CONSTRUCTION INSPECTION

EXCAVATION AND EMBANKMENTS

EXCAVATION:

Under Section 203 of the 1995 Specifications, details of earthwork operations are described. These operations basically involve 3 operations: topsoil removal, cut and fill.

Topsoil is removed from areas shown on the plans or as noted in the proposal and indicated on the cross sections. If the final grade is less than six feet from the original ground, the topsoil will be removed and placed in appropriate stockpiles or removed from the site. Since topsoil is not suitable for normal embankment construction, it will usually be stripped from both cut and fill areas, and placed in stockpiles for use when landscaping the highway. These stockpiles must be placed within the right-of-way in piles greater than 4 feet high, containing at least 200 cubic yards. They should be neat and shaped to prevent ponding of water.

During the topsoil stripping operations, the inspector must insure that the contractor only removed topsoil and not the underlying soil. The depth of stripping should be shown on the design cross sections. The engineer-in-charge and the Regional soils engineer should be contacted before the contractor is permitted to strip beyond the depths shown in the cross sections.

EMBANKMENTS:

The area which the embankment is built upon is known as the embankment foundation, from which all unsuitable material shall be removed before construction of the embankment is started. Unsuitable material is defined as: organic muck, peat, humus, roots, and other objectionable materials, as directed by the engineer. These soils are unsuitable because they will cause objectionable settlements due to their high moisture contents, and because they usually have low strength properties.

If the unsuitable material is removed from the embankment foundation, and the new foundation is under water, then filling with acceptable granular material shall be accomplished.

By granular is meant a soil composed of sands and gravels, and not silts and clays. Silts and clays would only become plastic and unworkable if placed under water. The granular item and its composition (sieve analysis) will be shown on the plans or noted in the specifications. This sand and gravel mixture must be tested to verify conformity with the specifications.

When the embankment foundation area is cleared, the area shall be rolled until the underlying soil is thoroughly compacted to the satisfaction of the engineer before any construction of the embankment is begun. Now that the embankment foundation is prepared, actual embankment operations can be started. Only suitable soils shall be used in the embankment construction.

Suitable soils include sands, silts, clays and gravel. These suitable soils may be too wet in their natural condition, which would make them unstable; especially the fine grained soils (silt and clay). If the soil is too wet, the moisture content can be lowered by added and thoroughly mixing dry soil into it, or by aeration of the wet soil. Aeration can be accomplished by use of a disc, harrow, or by blading with a bulldozer or motor grader. Aeration is best done on dry, sunny, windy, hot days. Soil which is too dry can be modified by adding water, either from a hose, water truck or other approved means. The moisture content is critical for proper compaction. In fact, no amount of compactive effort will bring a very wet soil up to specifications. The soil shall be placed in layers. Stones less than 2/3 of the loose lift thickness can be incorporated into the embankment as shown. See Sketch 1.

Stones or boulders greater than 2/3 of the loose lift thickness are not permitted due to the difficulty of compacting around them.

Particular attention must be paid to the top of the embankment in what is known as the subgrade area. This is the zone that gives direct support to the pavement. The subgrade area is defined as the cross sectional area with top dimension equal to the width of pavement plus one foot on each side, and with sides sloping downward on a 1 on 1 slope to a depth of two feet below the bottom of the subbase course or to the embankment foundation, whichever is higher.

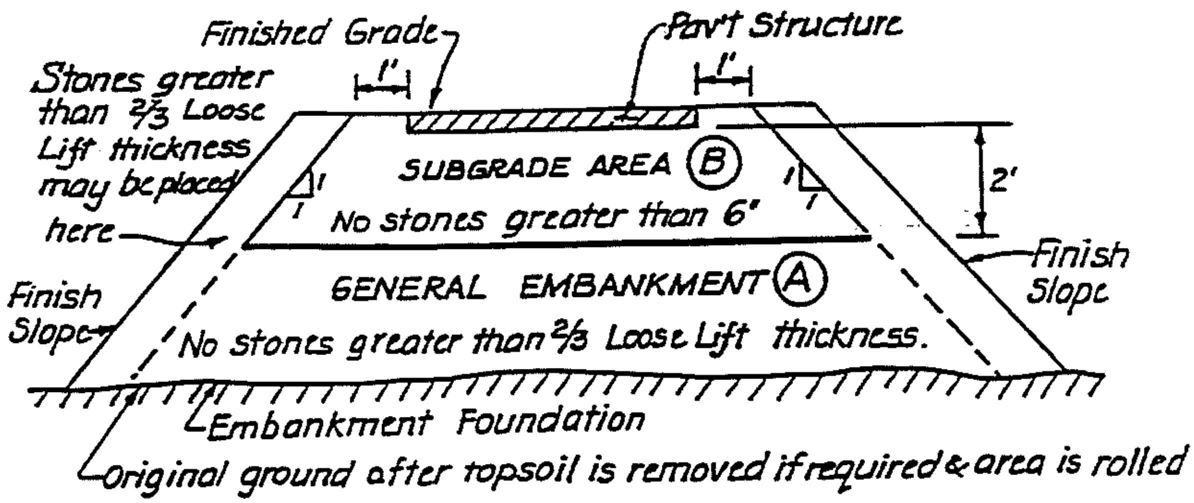
Keeping the thickness of the layer being placed within specifications is very important. This is constantly a point of friction with the contractor. He is attempting to produce as much embankment per hour as possible and his output will increase as he increases the thickness of the lift being placed. The inspector should not be conned into believing that the same result would be obtained by placing a thicker lift and running over it with more passes or using heavier equipment. In the same vein, the contractor should not be permitted to use under-weight equipment if he promises to go to thinner lifts.

