最適含水率附近で締め固めを行うことは多くの場合満足の結果をもたらすので，これに信頼し，放置して自然沈下の期間を設けずに鋪装等の仕上を行い資金の回転を促進するのが最近の傾向であるが，数多い工事のうちには，この結果粘性土等で鋪装後不等沈下が起り保守費を増大するような支障も起り，少くとも1年の仮路面仕上による交通荷重下の放置期間を設け，その後に本鋪装を行うべしとする論者[7]もある。またある鉄道築堤で[8]，盛土が塊状の粘性土であつたため，施工当時は上記のような近代的な示方を満足するよい結果であつたが，数年後土塊間に残存する微細な目を通じ雨水が滲透して土を軟化させ，遂に崩壊事故を惹き起した例もある。粘性土の取扱う際注意すべき点である。

以上を総合し土工処理上の要点を挙げると◎入手可能な土のうち良質のものを施工基面附近の上層に用い締め固め程度を築堤下部より高度に保つ。◎施工中常に排水を良好にするよう注意する。◎盛土撒布は締め固めを考慮した層厚に均等に行い，一地に堆積する方法を避ける。◎試験と経験に基づき締め固め方法，機械の撰定，使用方法を適切に行う。◎橋台，擁壁，暗渠等の構造物埋戻し土の締め固めには最大の注意を払う。

参考資料　1) E.E. Seelye: Data Book for Civil Engineers, vol. II, Specifications & Costs.
2) Bruce & Clarkeson: Highway Design & Construction, p.601　3) Armstrong: Soil Mechanics in Road Construction, p.125　4) Ritter & Paquette: Highway Engineering, p.326 等. 5) 資料 1), 2), 4) 等.　6) 資料 2) p.338
7) Effects of Base Compaction on Maintenance Cost & Performance, Bulletine, HRB. 1944.
8) ARER Bulletine 493, 1951, p.400

GRADING FOR RORDS, AIRPORTS, AND RAILROADS

I. Scope of Work.

Construction of embankments and grading shall be in accordance with the plans and specifications. (Specify any exceptions.)

II. Stripping and Spreading of Topsoil.

All topsoil shall be stripped from areas to be paved, excavated, or filled, and from other areas as shown on plans. If possible, specify depth of topsoil to be stripped. Topsoil shall be stored in stockpiles, the location of which shall be selected by the engineer or as shown on plans.

On areas shown on plans to receive topsoil, the subgrade shall be scarified to a depth of 2 in. for the bonding of the topsoil with the subsoil. Hand shoveling and raking will be required, followed by rolling with one pass of a flat roller weighing not more than 100 lb. per lin. ft. and not less than 25 lb. per lin. ft. On slopes steeper than 4 : 1 the topsoil shall be rammed or tamped in place as directed by the engineer.

Areas to be sodded shall receive 3 in. of topsoil: areas to be seeded shall receive 6 in. of topsoil.

III. Excavation.

Excavation shall conform to limits indicated on the plans or specified herein.

Excavation shall not be made below grade except where rock or stone masonry is encountered or removal of unstable material is directed by the engineer.

Material removed below grade shall be replaced with approved material thoroughly compacted or as otherwise directed by the engineer.

Excavated material suitable for embankments or fills shall be stored, if required, to minimize the use of borrow.

Borrow. Where required to complete the embankment or fill, the contractor shall provide the necessary additional material. The source and quality of borrow material shall be approved by the engineer.

The contractor shall give the engineer at least 5 days' notice before removing borrow material from any approved borrow pit.

Rock Excavation. Rock excavation shall include removal of ledge rock, concrete or masonry structures which require drilling or blasting, and boulders larger than — cu. yd. (varies with size of equipment used) in volume.

Ledge rock. boulders, concrete or masonry structures shall be removed to a minimum depth of — in. below subgrade and backfilled with approved material thoroughly compacted.

Rock shall be conserved if required for purposes shown on the plans, or for any other purpose, as the engineer may direct.

Drainage. Spring or seepage water encountered shall be reported to the engineer if drainage is not provided for by the plans. The contractor shall keep the excavation free from

water at all times by pumping or otherwise.

Excess or Disapproved Excavated Material shall be disposed of as directed by the engineer.

IV. Embankment and Fills.

Fills shall not be started untill the area has been inspected and approved by the engineer.

Embankment and fill material shall be free from frost, stumps, trees, roots, sod, or muck. Only approved material from excavation or borrow pits shall be used. Material shall not be placed on frozen ground.

Preparing Ground Surface. Sloped surfaces steeper than 4 : 1 shall be scarified or stepped and compacted to provide bond with new material.

When existing roadways are to be covered with less than 1ft. of fill the surface shall be scarified and compacted to the same density as adjacent areas.

When fill is to be placed over wet ground that will not support the weight of trucks or other equipment, the lower part of the fill shall be made with sand, gravel, or other selected material deposited in a blanket layer no deeper than necessary to support the operating equipment. Top 9 in. of blanket layer shall be compacted to required density before subsequent layers are placed.

Construction Methods. Excavated material shall be so handled, conserved, stored, and placed as to have the least desirable material at the bottom of embankments, grading up to the best material at the top.

Sandy Soils shall be placed in 4—in. to 6—in. layers and compacted with caterpillar tractor, tamping roller, or smooth-wheel roller weighing 8 to 10 tons.

Clay Soils shall be placed in 8—in. maximum layers and compacted with light tamping roller.

Glacial Till shall be placed in 8-in. maximum layers and compacted with heavy tamping roller.

The contractor may use other equipment if approved.

Places inaccessible to roller shall be compacted with mechanical or hand tampers.

