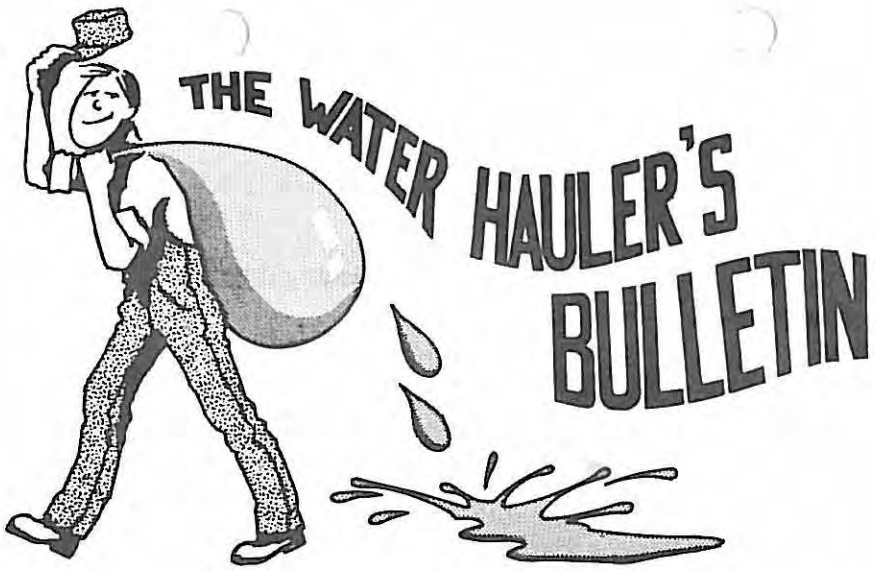

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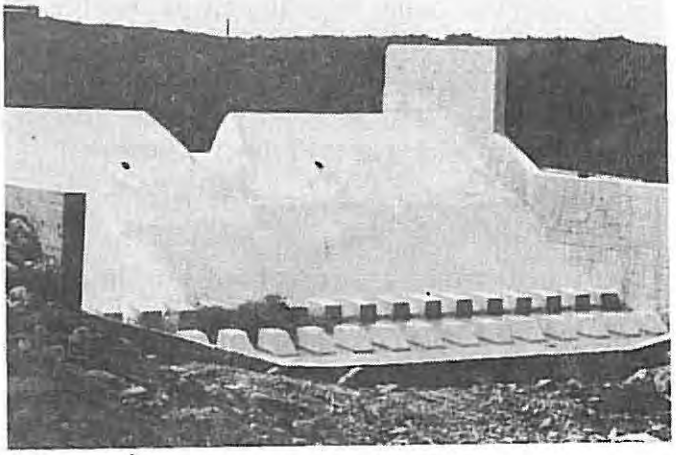
CHUTE DROP REPAIR INSTEAD OF REPLACEMENT

The Bow River Irrigation District had three chute drop structures on Lateral B Enchant that were deteriorating to the point where replacement or major repair work was necessary. Coring showed that the structures were basically sound, with only the top quarter to third of the slab thickness being rotten. The decision was made to repair damaged areas with new concrete and replace the stilling basin and chute blocks using Sika Top Mortar.

Sika Top Mortar was chosen because it is supposed to have excellent adhesion qualities to old concrete, good abrasion resistance, low shrinkage, and the ability to "breathe", thereby preventing a buildup of vapor pressure between the old and new concrete.

Where new concrete was added to the basin floors after chipping and sandblasting, spot-bonding with epoxy was carried out. Spot-bonding was used to eliminate the creation of a vapor-proof barrier between old and new concrete. Large cracks were grooved and filled with Sika Top Mortar, and smaller cracks were injected with epoxy.



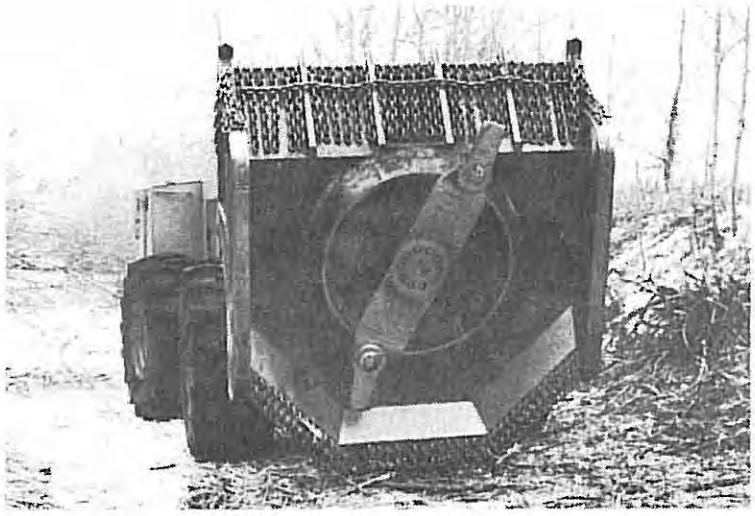
The Project Planning Branch will be monitoring these structures to evaluate the effectiveness of this method of repair.