Another point - the specifications state, "Any equipment not principally manufactured for compaction purposes...shall not be approved or used." Don't let the contractor tell you rollers are not required because his trucks are heavy or that his loaders give enough compaction.

The contractor must not be allowed to start embankment operations until he has the proper compaction equipment on the job site. All compaction equipment must be marked by means of an identification plate or other approved means, indicating:

1. Name of the manufacturer
2. Model number
3. Serial number

as a minimum.



SKETCH 1

TYPICAL EMBANKMENT SECTION

Compaction Requirements
Percent of Maximum Density

AREA	GENERAL EMBANKMENT	ROCK FILL EMBANKMENT
GENERAL EMBANKMENT (A)	90%	90%
SUBGRADE AREA (B)	95%	95%
MAXIMUM THICKNESS OF LIFT BEFORE COMPACTION	SEE SPEC.	MAXIMUM THICKNESS NOT TO EXCEED SIZE OF ROCK IN NO CASE GREATER THAN 2 FEET.

TABLE 1

This means of identification shall be permanently attached to the machine and shall be legible at all times. Proper compaction of the embankment is an operation with which the inspector must be intimately familiar. Not only must the embankment be compacted to the proper density, but it must be uniform and have the proper moisture content. The desire for uniform compaction should be obvious, because variable densities will yield variable pavement support conditions.

Compaction has been defined as "The practice of artificially densifying the soil mass by rolling, tamping, vibrating or other means." When a soil mass is compacted, its physical properties are altered. The bearing and shear strength area increased; the resistance to the passage of water is increased and the possibility for volume change, shrinkage and swell are decreased. The resistance to frost action is increased and the possibility of differential settlement is decreased.

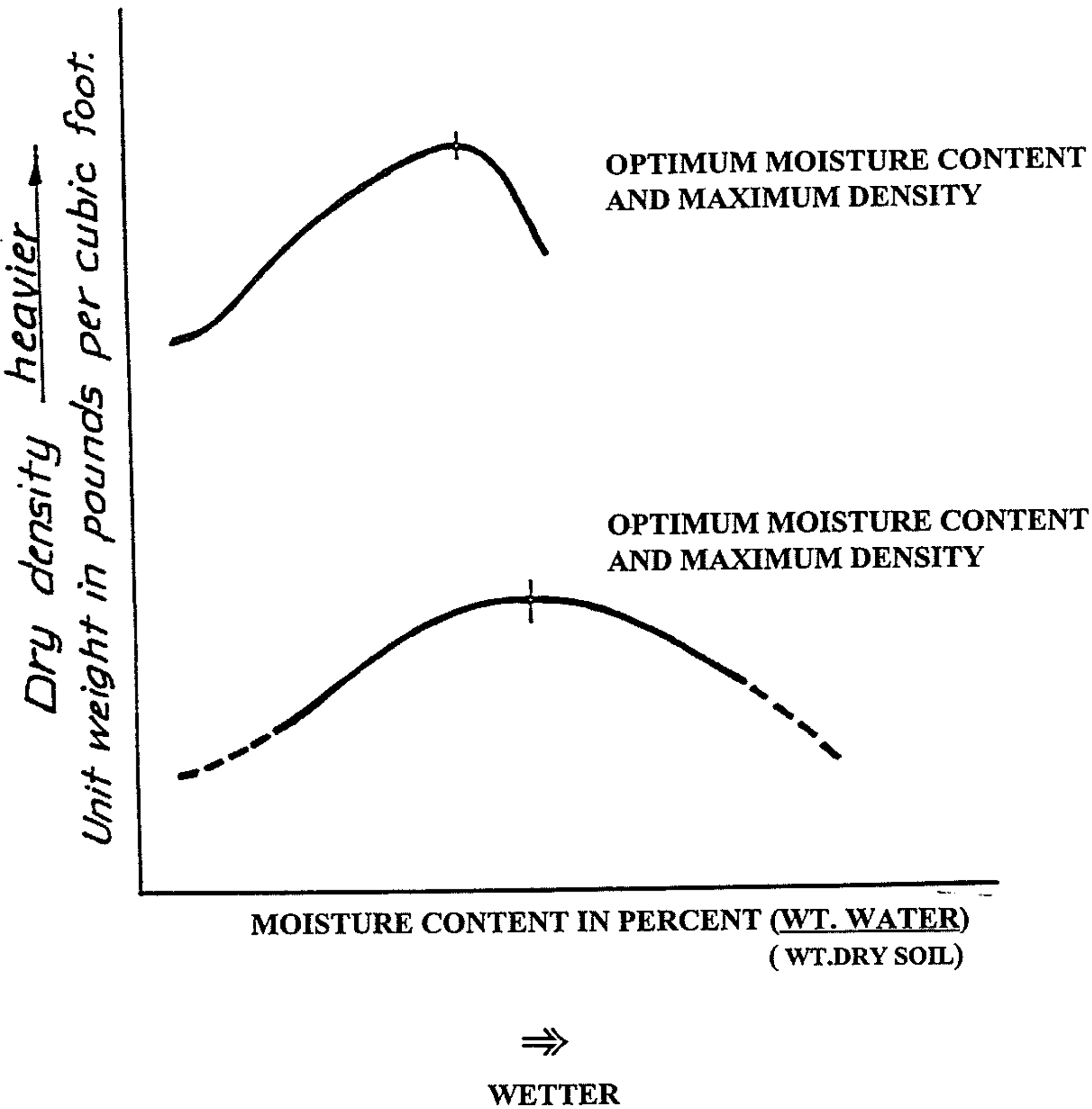
In the compaction process, we seek to reduce the volume of voids in the soil mass. By applying compressive or vibratory force to the soil particles, we can drive these particles closer together. These compactive efforts are resisted by friction of the individual particles rubbing against each other. As more water is added, friction is reduced and less effort is required to obtain a specified density. Beyond a point called the optimum moisture content, the water fills the voids and keeps the particles apart. It is obvious that soils should be compacted at or near this optimum content. As can be seen in Sketch 2, the same difference in moisture content in a silt-clay mixture will produce a much larger difference in density than the same moisture content difference will produce in a sandy soil. This explains why moisture is more critical in a fine-grained soil than in a sandy soil.

