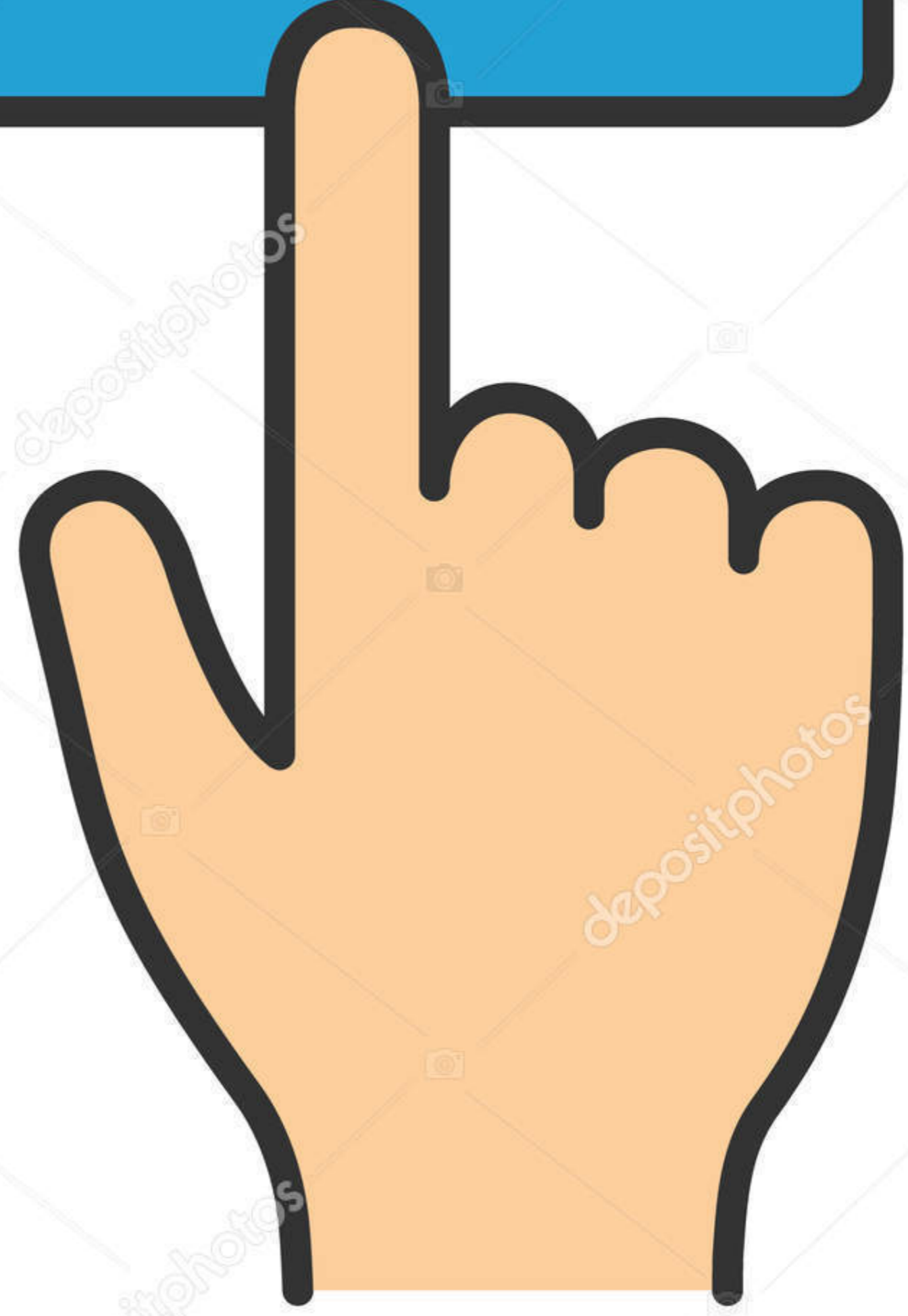


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progress sample of backfill material. This is approximately 60 percent of the actual rates measured by the corrosion probes.

Even though the above rates of metal loss are greater than the original estimated value, the 0.375-in-diameter bar mat is more than adequate for the actual field stress conditions. This bar mat will also provide sufficient sacrificial steel for the average measured uniform rate of 1.7 mils/year.

The corrosion data also appear to indicate that corrosion rates increase with depth. This may be due to the phenomenon of corrosion stress; i.e., under greater pressures, the corrosion rate is increased. There may also be more moisture retained at the lower levels, which would tend to accelerate corrosion.