* * *

W.I.D. IN TREE REMOVAL BUSINESS

The Western Irrigation District is coming to grips with its tree problem. Dense growth of trees and brush along its irrigation canals restricts water flow, consumes large quantities of water, and makes maintenance access impossible. The District's main objective in its tree removal program is to clear a working zone for machinery that will consequently reshape the canal to a future design "Q".

Three specialized pieces of equipment are used by the W.I.D. The Hydro-Axe Mulcher is a large four-wheel-drive crab-steer tractor with a heavy duty front mounted rotary mower. It is specially designed to work on uneven ground and the cab tilts to keep the operator level when working on slopes. The Fiat Allis FL 14C Track Loader is a caterpillar type tractor equipped with a rear ripper, log grapple and land rake. The Bobcat Feller Buncher is a large skid steer loader equipped to hydraulically slice off and pile trees up to three feet in diameter.



Hydro-Axe mulches trees up to 5"

FL 14C at work in W.I.D.

W.I.D.'s tree removal program is a year round operation. During the summer, the Hydro-Axe Mulcher clears to ground level all brush and trees up to five inches in diameter within the zone. The FL 14C uproots and piles trees up to twenty inch diameter. In extreme rough terrain areas and for larger trees, the Bobcat Feller Buncher is used to acccomplish the same purpose. A track mounted backhoe uproots trees too large for the other machines, as well as, removing all vegetation and sediment from the inside slope of the canal. The FL 14C then land rakes the entire zone to a depth of twelve inches, thereby removing roots and stumps. All debris is transported to drying piles and later burned.

In winter, the same equipment is used, but trees and brush can only be cleared flush to the frozen ground. The balance of the operation is performed the following summer.

A follow-up program of mechanical and chemical maintenance prevents reinfestation.

Gratitude is expressed to the management and staff of W.I.D. for their cooperation in obtaining information for this article.

* * *

THE AERIAL PHOTOGRAPHY MAPPING PROJECT

In 1974, the Irrigation Division of Alberta Agriculture initiated a pilot project, utilizing aerial photography, to determine the usefulness of that approach in providing a much more complete inventory of topographical data in the irrigated and potentially irrigable areas of Southern Alberta. It was determined that this photogrammetric approach for providing topographical information was considerably more economical, time-effective, and versatile than conventional surveying procedures. Therefore, in 1976, a master plan was laid out to collect all the data required for the much larger project area, as delineated in the following map.

Approximately six and a half years will be required to complete the data collection and assemble it to the "data bank stage". This is the result of three operations including aerial photography, ground control surveying, and aerial triangulation which assembles and adjusts the data collected in the first two operations in preparation for the actual mapping procedure, hence the "data bank".

Three types of photography are involved: 1:10,000 scale color, 1:20,000 scale panchromatic (black and white) and 1:20,000 scale black and white infrared. The color photography is used for the mapping process, but by itself it is very much utilized for identifying land use and cropping patterns, field dimensions, location of physical ground features, soil conditions and much more. Prints of this color photography are on file in all respective Irrigation Division offices, as well as, with all respective irrigation districts. The panchromatic and infrared photography is used primarily for soil investigation work for land classification and drainage and these photographs are maintained at the Irrigation Division headquarters in Lethbridge.

The ground control process involves establishing horizontal positioning and vertical elevations on specific limited points on the ground, which can also be identified on the photography either by their own physical features ("photo-identifiable points") or from ground "targetting". Two and one-half (2.5) metre long helix monuments, with brass caps, installed on a 10 km x 10 km grid spacing, provide the horizontal control framework. Adjacent to each photo I.D. point, each selected on an approximately 3 km x 3 km grid spacing, one metre long twisted pin bench marks were imbedded. Where no photo I.D. point was clearly available, the twisted pins were targetted for aerial recognition. All these photo-identifiable points then provide the vertical control. Level circuit elevations to the photo I.D. points were also carried through to the top of each twisted pin, for future reference in any other local survey work, and are referred to as A.D.A. bench marks. Both federal and provincial survey groups as well as several local contracted survey firms carried out the required second-order horizontal and vertical control surveys, with adjustment and publication of final positioning data being handled by Alberta Transportation.

Several contracted photogrammetric companies within the province compile and adjust the aerial data in consort with the ground control data, and transfer it to computer magnetic tape and hard-copy print-out. The data, in this form, is now ready for contour mapping or the like. This data is all filed at the IRRIGATION DIVISION headquarters in Lethbridge.

