U. S. Department of Agriculture
Soil Conservation Service
Engineering Division
Design Branch

August 19, 1969

DESIGN NOTE NO. 7*

Subject: Variation in joint extensibility requirements as sectional conduit is moved up or down from embankment-foundation interface. (See TR No. 18)

The subject presents several moot questions. Virtually no factual evidence, either from theory or field observations, exists to establish design criteria. For this reason the following recommendations rely heavily on judgment and as sound reasoning as we can muster.

We are concerned with the variation in the required joint extensibility along an arbitrary vertical line "A" formed by the intersection of a vertical plane through the centerline of the conduit and a vertical plane through the embankment centerline, as the conduit location is moved up into the embankment. The origin, or zero point, on this line "A" is taken at the interface between the embankment and foundation where the required joint extensibility is "J" as computed by procedures outlined in TR No. 18 "Computation of Joint Extensibility Requirements."

It seems reasonable to assume that the horizontal tensile strains decrease along line "A" as the conduit position is moved up into the embankment and become zero at some distance αH above the interface. It also seems reasonable that these variations would be quite gradual for small values of y. The value y is the distance from the origin on line "A" to the intersection of the conduit invert with line "A." See Figure No. 1.

Such a variation can be approximated by an equation of the following form.

$$J_y = J\left[1 - \left(\frac{y}{\alpha H}\right)^n\right] \qquad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (1)$$

Where J_y = the required joint extensibility at y distance above the origin in inches

J = the required joint extensibility at the interface (y = o) in inches

y = distance above the interface of the conduit invert on line "A" in feet as determined from TR No. 18

α = a ratio

H = height of the embankment above the interface, along line "A," in feet

n = an exponent greater than 1

*by M. M. Culp, Chief Design Branch

It is our best estimate that α should be 0.75 and n should be 2. Thus equation (1) becomes

$$J_y = J\left[1 - \left(\frac{4y}{3H}\right)^2\right] \quad \text{for } (0 \geq y \leq 0.75H) \quad . \quad . \quad . \quad . \quad . \qquad (2)$$

For example if y = 0.1H, i.e. the invert of the conduit on line "A" is 0.1H above the interface, the required joint extensibility for the conduit is

$$J_y = J\left[1 - \left(\frac{(4)(0.1H)}{3H}\right)^2\right]$$

$$\frac{J_y}{J} = (1 - 0.018) = 0.982$$

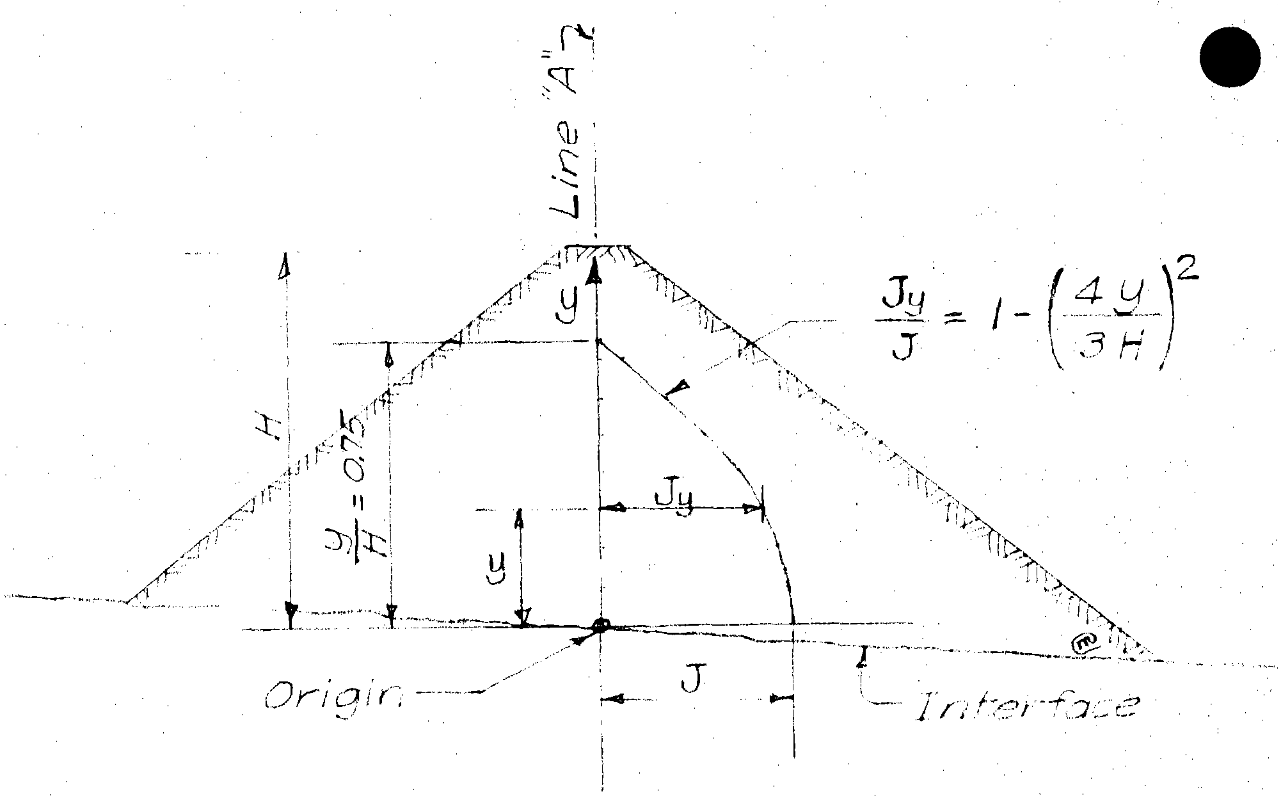

Fig. No. 1

Questions have been raised about the effect of placing compacted fill under the conduit on the required joint extensibility. Our present understanding indicates that compacted fill under the conduit of any reasonable extent will have such a small effect on required joint extensibility as to be considered negligible in any case where the required joint extensibility would require special joints or reduction in length of pipe sections.

As the conduit is moved downward from the interface into the foundation, within practical limits which would ensure free outlet for the conduit, the reduction in required joint extensibility, J, is believed to be so small that it may be neglected. Hence for all locations of the conduit below the interface the value of J at the interface should be used without modification.

A small discontinuity, such as a compacted "pad" under a conduit, which is limited in depth and lateral extent has very little effect on the movements in the large mass of earth under an embankment where joint movement is apt to be a problem. The foundation is three dimensional and the strains and deformations in it govern the movement in the conduit, a discontinuity in itself.