Density is measured in the field by the sand cone method. The sand cone is a device which measures the volume of the hole dug for the compaction test from which the density is computed. For details of this test, see Bureau of Soils Mechanics Soil Test Method STM-9, Test Method for Earthwork Compaction Control by Sand Cone or Volumeter Apparatus.

COMPACTION EQUIPMENT:

The results achieved in compacting soils are dependent upon the type of equipment and the methods used. Equipment suitable for one type of soil may prove inefficient for another type.

There are several types of compacting equipment - each with different characteristics and advantages. Restrictions on the contractor's method of operation vary with each category of equipment, with each manufacturer in that category and with each model of that manufacturer. The thickness of lifts, number of passes, speed of the machine, etc. all vary from one machine to another. Therefore, the inspector must be thoroughly familiar with the detailed provisions of the compaction specifications.



TYPICAL MOISTURE DENSITY RELATIONSHIP for DIFFERENT TYPES OF SOIL

SKETCH 2

Sheepsfoot or tamping rollers will prove best for silty-clayey soils. The tamping foot is able to penetrate the top crust formed by these soils and to compact the lower portion of the layer.

As the soil is compacted, the sheepsfoot roller will appear to “walk out” of the soil; that is, to ride higher on the fill. This does not always indicate properly compacted soil. Walking out may occur with low densities if the layer is too thick, the foot pressure is too low, or the soil is too dry.

By penetrating into the soil layer, the sheepsfoot also provides aeration which is often required for silt clay soils.

If, on the other hand, the roller continues to sink into the soil, the cause may be soil which is too wet or contact pressure which is too high.

While sheepsfoot rollers are best for cohesive soils (silts-clays), they are not the only type which can be used.

Recently, equipment manufacturers have produced rollers with vibratory tamping feet. They are good in the silt-sand-clay mixtures.

Vibrating drum rollers are used to compact sands and gravels. In fact, the best type roller for compacting sands is a vibrating smooth steel wheel roller. The vibration tends to shake the particles together since there is not much cohesion between sand grains.

When these rollers are used, the contractor must furnish the inspector a vibrating reed tachometer. It enables the inspector to measure the vibrating frequency which determines the dynamic force in the soil. Do not allow the compaction with vibrating equipment to begin until you have been furnished a tachometer.

The actual construction of embankment requires more than just checking compaction equipment. The soil must be properly dumped and spread. The various haul units, such as end dump trucks, bottom dump wagons and scrapers, have individual characteristics on embankment construction. Trucks which dump in piles may cause a problem if many loads are dumped in the same area. A dozer or grader is used to spread the material out so that the layer will not be thicker than specifications allow. Trucks also tend to rut the embankment surface. This rutting can be minimized by passage with a grader or a dozer.

In cases where large earthmoving equipment is used, a great volume of soil may be brought to the fill site faster than the spreading equipment can spread it into a proper size layer. This can be remedied by using additional spreading equipment. Each layer must be rolled with a minimum number of passes before the next one is placed.