Any potential user of this material, if not already prepared, must, at his cost, make arrangements with a photogrammetric firm to have the specified work carried out and have the IRRIGATION DIVISION forward the appropriate data bank materials to the contracted company.

The entire data bank package is designed to provide contour mapping at one-metre contour intervals, half-metre machine-interpolated contours, location of physical features, profile and cross-section data, and larger scale area mosaics.

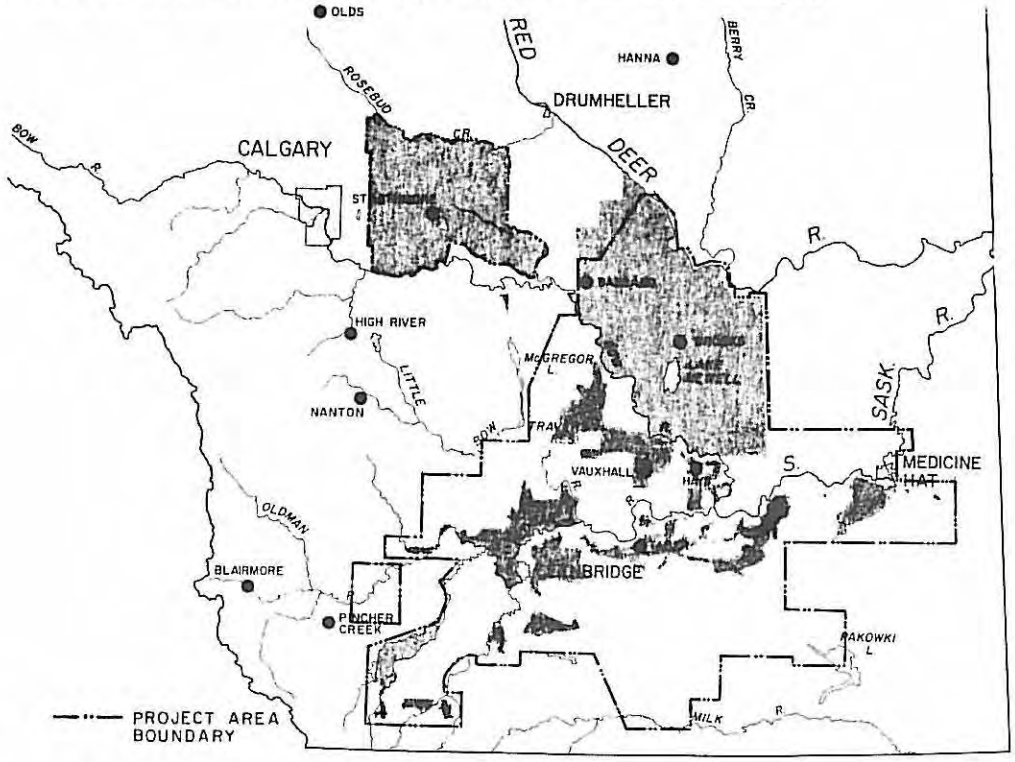
At the time of this writing, the Aerial Photo Mapping Committee of the Irrigation Division has the following completed:

- all photography of the project area
- virtually all survey ground control
- data bank preparation for: Raymond, Magrath, United, Lethbridge Northern, St. Mary (West block) and Eastern (Kitsim) Irrigation Districts, and the Big Lease area of the Blood Indian Reserve. (This means mapping in these areas can now be carried out as desired.)
- contour mapping for: Raymond Irrigation District and the Kitsim Reservoir area.

The data bank is presently being completed for: Taber and St. Mary (East Block) Irrigation Districts. All other areas will continually be data banked through 1981 until Spring, 1983.

For further information on the program contact Art Potvin, C.E.T., Chairman Photo Mapping Project, Irrigation Division, Agriculture Center, Lethbridge, Alberta, 329-5170.

(Condensed from an article by Wally R. Chinn, P. Eng.)



MAP OF SOUTHERN ALBERTA SHOWING IRRIGATION DISTRICTS AND BOUNDARY OF THE AERIAL PHOTOGRAPHY MAPPING PROGRAM.

* * *

NEWS FROM APPLIED RESEARCH SECTION

BARNWELL SEALANT TEST PLOT

Following is a brief description of the performance of seven types of sealants used in cracks on concrete irrigation canal lining after one winter. The winter of 1980-81 had more than the average number of freeze-thaw cycles.