In April 1980, approximately 46 months after the completion of level C of the upper MSE wall, a segment of the bar mat at this level was retrieved for further corrosion analyses.

The bar-mat segment was covered with a light layer of rust. As stated previously, the average corrosion rate at this level of the embankment was 0.4 mil/year, which is about one-fourth of the entire MSE average. The analysis was limited to level C since no samples could be obtained from lower levels.

Various specimens were cut from the retrieved bar-mat segment for tests to measure weld shear resistance and tensile strength of the longitudinal reinforcement.

The results indicated that strength of the steel was virtually unchanged. Also, the welds' minimum shearing strength was 1800 lb, which is well above the approximate 70-lb design requirement (assuming a uniform distribution of stress throughout the bar mat). A microscopic examination of the light rust on the welds showed that it had not penetrated or weakened the welds or the mat.

The rate of corrosion at location B (RE) was measured in the fill by means of two corrosion probes per level in levels A, B, and C. Since the same backfill material as that for the MSE walls would be used, a 1.8-mil/year rate of corrosion in terms of pitting was predicted initially from laboratory tests for pH and resistivity as defined previously.

Measured and estimated corrosion rates are plotted in Figure 15 for levels A, B, and C. Although the corrosion rates vary somewhat from those measured in the MSE walls, the average for all the gauges is very nearly the same.

The average uniform corrosion rates at each level range from 2.0 to 1.18 mils/year for levels A, B, and C, respectively. The average of these rates is 1.6 mils/year [0.82-oz/(ft²-year) uniform rate], which is somewhat higher than the pitting rate of 7 mils/year [0.5 oz/(ft²-year)] estimated for the actual backfill samples.

CONSTRUCTION COST

A valid comparison of construction cost for MSE and RE walls on this project based on contract bid items is not possible due to the vagaries of the bidding process, construction timing (location A was constructed after location B), and the fact that location A was the first MSE project whereas the construction industry was generally familiar with RE projects. As an example, steel for the RE wall was bid at \$0.53/lb as compared with \$1.00/lb for the MSE walls.

If we take these factors into consideration, an appropriate means of developing a cost comparison of the two systems is believed to be quantities of principal items and erection time. Excavation quantity was not considered, since this was primarily

dictated by site geometry rather than by system type. Also not included were items associated with the subsurface drainage since the same system was used for both RE and MSE walls.

Actual costs for wall facing for the two systems were closely comparable (\$4.60/ft² for the RE wall versus \$4.50/ft² for the MSE walls). To normalize the data for comparison, quantities are presented below by amount per 100 ft² of wall face; phase 1 of the RE construction involved 10 563 ft² and the lower MSE wall construction involved 5825 ft²:

| Item | System | |
|---|--------|-------|
| | RE | MSE |
| Select backfill/100 ft ² | 80.5 | 89.2 |
| Steel for reinforcement (lb/100 ft ²) | 490.5 | 946.2 |
| Erection time (days/100 ft ²) | 0.27 | 0.19 |