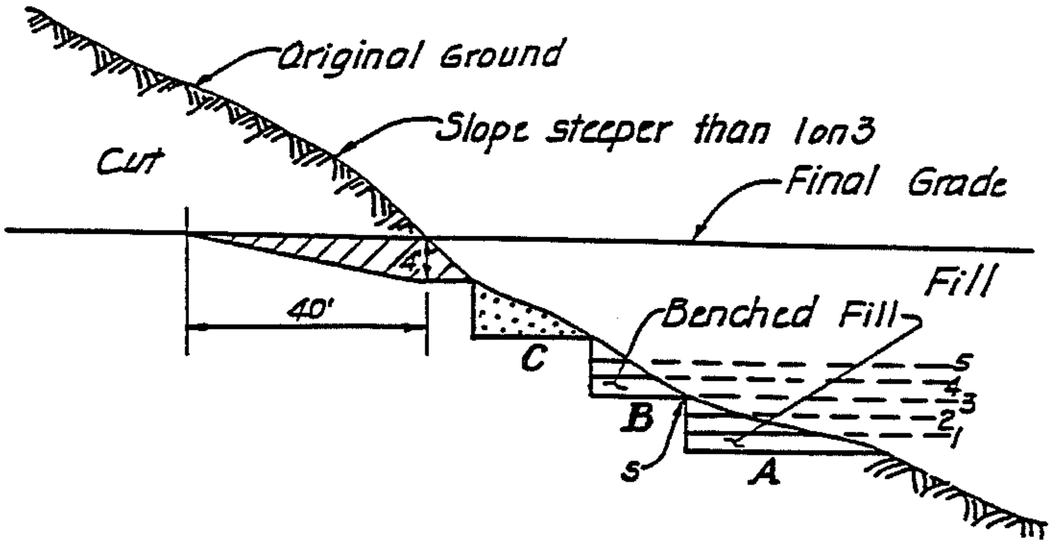
Throughout this earthwork operation, the contractors must be careful to shape their work area so that water does not pond. There cannot be too much emphasis placed on this subject. A properly formed embankment can be ruined by rain if it is not properly shaped and ditched. If an area is properly shaped and rolled with a smooth wheel roller, most rain will run off where it will not harm the embankment. If not shaped and sealed, rain will soak into the grade, softening the soil. Passage of equipment will cause rutting which aggravates the situation. More water collects and a soft spot develops. Ditches may be required to carry the water off and away from the grade, and are critical in cut areas. Without proper ditches in cut, the grade can become a lake. If the contractor does not protect his site from excess water, he will be burdened with the expense of aerating the area to dry it out. NO additional layer can be placed until the condition is correct.

BENCHING:

Whenever embankment is to be constructed on a hillside, or placed against existing embankment, the slopes of which are 1 vertical on 3 horizontal or steeper, the slopes shall be benched as the fill is constructed in layers.

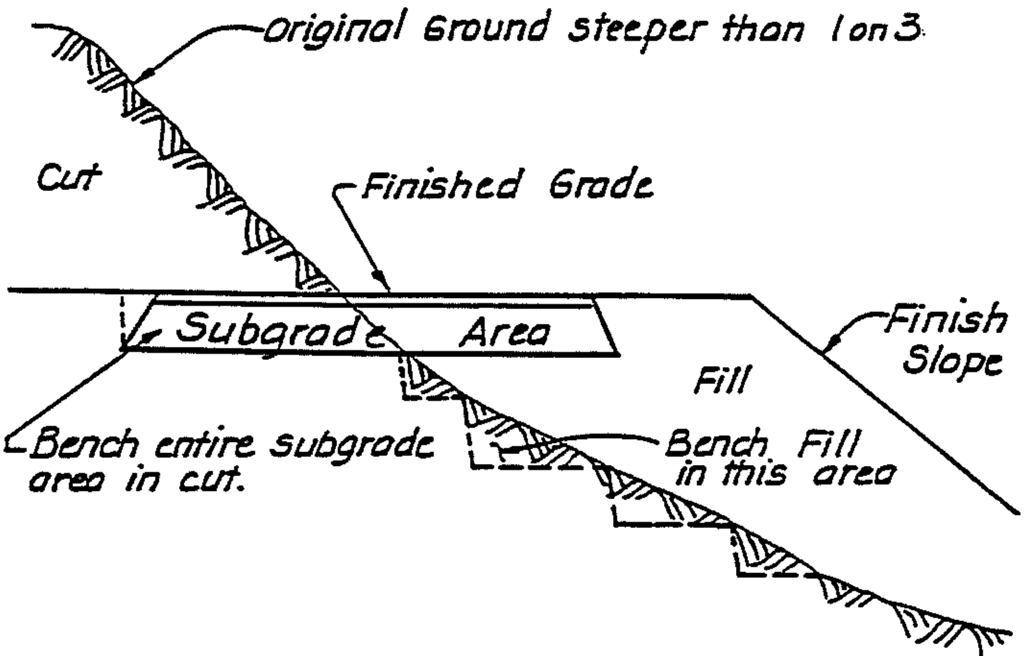
Benching is necessary because proper compaction is difficult at this steep interface. The volume of the soil removed for the benching operation must be measured for possible payment.

A typical benching section is shown in Sketch 3. The bench at "A" is cut first with vertical side on the left, then layer (1) is placed and compacted up to the vertical face.



TYPICAL LONGITUDINAL BENCHING SECTION

SKETCH 3



TRANSVERSE BENCH SECTION

SKETCH 4

Next layer (2) is placed and compacted, and so on until Point "S" is reached. Then bench "B" is made and layers (4)(5)... and so on are placed.

In this manner, the compaction equipment, which operated perpendicular to the horizontal grade line, never need contend with a steep grade. If the subgrade foundation changes from cut to fill transversely, and the slope of the existing ground is 1 on 3 or steeper, the existing ground slope shall be benched to an elevation 4 feet below the bottom elevation of subbase course for the width of the subgrade area. See Sketch 4.

PROOFROLLING:

When the subgrade is completed, the contractor will be required to proof roll the entire top surface of the subgrade with a pneumatic tire roller.

The gross weight of the roller and tire pressure vary depending on the classification of the soil being compacted.

The standard specifications provide a guide for selecting those requirements in both cut and fill sections.

By rolling over the subgrade with this heavy roller, weak spots can be found and corrected.

The inspector must watch the reaction of the subgrade as the roller moves over it. At this point, there is no substitute for experience.

The roller will react quite differently with different types of soil and moisture content. Naturally, if the roller bogs down or ruts, something is wrong. Remove the weak area, replace it with suitable soil properly compacted, and continue rolling until no depressions develop. The roller used for this operation must be checked to see if it weighs at least 50 tons.