1. Chopped fibreglass - generally in good shape. In one place where there was a considerable movement of concrete (approx. 20 mm), the bond between concrete and fibreglass broke over a length of about 2 m.
2. Crafco Overflex MS - good adhesion to concrete and remains flexible. However, on this installation, very little material was pushed into the crack. Possibly a narrower nozzle and more pressure would improve the application. Price is within reason.
3. Butyl rubber - thin layer of material bridged the crack; rest ran down through the crack. Not as good adhesion to concrete as Overflex.
4. Vibrapair polyurethane grout - poor adhesion to concrete. Moisture in concrete seemed to force it to release its bond. Very expensive material.
5. Roofing tar - no good. Brittle. Virtually no adhesion to concrete. Inexpensive material.
6. Asphaltic cement (asphalt-sulphur mix) - much better than tar. Good adhesion to concrete, but is brittle and will not withstand any movement of concrete. Inexpensive material.
7. Polyurethane foam - generally very good. Easy and fast application. Is not bothered by crack moisture. Flexible enough to withstand some movement of concrete. Relatively inexpensive. Minimal surface preparation required.

All materials with the exception of Polyurethane Foam will have to be applied on a sandblasted surface; otherwise it would be a waste of labor and materiál. The final report on this test plot will be written at a later date.

CONCRETE LINING REINFORCEMENT

The Lethbridge Northern Irrigation District is cooperating with the Irrigation Division on a wire mesh reinforcement experiment. On the East Park Lake Canal which was concrete lined 7 years ago and is very badly cracked, there was 600 ft. of canal rebuilt last month. The old concrete was taken out, canal was bulldozed in, retrenched and relined with concrete. The concrete was reinforced with 2" x 2" and 4" x 4" wire mesh. The ground water movement and frost penetration will be monitored and and the performance of this reinforced concrete will be evaluated over the next couple of years.

Reinforced concrete lining

M.V.I.D.

The heavy rains in May and June caused flood waves in Mountain View Irrigation District. Their newly reconstructed main canal designed for 34 cfs was overflowing and carrying about 120 cfs above the Jones' lakes. Probably these lakes saved the District from heavy damages downstream by flattening these flood waves.

L.I.D. PVC LINING

Leavitt Irrigation District installed on their Lateral "K", 20 mil PVC lining. Approximately 300 ft. of lining was installed in this contour canal. The shallow bedrock conditions caused some problems with the excavation. The lining was installed on a 2:1 sideslope. The general performance of this type of lining will be observed in the next few years.

20 mil PVC lining

E.I.D. LINING EXPERIMENT

The experiment with the exposed flexible linings was carried out in the Eastern Irrigation District. Two basic lining materials were installed - 1100 ft. of 4 different types of fibreglass, and 300 ft. of 100 mil chlorinated polyethylene lining called "Schlegel Sheets". Flow measurements to compare these two linings will be made, as well as, some material testing and ground water monitoring over a period of 5 years. So far, the ditching and installation procedures were smooth and this 15 cfs ditch looks pretty good.

fibreglass and Schlegel linings

* * *

SALINITY CONTROL UNDER IRRIGATION

By Kaljo Pohjakas, Soil and Water Specialist

Southern Alberta is unique because many of the soils under irrigation here would be considered not suitable for irrigation elsewhere. This applies specifically to the glacial till soils which generally transmit water so slowly that in most other countries they would be considered non-irrigable.

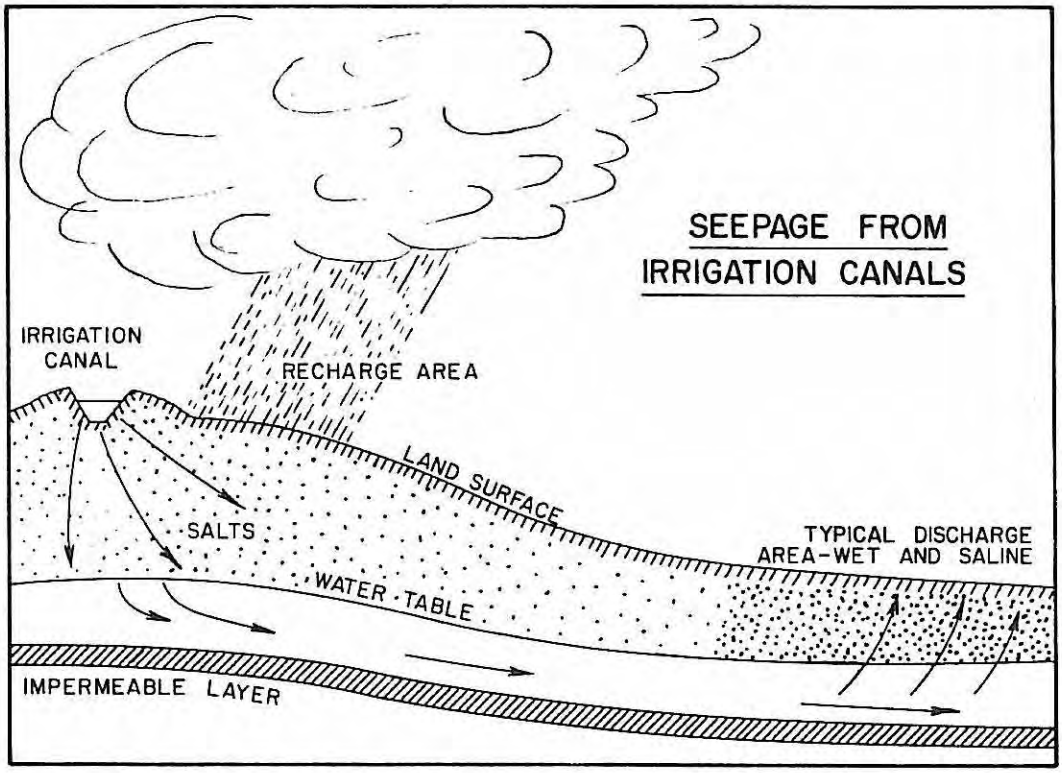
Here many such soils have been under irrigation for decades without any adverse effect. Our studies by the Irrigation Division have shown that under-irrigation is much more common than over-irrigation. Only in exceptional cases does farm water use reach and exceed the maximum that a crop can use. On the majority of irrigated fields water stresses develop periodically which limit crop yields. This may be one of the reasons why local irrigation practices have contributed little to the build-up of groundwater tables. It is estimated that as much as 10% of the presently irrigated land is saline or salt affected. Waterlogging and the salinization process in most cases are not directly related to irrigation practices on fields, but are generally caused by the extra water which escapes from leaky canals and water control structures of the distribution systems.

