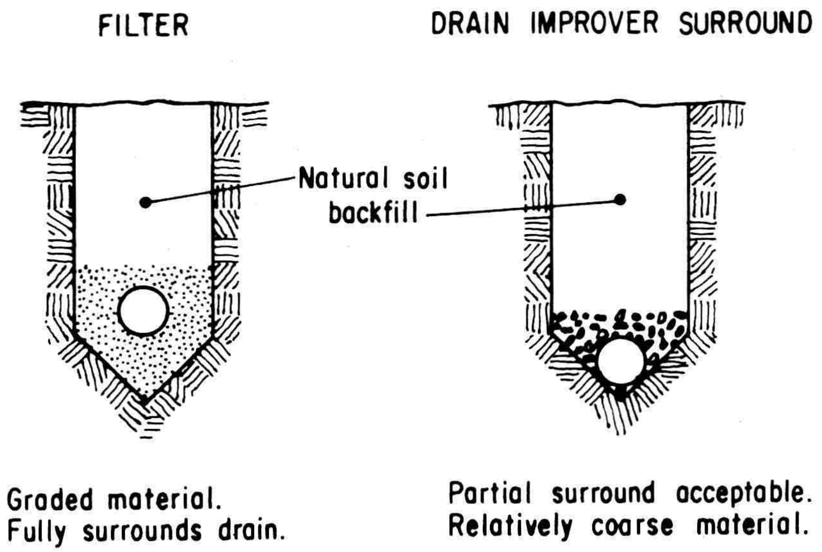

Fig. 1-1 TYPES OF DRAIN ENVELOPE TO FULFIL THE FILTER FUNCTION OR THE DRAIN IMPROVEMENT FUNCTION

1.4 FILTERS

As is shown in Annex 3 the grading criteria recommended by different authorities vary somewhat. It may be that the variation is not important and that all are within the acceptable range. However, this is an area which would seem to merit further research. One difficulty is that research on filters in a laboratory does not yield a complete answer as it is the long term performance that is of interest and time cannot be speeded up. In the field the inevitable lack of homogeneity and the various interactions make precise interpretation difficult. Perhaps the most important question with regard to filters is the definition of conditions requiring a filter. Although the available criteria differ slightly there is substantial agreement and it would seem that research is within sight of definitive criteria. Details are presented in Annex 2.

In terms of technical performance granular filters are preferable because they can be designed to match the soil. However, such filters can be expensive if sieving is needed. The general recommendation is to accept, at least for initial testing, any locally available natural material which falls within the overall limits given in Annex 3.

Pre-wrapped pipe/filter systems are discussed in Annex 1 but there are little definitive data available. Such pipes have many advantages but cannot usually be matched to the soil as can a granular filter. Thin cloth type filters are not recommended and any pre-wrapped pipes selected for tests should have a filter of at least 2 cm thick.

1.5 DRAIN SURROUNDS

These are distinct from filters in that the sole aim is to improve the drain entry characteristics - to create an ideal drain. There are few real problems in theory and the effect of any type of surround can be predicted. The problem is again the question of interaction with the soil and, in particular, the extent to which a surround will be an antidote to a slurry problem. Annex 1 provides a simple method by which the effect of adding a surround can be estimated. In general terms clayware or smooth plastic pipes will benefit more from a surround than will corrugated plastic pipe, because of the closer spaced perforation pattern. Annex 2 provides some information on situations likely to require a surround and Annex 3 gives design information.

1.6 DRAINAGE DESIGN THEORIES AND TECHNIQUES

The scientific side of drainage theory has outstripped practical application and proven formulae are available which are far more precise than the basic soils data which is the starting point of the calculations. Computer techniques are available which require almost no simplifications and which will deal with situations of layering and variability well beyond our capability to obtain the primary field data. Details of some of the more simple and practical methods are given in Part II and Annex 7.