The tire size, type and pressure must be verified. Pressure is determined with a gauge that can read at least 130 p.s.i. A lower tire pressure or underweight roller will not be efficient in finding weak spots.

During the rolling operation, the roller should not be allowed to pass over any buried pipe or conduit unless there is at least 5 feet of cover over the pipe. If this precaution is not observed, the pipe or conduit may be crushed.

Two complete passes of the proofroller area required. When the proofroller is complete, the surface of the subgrade shall be finish-rolled with a smooth wheel 10 ton roller. This smooth surface is now checked to see if it falls within tolerance allowed for the subgrade item.

ADDITIONAL INFORMATION:

A more comprehensive description of procedures for embankment construction is contained in the Soils Engineering Manual SEM-12/87, "Guidelines for Embankment Construction."

DRAINAGE

WHY DRAINAGE?

Water in one form or another on or beneath the road surface is the greatest enemy to a stable and permanent road structure. The problem in drainage is to provide construction which will expedite the removal of surface and subsurface water without introducing unnecessary hazards to traffic. In providing for highway drainage, consideration must be given to three distinct groups of problems:

1. The satisfactory disposal of precipitation (both rain and snow) from the roadway section.
2. The elimination and control of subsurface water which can cause softening of embankments, loss of bearing power or frost action in the subgrade, and erosion or sliding of cut slopes and embankments.
3. The spanning of streams and other natural or man-made drainage channels.

HOW IS DRAINAGE ACCOMPLISHED?

Drainage structures may be divided into three general classes:

1. Surface drainage structures
2. Under drainage structures
3. Cross drainage structures

Surface drainage structures, such as side ditches, catch basins, drop inlets and their connection pipes, are used to carry water from the roadway surface to its point of disposal.

Under drainage structures, such as pipe or stone under drains, are used to take water away from the pavement subgrade. They are required when the ground water must be lowered or when there is seepage from springs or side hill cuts.

Cross drainage structures, or culverts, are used to carry water through the highway embankments. This would be water from intercepted streams or ditches. Culverts can be masonry or pipe (reinforced concrete, clay or metal). Any bridge with a span of 20 feet or less between abutments is classified as a culvert.

As mentioned before, the disposal of water is an important part of any highway project; therefore, the construction of a satisfactory drainage system is of the upmost importance.

Because the major portions of most drainage systems are buried, drainage work is susceptible to corner cutting. It may be a year or two or three before any trouble shows up. By that time, reconstruction could be very expensive and difficult to effect. There are many details that must be attended to in order to get a good tight drainage job. Many of these details would be unattended if left uninspected.

The design of a drainage system is not within the scope of this text, which will get into the practical construction aspects of drainage installation.

First, of course, the drainage structure must be laid out. The following is a brief rundown on usual procedures for laying out pipe lines, basins, etc., so that as a drainage inspector, you will know what to expect.

GRADE

STRUCTURE:

The drainage structure is installed before the pipe. Set the structure using two offset points with invert grade. The elevation of the structure bottom is determined by taking invert elevation and subtracting the thickness of the pipe and the thickness of bottom slab from it.

PIPE:

The elevations for all pipes are given on the plans as the invert elevation at every structure. Between structures, there is a straight and true rate of grade; therefore, an elevation may be computed for the pipe invert at any given station.

Most drainage excavations require sheet piling. Sheet piling serves two purposes: either to protect a structure or pavement from collapse, movement or undermining when excavation is done nearby, or to protect workers inside the trench.

Safe operation sheet piling is used to insure the safety of workers and the public exposed to the hazard of falling or sliding material. Details of this sheeting must conform with the requirements of Title 29 Code of Federal Regulations, Part 1926, Safety and Health Regulations for Construction (OSHA). Currently, this sheeting must be used if the depth of excavation is greater than five feet.

LAYING DRAINAGE PIPE

After the sheeting is in final position, placement of pipe can begin. Our specifications state, “All pipe shall be laid in reasonably close conformity to line and grade and shall have a full, firm and even bearing at each joint and along the entire length of pipe.

Pipes must be laid in reasonable close conformity to line and grade with bells upstream for a number of reasons:

1. Good line is required to prevent clogging. Excessive bends in either a storm or sanitary sewer invite debris to lodge at the bends, thereby causing internal obstructions. Most pipe joints are designed to be tight when the spigot fits into the bell in a straight line. By introducing unnecessary bends in the line, the pipe joints are necessarily weakened, both in strength and water tightness.
2. True grade is necessary for the same reasons as good line and also to carry the run-off in the right direction.
3. Bell ends are placed upstream for the following reasons:
    a. Water flowing from the spigot toward the bell will tend to keep the joint tight because of the slope of the pipe and the weight of the water flowing in the pipe.
    b. By placing the bells upstream, the joint with its caulking is behind the area where spigot meets bell and, therefore, any slight opening in the joint will have little or no effect on its water tightness. With bells downstream, the water is actually working against the joint and in time could loosen and destroy its water tightness.