In an almost watertight subsoil, this extra water from the leaky canal system is known to travel great distances below the soil surface raising water tables and bringing soluble salts to the soil surface.

Prevention of canal seepage, interceptor drains or subsurface drainage of the affected area are used for controlling water tables and resulting soil salinity. Soils on slowly permeable subsoils require careful water management to maintain their productivity. Studies have shown that most irrigated soils contain soluble salts and require some leaching for maintaining a favorable salt balance.

The leaching process has to be carried out carefully in conjunction with irrigation without raising the groundwater tables close to the soil surface. As the water table rises, the upward movement of water and salts increases rapidly and instead of a desired leaching we may promote a salinization process by applying too much water.

Water management is critical in glacial till soils and an understanding of water management principles is essential for maintaining continued productivity of our irrigated soils.



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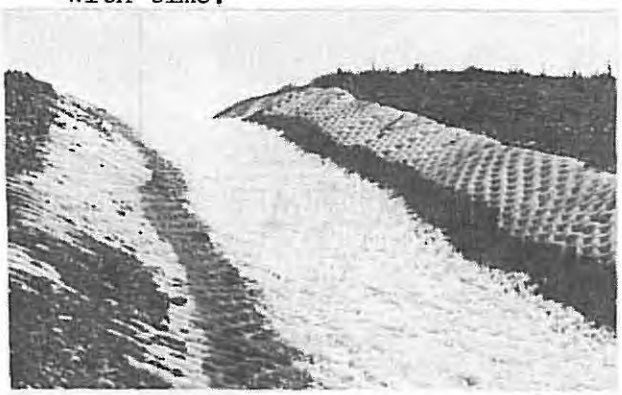
FABRIFORM CHUTES FOR SPILLWAYS ON STEEP GRADES

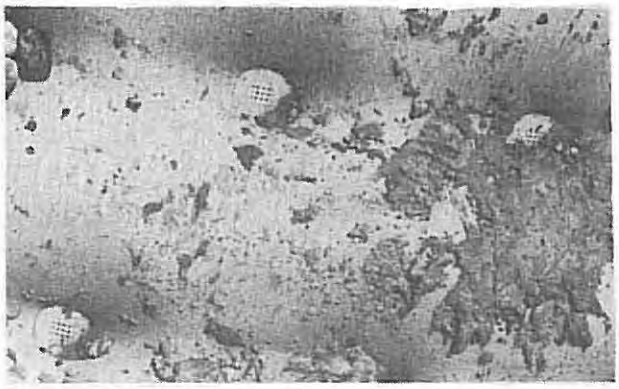
The chute shown in the picture is part of Imperial Spillway in E.I.D. This chute is made by pumping concrete grout into a nylon fabric laid on the already shaped earth. The commercial name of this product is Fabriform and it seems to provide a very good solution to spill water down a steep grade. The nylon mat is a specially woven material sewn in such a way that filter points are evenly distributed throughout its surface. This ensures that uplift pressure is relieved throughout the length and cross-section of the mat. Because of the way the material is stitched, when it is pumped full of concrete, it has a regular undulating surface. This undulating surface seems to be quite effective in controlling water velocity on steep grades.

