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NAVFAC DM-7.3
APRIL 1983

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SOIL DYNAMICS, DEEP STABILIZATION, AND SPECIAL GEOTECHNICAL CONSTRUCTION

DESIGN MANUAL 7.3

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
200 STOVALL STREET
ALEXANDRIA, VIRGINIA 22332

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CONTENTS

can result from sea floor movements. For further guidance, se
Wave-Induced Slides in South Pass Block 70, Mississippi Delta

3. SHALLOW FOUNDATIONS. The principles of design for shall[illegible] given in DM-7.1, Chapter 5, and DM-7.2, Chapter 4. Additional [illegible] must be considered for offshore structures include: prediction of skirt and dowel penetration at emplacement; resistance to overturning and sliding; instability due to scour; and pore water pressure build up due to construction procedures, cyclic loading, earthquakes; etc. For detailed design procedures see Reference 18, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, by the API, and Reference 19, Design and Construction of Dry Docks, by Mazurkiewicz.

4. PILE FOUNDATIONS. See DM-7.2, Chapter 5 for design of deep foundations. The loads carried by piles supporting offshore structures are many times those on land; working loads o n the order of 3,000 tons in compression, 1,000 tons in tension are quite normal. In addition, the piles must resist large lateral forces. The susceptibility of the foundations to corrosion should be considered, and appropriate precautions/compensation must be taken. In addition, see Reference 18 for methods of designing and installing piles.

Section 6. SPECIAL PROBLEM SOILS

1. SANITARY LANDFILLS.

a. Introduction. Sanitary landfills are becoming the major sites for solid waste disposal. The geotechnical engineer's role in solid waste disposal includes:

(1) Evaluation of physical and chemical material properties;

(2) Design and supervision during construction of disposal facilities;

(3) Monitoring of facilities during operation to ensure satisfactory performance; and

(4) Evaluation of potential land uses after completion of disposal operations.

b. Composition of Material. The engineering properties of sanitary landfill are largely influenced by the composition of the refuse. Reference 11 presents the results of numerous determinations of refuse composition.

c. Settlement Characteristics.

(1) Unit Weights. Table 3 (Reference 11) presents typical unit weights of municipal refuse.

(2) Subsidence of Refuse Fill Under Self-weight.

TABLE 3

Typical Unit Weights of Municipal Refuse

	Unit Weight (lbs./cu. ft.)	
	Total (γ_T)	Dry (γ_D)*
Household Trash Can	7	5
Delivery Truck	15	10
Sanitary Landfill: Not Shredded		
- poor compaction	20	15
- good compaction	40	28
- best compaction	60	42
Sanitary Landfill: Shredded	55	39
High-Pressure Baling (3500 psi)		
- during compaction	90	64
- after volume expansion	60	42
Complete Elimination of Voids	-	90

* Calculated for moisture content of 42% (dry weight basis)

Low Density Baler 30-35#/ft³ Big Spring

Transfer trucks (40yd) 26# (light dry) to 47# (heavy/very wet) NTMWD

Fill density 40.74#/ft³ NTMWD

(a) The following mechanisms can lead to surface subsidence:

(1) Movement of particles into large voids;

(2) Biological decomposition of organics;

(3) Chemical reactions, including oxidation and combustion;

(4) Dissolving of soluble substances by percolating groundwater or leachate;

(5) Change in deformation properties with time;

(6) Plastic flow or creep.

(b) The time-settlement relationship of subsidence under self weight is analagous to the secondary compression of soils after a short period of pseudo-primary (mechanical) settlement typically 1 to 4 months long. Measurements indicate a coefficient of secondary compression ranging from 0.1 to 0.4. Thus, settlement of the fill under its own weight after completion can be estimated by:

$$(\Delta H) = HC_\alpha \ \text{Log} \frac{t_2}{t_1}$$

where:

(ΔH) = settlement at time t_2 (length unit)

H = thickness of fill (length unit)

t_1 = time pseudo-primary (mechanical settlement) to occur after completion of fill

t_2 = time after completion of fill

C_α = coefficient of secondary compression (any mathematically compatible units acceptable)

(3) Subsidence of Refuse Fills Under External Loads.

(a) The time-settlement behavior of old refuse fills under an applied load is analagous to the behavior of peat. Primary settlements will likely occur as the load is applied. Secondary compression occurs over a long period of time and the amount of long-term settlement is determined by environmental conditions (i.e. humid environment is more conducive to decomposition) as well as the composition of the refuse. Reported primary compression indexes ($C_c/1+eo$) ranged from 0.1 to 0.4 and the coefficient of secondary compression (C_α) from 0.02 to 0.07. These values are for fills which have undergone decomposition for some time prior to loading (10 to 15 years, typically). Higher compressibility is usually associated with high organic content and/or advanced degree of decomposition.

d. Construction Over Sanitary Landfills. Any foundation investigation for a structure being built over a sanitary landfill should include the evaluation of the following potential problems:

(1) Differential settlement of floor slabs, walls, and utilities;
(2) Irregular subsidence due to highly variable composition;
(3) Corrosion of concrete foundations and pipe utilities;
(4) Generation of methane gas (see DM-7.1, Chapter 2);
(5) Slope stability;
(6) Effect of construction on leachate control.

e. Methods of Treatment for Foundation Support.

(1) Control and compaction during placement. Compaction and shredding of refuse as it is being placed in the landfill will greatly increase its suitability for later use. The typical unit weights of municipal waste presented in Table 3 give an indication of the reduction of voids and volume by such treatment.

(2) Proofrolling of fills and replacement of soft pockets with compacted soil will reduce irregular settlements.

(3) Use of surcharge fills where refuse is thick.

(4) Deep foundations founded below the refuse fills. If piles are used provisions must be made for the corrosive environment and possible damage during driving, as well as re-sealing any holes created in leachate cutoffs.

(5) Grouting of refuse fills to stabilize voids.

(6) Use of flexible connections for utilities.

Further guidance on construction over sanitary landfills is given in Reference 20, Design and Construction of Covers for Solid Waste Landfills, by Lutton et al., and Reference 21, Development of Construction and Use Criteria for Sanitary Landfills, by the County of Los Angeles and Engineering-Science, Inc.

2. COLLAPSING SOILS.

a. General. The distinctive characteristics, geographic distribution and methods of identifying collapsing soils are given in DM-7.1, Chapter 1.

b. Foundation Difficulties. The problem of sudden settlements results from the loss of capillarity, cementation, or bonding as water comes in contact with soil. Wetting may result from landscaping, leakage through water pipes, drains, and reservoirs.

The conventional methods of sampling, where water is used for cleaning bore holes, are unsuitable for collapsing soils. For shallow depths trim specimens manually from test pits. For deep sampling, use air for cleaning bore holes and obtain undisturbed specimens using thin walled tubes.