SETTING GRADE

LASER METHOD:

After the structure has been installed, the elevation is taken off the top of the bottom slab of the drainage structure to establish the grade of pipe invert. The laser is set up on top of the bottom slab to the elevation of the middle of the pipe to be used. This will enable the laser to emit light through the center of the pipe. The grade of the pipe is programmed into the laser. Only when the laser is set and light is emitted is the pipe ready to be placed (laid). The trench is excavated with a backhoe, or similar digger, to a few inches above the invert of pipe. This can be checked constantly because the laser is emitting light constantly. As with structures, teeth should be removed from the excavation machine to prevent undercutting.

PIPE BEDDING:

See Sketch No. 8. What is its significance and importance? All too often drainage pipe is placed in the ground without proper grade and even blocked up with wood or brick when the subgrade is off. A look at tables showing how supporting strength of pipe is affected by bedding would immediately bring home to you the significance of proper bedding. The following example is taken from Seelye'sDesign Handbook.

SEALING JOINTS:

Pipes of smaller diameters are usually made of concrete with bell and spigot type joints. Preformed elastomeric sealers are installed in a groove in the spigot. If the clearance between the spigot end and bell end is so great as to render the sealer ineffective, then the joint must be caulked with oakum and cement mortar. Oakum, which is the closely twisted fibers of hemp or jute containing a small amount of coal tar as a binder, is laid in a bed of mortar in the lower part of the bell so that the entire annular space is filled. After the pipe laying has advanced some 4 or 5 lengths, oakum is placed into the rest of the joint with a caulking tool, taking care not to dislodge the alignment of the pipe. The annular space in the bell is then filled with mortar and the inner surface of the pipe at the joint is brushed smooth. If other types of caulking compounds are to be used, you should refer to the manufacturer's instructions for the proper method of installation.

Pipes of large diameters are usually made of reinforced concrete with tongue and groove type joints. Flexible water-tight elastomeric gaskets must be used. They fit in an annular groove. Vitrified clay pipes that carry sanitary or combined sewage will require special sealers. The installation of these sealers must be accompanied in accordance with the manufacturer's instructions so as to insure a satisfactory joint.

PIPE BEDDING:

The standard sheets show various bedding details for different soil conditions and different types of pipe. For most round pipe in stable soil, the bedding depth is equal to one-tenth the outside diameter of the pipe. The bell end of pipe is shaped deeper to allow the pipe to be fully bedded. Each pipe is then "sent home" with a long steel bar. Pipes must be laid true to line and grade with bell upstream.

The inspector should inspect every pipe being used and should number the pipe before the pipe is lowered into the trench. This way he can always check himself as to how many lengths of pipe are placed. By checking pipe ahead of time, the inspector can reject pipe which is damaged during handling and transportation to job site. A New York State Department of Transportation booklet entitled, "Materials Method 1, Quality Assurance Procedure for Concrete Pipe Items," provides criteria and includes sketches for rejecting damaged concrete pipe.

BACKFILLING TRENCHES:

The contract plans may specify that a selected granular material be used for a portion of the trench backfill, usually the backfill surrounding the pipe. This material will generally be brought onto the job site from an approved source and will be subjected to gradation testing by the soils inspectors. The major portion of the trench, however, will be backfilled with material existing on the job site. It is the replacing and compaction of this material that will require constant inspection to insure a properly compacted trench.

COMPACTION EQUIPMENT AND METHODS:

The types of compaction equipment used in highway construction are many and varied. They vary in shape, size and method of compaction. The choice of compactor to be used will depend upon the maneuverability requirements of the fill or backfill and the type of soil being laid. Thus, the choice of large type fillers ordinarily used on embankments are eliminated for trench backfill because they are too big to fit in a trench and they are forbidden by specifications to be used within 5 feet of the centerline of any drainage structure. The choice then narrows down to the use of smaller manually controlled “tampers” powered by gasoline engines. A further choice must be made among these tampers depending on the type of material being used in the backfill.

Any tamper that meets the qualifications set by the specifications and must be tested in the field to determine its efficiency. This evaluation is made on the basis of compaction tests taken during the use of such equipment. The specifications mandate that layers should not be greater than 6 inches prior to compaction and that a minimum of 95 percent of Standard Proctor Maximum Density be obtained. From this criteria and the compaction tests, the number of passes required may thus be determined.

DRAINAGE INSPECTOR’S CHECKLIST

BEFORE GOING ON INSPECTION:

1. Read the specifications and proposal and study the plans so that you know what your job entails and how your job fits into the overall picture.
2. Ask your engineer-in-charge for any special instructions he might have.
3. Know what the payment units and measurements are so that your daily report will be accurate and comprehensive.
4. If there is anything you do not understand, ask your engineer-in-charge for clarification.

PIPE LINES:

1. Check the survey work whenever possible. Be sure to check grades often, especially at manholes and catch basins.
2. If sheeting is required, check for good workmanship.
3. Check pipe bedding (VERY IMPORTANT).
4. Be there when the pipe is being placed and check the measurement from string line to pipe invert frequently.
5. Check the sealing process very closely.
6. Check for proper backfilling procedure.

BITUMINOUS PAVEMENT

THE ENGINEER AND THE CONTRACTOR:

Since the contractor and the engineer are both very much involved in the placement of a bituminous pavement, it is essential that there be maximum cooperation between the two. Each should recognize the position of the other. The engineer, as a representative of the traveling public, has the responsibility of seeing that a high standard of workmanship is accomplished and that each phase of the construction meets the specification requirements.