In the case where water is draining out of the upper ground throughout the winter months and running down or forming ice on the spillways, this type of structure provides a good solution. This particular structure worked partly through last summer, last winter, and is working quite effective now as can be seen from the picture.

Quite recently the St. Mary River Irrigation District had one of these chutes constructed for the Medicine Hat Airport Spillway. The condition with winter spill is similar to the Imperial Spillway. The Bow River Irrigation District had a Fabriform chute constructed recently on Lateral A1K (Vauxhall). There is one more of these structures to be constructed in this District at the end of the H-B Wasteway where it empties into Enchant Drain.

It is expected that with time the nylon fabric will deteriorate and disappear but the concrete, which is quite high strength, (because of the interesting way the excess water is bled out of the wet concrete as it is being pumped into the nylon fabric) should form an effective protection against erosion. The Project Planning Branch will continue to monitor these structures to evaluate their effectiveness and durability with time.





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THE WATER HAULER'S BULLETIN

Designed to provide the operation and management personnel of Irrigation Districts with items of interest in their line of work. Comments are welcome. Please contact Roger Knibbs at 329-5164, Lethbridge.

Published quarterly by the Evaluation and Management Section, Project Planning Branch, Irrigation Division, Alberta Agriculture, Agriculture Center, Lethbridge, Alberta T1J 4C7.

EARTH LOAD CARRYING CAPACITY OF PVC & POLYETHYLENE PIPE BY SOIL INTERACTION

Significant Factors in Pipe - Soil Interaction - ASTM D2321-74.

The nature and degradation of the material used in bedding, haunching and initial backfill, as well as, the manner and care with which it is installed are important factors in achieving satisfactory installation of flexible conduit. The amount of diametric deflection that can be anticipated during installation is related to the nature and degradation of the embedment material and pipe stiffness, as well as, the care with which it is placed under, around and over the pipe. Thus, careful consideration should be given in choosing these materials and the method of placement and compaction.

Extracted from ASTM D2321-74 Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.

Within recent years Space Age Plastics had reached the Irrigation Districts of Southern Alberta in the form of PVC and Polyethylene buried pipelines. Already over 40 miles of the plastic pipes are in use by the Irrigation Districts. The trend is for an ever increasing use of these pipes and justifiably so because of their many excellent qualities and their competitive cost within a particular range of diameters. These pipes are, in fact, not difficult to install (another plus) but we should not forget that they are flexible pipes. These pipes require special care in placement and compaction of embedment material to ensure that they can take the earth load above without deflecting too much.

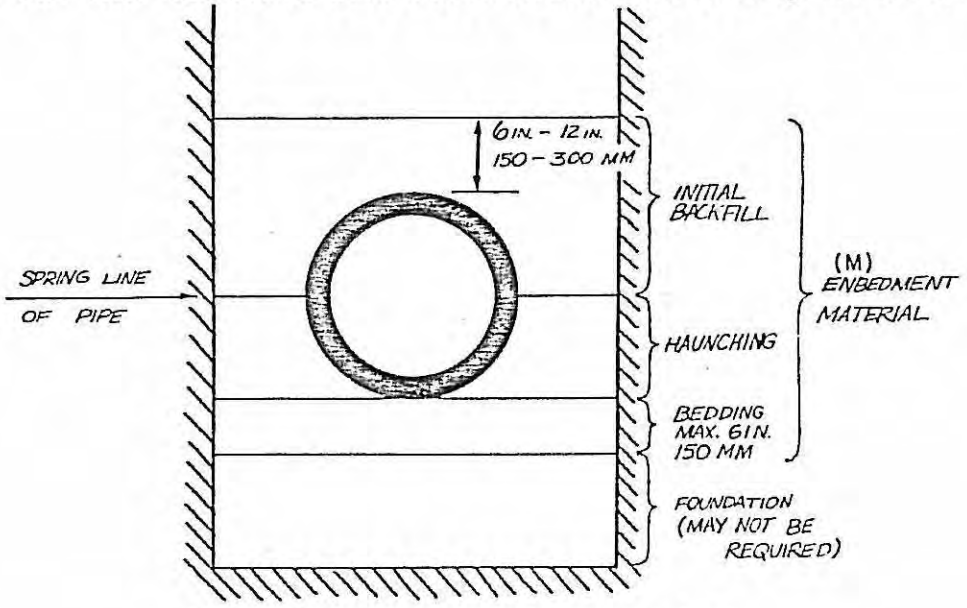

FIG. 1 Trench Cross Section Showing Terminology Relationship.