Final rolling of top layer shall be with a smooth-wheel power roller weighing 8 to 10 tons.

Stones in earth fill shall be well distributed. No stones over 4 in. in diameter shall be within 12 in. of finished subgrade.

Each layer shall be free of ruts and shall meet compaction requirements before succeeding layer is placed. Layers shall be maintained with crown or slope to provide drainage and prevent erosion.

Rock Fill. In embankments or fills, rock may be any maximum size if uniformly graded. All void shall be completely filled with fine material and compacted to form a dense mass.

The fill for a thickness of at least 2 ft. below the finished subgrade shall be selected earth material placed and compacted in layers to the degree specified below.

Operation of Equipment shall be distributed to avoid rutting and unequal compaction.

Protection of Structures. Culverts, headwalls, and other structures shall be constructed before fills is placed. Fill around culverts, headwalls, or other structures shall be carefully and symmetrically placed in 6—in. to 8—in. layers and shall be compacted to the degree specified below.

V. Compaction Requirements. (Specify one of the following.)

Test-Controlled Compaction. (Use for large or important projects.) In construction of embankments and preparation of subgrades, all soils shall be compacted to 90% of maximum density at optimum moisture as determined by A.S.T.M. D-698, except that soils for a depth of 9 in. below pavement subgrades in both cuts and embankments shall be compacted to not less than 95%.

Soils which weigh less than 100 lb. per cu. ft. shall be wasted or mixed with heavier soils to obtain the required weight.

When material varies from optimum moisture content, it shall be treated as follows :

When wet it shall be drained or worked until optimum moisture content is attained. When dry it shall be sprinkled with water and mixed until optimum moisture content is attained.

Practical Control. (Use only where test control is not warranted by size or importance of project.) In construction of embankments and preparation of subgrades the soil shall be compacted with approved equipment. The soil shall be treated and worked so as to be damp but not wet.

If tamping rollers are used, 10 or more passes will be required on each layer as directed by the engineer.

When smooth-wheel power rollers weighing 8 to 10 tons are approved and used, the layer shall be rolled until no weaving or creeping appears ahead of the roller.

VI. Subgrade Preparation. (Specify one of the following.)

In cut areas the subgrade shall be scarified and compacted to 95% of maximum unit weight at optimum moisture for a depth of at least 6

in. See Paragraph V above.

In cut areas the subgrade shall be scarified and compacted for a depth of at least 6 in. by rolling with a 3-wheel power roller weighing 8 to 10 tons.

Rough subgrades shall be formed and compacted in accordance with the plans within a tolerance of $1^1/_2$ in.

Soft areas in subgrade shall be reinforced with crushed stone, gravel, or telford as directed by the engineer. These areas shall be drained as directed by the engineer.

Final rolling of subgrade shall be with 3-wheel power rollers weighing 8 to 10 tons.

Rough subgrades, including slopes and ditches, shall be formed and maintained to provide proper drainage.

VII. Fine Grading of Subgrade. (This item may be included as part of the contract covering the construction of the base course or pavement.)

Rough subgrade shall be cleaned of all loose or foreign material and reshaped if rutted. Approved material shall be added to meet required grade. Shaping and compacting shall be done with blade graders and a 3-wheel power roller weighing 8 to 10 tons. Soft spots shall be reinforced and drained as specified in Paragraph VI above.

Tolerances. Finished surface shall be smooth and even and shall not vary more than 3/8 in. in 10 ft. from true profile and cross section or more than 1/2 in. from true elevation.

VIII. Shoulder Construction.

Where trench method of construction is to be used for pavement, sides shall be cut to vertical face at proposed edge of pavement.

Shoulder material shall be placed in uniform layers for full width and thickness. Each layer shall be compacted by rolling. Roller shall overlap shoulder when rolling both base course and pavement. Finished shoulder shall be firm against pavement.

Drainage shall be provided for pavement subgrade at low points.

IX. Finishing Slopes and Surfaces.

All areas shall be finished to smooth, compact surfaces in conformity with the plans.

Slopes. Blade grader or scraper finish will or will not be allowed. Hand shovel finish will or will not be required.

Shoulder, Ditches, and Gutters. Hand shovel and raking finish will be required.

Maintenance. Finished work shall be drained and maintained in accordance with the plans until final acceptance.

X. Tests. (For test-controlled compaction see Paragraph V above.)

The contractor shall provide labor, material and transportation for the following tests and sampling. The engineer shall provide expert services and testing and sampling equipment.

Sampling. The engineer shall follow A.S.T.M. methods of sampling. (See "Data Book—Field.")

Laboratory Tests. Methods of test shall be the latest revision of the following:

	NUMBER OF TESTS
Dry weights when compacted A.S.T.M. D-698 at optimum moisture of various types of soil	As required to provide a control for moisture and density field tests.

Field Tests. (See "Data Book—Field.")

	NUMBER OF TESTS
Moisture content dry weight of compacted soil	At least one for every 500 sq. yd. on each layer, or sufficient number of tests to insure thorough and uniform compaction. Additional tests if soil or moisture conditions change.

Auger borings shall be made as directed by the engineer when there are indications of poor material underlying subgrade.

XI. Basis of Payment. (Specify that the contractor be paid at unit or lump sum price called for in the contract.)

Give work included and excluded under this price or give method of measurement.

If unit price, itemize price units.

If lump sum, itemize basis of payment for extra work including the following items:

Price per cubic yard for earth excavation.
Price per cubic yard for rock excavation.
Price per cubic yard for borrow.
Price per cubic yard per 100-ft. station for overhaul
Price per cubic yard for placing topsoil.
Price per square foot for sodding.