Because it is not practical to extend the specifications into minute details, it is desirable that, before construction begins, the engineer and his inspectors confer with the contractor's superintendent and foreman to discuss and review the plan of operation. Some of the things that should be discussed are:

1. The giving and receiving of instructions. The contractor should have a responsible foreman or superintendent available at the operation at all times. The inspector should only give instructions to these men. The engineer-in-charge should keep the inspector informed of any instructions he might give regarding the paving operations.
2. Continuity of Operations - Good riding qualities are easier to obtain in a continuous operation than in a start-stop operation. Any mix in or under the paver cools in proportion to the delay, making it difficult to roll to the same density as that placed at the correct temperature. Efficiency suffers also, when the paver stops and equipment and labor are idle. The contractor and the engineer-in-charge should determine the number of trucks that will produce maximum efficiency.
3. Method of Spreading - Which method will give the best job?
4. Number and Types of Rollers - This is spelled out in the specifications. Generally, a combination of vibratory and steel wheel, or steel wheel and pneumatic-tired rollers are needed. This will vary, depending on the rate of placement.
5. Width of Spread - The longitudinal joint should fall six inches from the underlying joint.
6. Rejection of Mix - The engineer-in-charge should inform the contractor of possible reasons for rejection.
7. Direction of Paving - The contractor should submit a paving plan to the engineer-in-charge for approval.
8. Maintenance of Traffic - This is especially important in reconstruction projects. The plan should be worked out in every detail and all signs should conform to the Traffic Manual.
9. Opening to Traffic - This should be agreed upon before construction begins, to avoid conflict later on.

INSPECTOR’S CHECKLIST

SUBGRADE OR SUBBASE:

This is probably the most important factor in determining if you will get a smooth riding job. The following items should be checked before paving:

1. Have all the courses of the foundation been compacted to the required density?
2. Has the subbase been proof rolled (if required)?
3. Have all depressions been filled and compacted?
4. Is the subbase dry and thoroughly clean?
5. Has the subbase been shaped as per plan?

HAULING EQUIPMENT:

1. All contact surfaces of truck bodies should be clean and smooth, and free from cracks and holes.
2. All loads should be covered with canvas or tarpaulin. When the temperature is near the minimum, the sides of steel-bodies vehicles should be insulated.
3. The inside surfaces of the vehicles should be coated with a mild lime water and soap or detergent solution before the vehicles are loaded. After the truck has been coated, the truck bed should be raised so the excess can drain out.
4. The truck should be able to back up to the paver without its frame touching the paver, and the truck bed should not bear down on the paver while dumping. Rough pavement will result if either condition exists.
5. The mixture should be delivered within the tolerance allowed in the specifications. A good workable temperature for top course asphalt is 275°F.
6. No loads should leave the plant if the weather will hinder proper placement. The engineer-in-charge should have an understanding with the contractor and plant inspector regarding the weather situation. If it has rained the previous day, or rain is predicted, the contractor’s superintendent should be on the job before trucks are scheduled to leave the plant to make the final decision. The specifications require that the mix be laid on a dry pavement.

PAVER:

Most pavers consist of two units, the tractor unit and the floating screed unit. The tractor unit provides motive power through crawlers or pneumatic tires traveling on the road base. The tractor unit includes the receiving hopper, distributing augers or spreading screws, power plant, transmissions, dual controls and operator’s seat. The screed unit is towed by the tractor unit and it consists of the screed plate, vibrators or tamper bars, thickness controls, crown control and screed heaters.

The following points should be checked before paving and periodically thereafter:

1. Check the governor on the engine for proper operation.
2. The slot feeders in the hopper and the spreading screws should be checked for excessive wear and proper operation.
3. On pneumatic tired machines, check the air pressure in the tires against the manufacturer's recommendations.
4. On crawler mounted machines, make sure the crawlers are snug.
5. The self-dumping hopper should be actuated after every few loads to prevent accumulation of cold mix at the hopper sides.
6. Check the crown adjustment on the screeds. Both leading and trailing edges can be crowned independently. The leading edge should always have slightly more crown than the trailing edge to provide a smooth flow of material under the screed.
7. Check the screed heaters for proper operation.
8. Inspect the tamper bars or vibrators for any defects.
9. If more than a one foot extension is placed on a vibratory screed, additional vibration must be added to the screed.
10. Newer model machines are equipped with variable width screeds. The screeds allow you to pave at widths up to 13'-6" with vibration. When paving greater than 17 feet wide with automatic screed control, a reference shall be used on both sides of the screed.
11. The screeds, receiving hopper, feed bars, spreading screw, etc., should be clean.

AUTOMATIC SCREED CONTROL:

This unit, which is required on most jobs, automatically adjusts the screed track and increases or decreases the thickness of the material being placed to compensate for irregularities in the underlying material. The five main components are a sensor, a pendulum, a control box, a command panel and motors to change the screed tilt.

1. Make sure the contractor has trained personnel to operate the automatic screed control.
2. The contractor must have sufficient string line and/or a thirty foot long ski.
3. Check the string line for line and grade. Make sure it is taut.
4. A short ski (shoe) may be used after the first lane is completed.
5. Constantly check that the sensor unit has not fallen off the string line or ski.
6. If the slope of the pavement is to change, make sure the necessary adjustments are made to the unit.