A flexible pipe is defined as capable of deflecting at least 2% without suffering any structural distress such as injurious cracking. Though arbitrary, this definition is still widely used. PVC and Polyethylene pipes fall under this definition since they can deflect more than 2% without any structural distress. Unlike the rigid pipe, the flexible pipe gains its ability to carry the earth load above by the pipe-soil interaction and not by the pipe alone. If the soil at the haunching and the initial backfill is compacted properly to meet the existing conditions

based on burial depth, pipe stiffness, soil type, etc., it is expected that the pipe will not deflect too much under its earth load. The applied earth load above the rigid pipe must be carried totally by the pipe. In the flexible pipe system the applied earth load is carried in large by the earth at the sides of the pipe because the flexible pipe deflects downwards away from the load. As the flexible pipe deflects vertically (vertical diameter decreases) the soil over the pipe "arches" and transmits a portion of the load to the compacted soil at the sides of the pipe. The vertical deflection of the pipe is accompanied by a tendency to increase the horizontal diameter. This tendency is restricted by the passive resistance of the compacted soil at the sides of the pipe. The soil at the sides of the pipe, therefore, takes the lateral loading due to the lateral bulging tendency. Through this deflection mechanism, the earth load is carried mainly by the surrounding soil and to a lesser extent by the pipe itself, and the final pipe deflection is small or negligible.

Polyethylene and PVC are thermoplastic materials and because the pipes made from these materials fall under the classification of flexible pipes the Standard Recommended Practice for the Installation of Flexible Thermoplastic Sewer Pipe: ASTM D2321-74 provides a guide for the installation of these pipes especially where certain conditions such as unstable trench walls or bottom are encountered because of ground water or water running into the trench. An important goal should be that the pipe has adequate support at the sides so that it does not deflect too much under the earth load.

Handbooks and design aids given by the major Polyethylene and PVC pipe manufacturers or sales agents also provides guides for proper installation of these pipes. These guides all emphasize the importance of adequate compaction for the haunching and the initial backfill.

The bottom line, therefore, is that the haunching and initial backfill of buried Polyethylene and PVC pipes should be adequately compacted to ensure that the pipes do not suffer serious deflection or even failure.

So far nothing is said specifically about what degree of compaction is required since this is dependent on burial depth, pipe stiffness, soil type, etc. To appreciate this let us look at the existing theory used to predict pipe deflection. Work by M. G. Spangler and later modification by Reynold K. Watkins give rise to the Modified Iowa Formula which is:

$$\Delta X = D_L \frac{KW_c r^3}{EI + 0.061\, E' r^3}$$

Where D_L = Deflection lag factor

K = Bedding Constant

W_c = Marston's load per unit length of pipe, lb/Lin

r = Mean radius of the pipe, in.

E = Modulus of elasticity of the pipe material, psi

I = Moment of inertia of the pipe wall per unit length, $in.^4/Lin = in.^3$

E' = Modulus of soil reaction

ΔX = Horizontal deflection or change in diameter, in.

The value of E′ for various types of soil, conditions and degree of compaction was difficult to obtain. Since it required assumptions regarding bedding factor, load and deflection lag factor, the values of E′ obtained by back calculation from measured values of ΔX gave a wide range by different researchers. Amster K. Howard from USBR compiled all known data from various sources, assumed values of E′, K and W_C for various types and densities and back-calculate using the above formula to obtain the theoretical deflection. He used K = 0.1 and D_L = 1.0 and the results he obtained compared well with the measured values. For instance if theoretical deflection was say 5% the measured value was between 3% and 7%. The formula in its present form cannot be used since for plastic pipes the pipe stiffness is either defined as (F/ΔY) or outside diameter to wall thickness (DR = dimension ratio).

Spangler's original work gives the following formula for deflection when the pipe is not buried

$$\Delta Y = 0.149 \frac{Wr^3}{EI}$$

$$\text{and} \quad \Delta X = 0.136 \frac{Wr^3}{EI}$$

If it is assumed that for small deflection ΔX and ΔY are equal and introduce the new description for plastic pipe stiffness the formula after transposing becomes

$$\% \frac{\Delta Y}{D} = \% \frac{\Delta X}{D} = \frac{D_L \, KP(100)}{[2E/3(DR-1)^3] + 0.061 \, E'}$$

Where P = Prism Load (Soil Pressure), psi

The values of E′ can be obtained for different soil types and degrees of compaction from the Handbook of PVC pipe, Uni-Bell Plastic Association* which reproduced these values from the original work of Amster K. Howard. If the value of K = 0.1 and D_L = 1.5 a conservative design value of percentage deflection is obtained. The value of D_L = 1.5 is used to take care of long term maximum deflection since plastic pipes creep with time. Creep stops when the soil reaches the density required to support the load.

To illustrate how the formula is used and how the deflection can be different for two densities of the same embedment material an example is given.