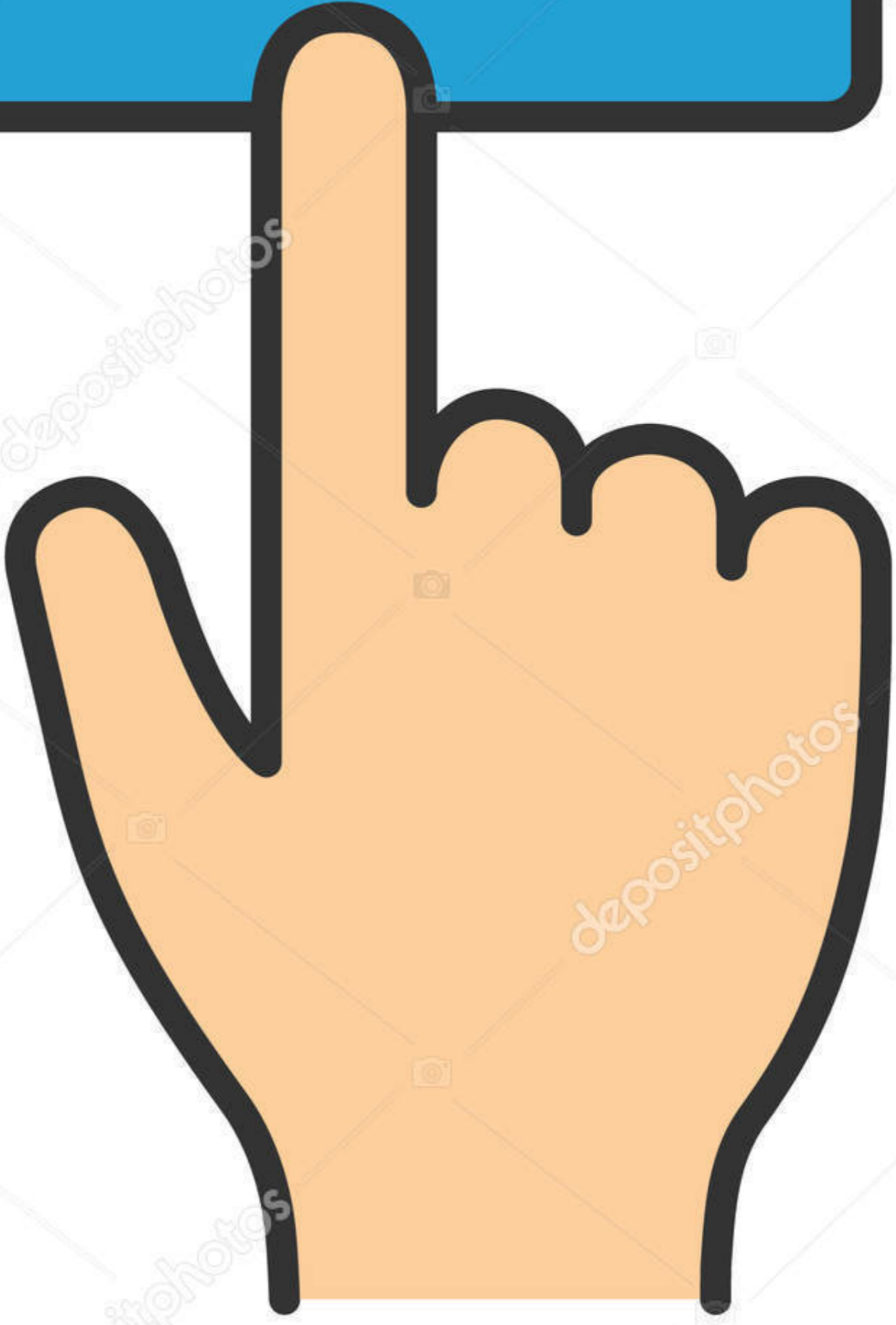
These data indicate that reinforcement steel quantities for MSE walls per unit area of wall face were approximately double that of the RE wall due to the presence of the transverse members. In terms of erection time, the MSE wall was found to offer a slight advantage.

In assessing the relative costs of the two systems used on the project, two key factors should be borne in mind with respect to the MSE installation. First, a subbase-quality backfill was used on both systems for the purpose of comparing response to load. The results of laboratory pullout tests referred to earlier indicated that a low-plasticity (PI<10) nonexpansive native material would have been satisfactory for the MSE installation. Also, the extremely low and relatively uniform steel stresses measured in the MSE installation indicate that No. 2 rebar (W5 wire) rather than No. 3 rebar (W11 wire) would have provided adequate tensile strength and a corrosion life equivalent to that of the RE strips. The use of No. 2 bars (W5 wire) would have resulted in a net reduction in steel quantity of 55 percent for the MSE project.

CONCLUSIONS

1. Horizontal pressure on the upper wall at location A (MSE system) and the RE wall at location B approximated the active Rankine state, which verified design theory.
2. The stresses in the MSE bar mats suggest a redistribution of stress in the reinforced soil mass and a uniformly low steel stress level at a maximum of 4 ksi as compared with the variable stress measured on the RE strips (9.3 ksi maximum). This is possibly due to the greater stiffness of the MSE system.
3. The extremely low and relatively uniform stresses measured in the bar-mat steel for the MSE system suggest that a 0.25-in-diameter rather than a 0.375-in-diameter bar would have been adequate for tensile strength and a corrosion life equivalent to that of the RE system.
4. Laboratory pullout tests suggest that MSE bar mats provide a pullout resistance that is greater than five times that of the smooth RE strips of the same surface area. These results also suggest that lower-quality backfill materials would be suitable for the MSE system.
5. Corrosion rates determined by corrosion probes buried in the backfill soil were somewhat questionable and provided a poor correlation to predicted soil corrosion rate based on Caltrans steel-culvert criteria.
6. Both the MSE and the RE systems performed satisfactorily.
7. The MSE system will require more steel due to the presence of transverse members but can apparent-

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