Example: A polyethylene pipe of Series 45 and diameter of 8" is laid with a cover of 14'-0 and the type of soil is coarse-grained soils with fines. The haunching and initial backfill is slightly compacted (i.e. less than 85% Standard Proctor) and in another case to moderate compaction (i.e. 85% - 95% Standard Proctor).
Find the maximum deflection in each case.

E = 105,000 psi, for Series 45, DR = 31.4, γ = 105 lb/ft^2

For 1st case: E′ = 400

The Formula: $\frac{\Delta}{D} \% = \frac{D_L \, KP(100)}{[2E/3(DR-1)^3] + 0.061 \, E'}$

*Table of E′ values attached

Prism load $P = \frac{14 \times 105}{144} = 10.2$ psi

$$\frac{2E}{3(DR-1)^3} = 2.49 \text{ psi}$$

$$0.061\ E' = 24.4 \text{ psi}$$

Therefore $\frac{\Delta}{D}\% = \frac{1.5 \times 0.1 \times 10.20 \times 100}{2.49 + 24.4}$

$= 5.69\%$

For 2nd case: $E' = 1000$ $\qquad 0.061\ E' = 61$

Therefore $\frac{\Delta}{D}\% = \frac{1.5 \times 0.1 \times 10.20 \times 100}{2.49 + 61}$

$= 2.4\%$

= vertical deflection

It is seen here that if the embedment material is compacted moderately, the deflection is less than half the deflection when the compaction is only slight. For this particular case it should be noted that the maximum deflection of 5.69% will not cause any structural distress to the pipe. If the soil 1000 ft. along is now a fine-grained soil (a soil with medium to no plasticity) the E' is now only 200 psi when slightly compacted, so the deflection will now be over 10%. This is in excess of the manufacturer's recommended allowable deflection for this pipe Series or Dimension Ratio. If the embedment is compacted to over 95% Standard Proctor Density the deflection will be 2.4%.

It is not suggested that this Series of pipe will be buried to this depth without adequate compaction of the embedment material but used merely to illustrate the importance compaction makes to the pipe's ability to carry earth load by the pipe-soil system.

Article by J. H. Ganesh, P. Eng., Head, Evaluation & Management Section, Project Planning Branch, as a result of concerns expressed by the Director of the Irrigation Division.

References:

Handbook of PVC pipe, Design and Construction, Uni-Bell Plastic Pipe Association.
1979 Annual Book of ASTM Standards.
Driscopipe High Density Polyethylene Industrial Pipe Manual.
Sclairpipe High Density Polyethylene Pipe Manual.

AVERAGE VALUES OF MODULUS OF SOIL REACTION, E'
(For Initial Flexible Pipe Deflection)

Soil type-pipe bedding material (Unified Classification System[a]) (1)	E' for Degree of Compaction of Bedding, in pounds per square inch			
	Dumped (2)	Slight, <85% Proctor, <40% relative density (3)	Moderate, 85%–95% Proctor, 40%–70% relative density (4)	High, >95% Proctor, >70% relative density (5)
Fine-grained Soils (LL > 50)[b] Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent soils engineer; Otherwise use $E' = 0$			
Fine-grained Soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	50	200	400	1,000
Fine-grained Soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with more than 25% coarse-grained particles	100	400	1,000	2,000
Coarse-grained Soils with Fines GM, GC, SM, SC[c] contains more than 12% fines				
Coarse-grained Soils with Little or No Fines GW, GP, SW, SP[c] contains less than 12% fines	200	1,000	2,000	3,000
Crushed Rock	1,000	3,000	3,000	3,000
Accuracy in Terms of Percentage Deflection[d]	±2	±2	±1	±0.5

[a]ASTM Designation D-2487, USBR Designation E-3.

[b]LL = Liquid limit.

[c]Or any borderline soil beginning with one of these symbols (i.e., GM-GC, GC-SC).

[d]For ±1% accuracy and predicted deflection of 3%, actual deflection would be between 2% and 4%.

Note: Values applicable only for fills less than 50 ft (15 m). Table does not include any safety factor. For use in predicting initial deflections only, appropriate Deflection Lag Factor must be applied for long-term deflections. If bedding falls on the borderline between two compaction categories, select lower E' value or average the two values. Percentage Proctor based on laboratory maximum dry density from test standards using about 12,500 ft-lb/cu ft (598,000 J/m³) (ASTM D-698, AASHO T-99, USBR Designation E-11). 1 psi = 6.9 kN/m².

SOURCE: "SOIL REACTION FOR BURIED FLEXIBLE PIPE" BY AMSTER K. HOWARD, U. S. BUREAU OF RECLAMATION, DENVER, COLORADO. REPRINTED WITH PERMISSION FROM AMERICAN SOCIETY OF CIVIL ENGINEERS JOURNAL OF GEOTECHNICAL ENGINEERING DIVISION, JANUARY 1977, PP. 33-43.