ROLLER EQUIPMENT:

1. Steel Wheel Rollers
    a. Check the total weight against the specifications.

b. Check the weight per inch of width against specifications.
c. With a sharp metal straight edge, check the wheels for wear. If grooves or pits have worn into the rolling surface of the wheel, the roller should not be used.
d. Make sure the roller can start, stop and reverse smoothly. A roller that has a jerky reverse causes the wheel to spin and makes a depression in the asphalt.
e. The scrapers an wetting pads should be checked for wear and proper operation.
f. Check the sprinkler system for proper operation.

2. Vibratory Rollers
   a. Check the Approved List Manual for Manufacturer and Model.
   b. Check the Approved List for vibrations per minute (VPM) and amplitude setting.
   c. Have the contractor supply a vibrating reed tachometer to check VPM setting.
   d. Check that the roller speed in an allowable vibratory mode is 2.5 miles per hours or 220 feet per minute. Never should a roller in the vibratory mode exceed 2.5 miles per hour. Non-vibratory speed is 3.0 miles per hour maximum.

PLACEMENT:

1. Make sure the screed is heated before starting.
2. When the truck is dumping, its wheels should firmly contact the truck rollers of the paver. If a truck is skewed, the spreader tends to skew causing irregular joints.
3. The mixture should be spread to a loose depth that will produce the specified thickness A rule of thumb is 1.25 times the desired compacted thickness, but it is not unwise to allow the foreman to set the paver at the start of work. You can check his setting after the roller has made its first pass. Do not keep changing the adjustment of the paver as this will give a rough riding job.
4. The amount of material ahead of the screed should be kept uniform. Variation may cause surface roughness.
5. Check the thickness of the course as soon as possible.
6. Determine the yield after first the load is placed.
7. Loosen material that clings to the side of the hopper and push it into active mix.
8. Avoid excessive hand-raking behind the paver.
9. The contact surfaces of all curb, gutters, manholes and of adjacent pavement edges should be painted with bituminous material before placing the course.
10. Test the surface with a 16 foot straight edge or string line placed parallel to the centerline. Variations exceeding one-quarter inch should be eliminated. A 10 foot straight edge or string should be used transversely. The surface should be checked immediately after initial rolling, so that corrections can be made while the mix is still hot. If the surface has cooled and corrections are needed, have the contractor remove the section full depth and replace.
11. Check the temperature frequently. Temperature may be checked in the truck or in the hopper.
12. The paver should operate at the proper speed. If dragging or checking appears, slow down the paver.

JOINTS:

Longitudinal joints and transverse joints must be made in a careful manner. Well bonded and sealed joints are required. Joints between old and new pavements or between successive day's work, must be carefully made in such a manner as to insure a thorough and continuous bond between the old and new surface.

COMPACTION:

Rolling should start as soon as possible after the material has been spread by the paver. Rolling of the longitudinal joint should be done immediately behind the paving operation. The initial or breakdown pass should be made as soon as possible to roll the mixture without cracking the mat or having the mix pick up on the roller wheels. The second or intermediate rolling should follow the breakdown rolling as closely as possible and should be done while the paving mix is still at a temperature that will result in maximum density. The finish rolling should be done while the material is still workable enough for removal or roller marks. Check Specification Book.

CONCRETE PAVEMENT

PURPOSE:

A durable surface, that affords a smooth, safe and comfortable ride, is the ultimate goal of all highway projects. All the good work which has gone before will be of insignificant importance if the final surface does not reflect care and good workmanship. The pavement surface is that portion of the highway project that is most subject to the scrutiny of the public and is the cover on what may be a good or bad section of highway in their opinion. Only proper inspection, with attention to the many seemingly small details, can obtain a good pavement surface.

PROCEDURE: (checklist)

Check the Plans:

1. Note the typical sections and where applicable.
2. Note banking (curves).
3. Note the type and spacing of longitudinal joint supports.
4. Note the type and spacing of transverse joint supports.
5. Note the panel length (minimum and maximum).
6. Note the panel widths (the contractor should provide the engineer-in-charge with a panel layout well in advance of the start of paving).
7. Note the locations of basins and low points and type of castings.

FINE GRADE:

1. Check that the subbase is firm and has been compacted in accordance with the specifications.
2. Check for soft or spongy spots in the subbase. If found, replace with good material and recompact. Do not remove and fill with pavement concrete. This prevents sliding of pavement during temperature changes and may lead to cracking.

PAVING:

1. Check the time limitations in accordance with the Standard Specifications.
2. Make periodic slump and air tests for an indication of the consistency of the mix. Testing rate shall be one at the initial daily placement and thereafter at the rate of one set per 150 to 200 cubic yards of concrete placed (samples should not be taken at the beginning or end of discharge). Check temperature of the concrete at discharge.
3. If water needs to be added, make sure 30 additional revolutions are made. Water cannot be added more than twice.
4. Make certain that reinforcement mats, if used, are clean, free of thick rust, and properly placed (mats should be lapped in the direction of paving). Never allow the mats to be placed higher than shown on the plans. If they are too close to the surface, the pavement will spall in a few years.
5. Concrete shall be unloaded into an approved spreading device and mechanically spread.
6. Concrete shall be distributed to the required depth for the entire width of the pavement by a mechanical spreader. The spreader should be equipped with a hopper to receive the concrete.
7. Check that all vibrators (surface, pavement edge and joint) are working properly and they are not left in the concrete when the equipment is not moving. Concrete placement shall be discontinued any time the vibrating equipment is out of order.
8. Contraction joints should not move.
9. End each day's run at a fully bulkheaded joint.
10. No direct placement of concrete onto the grade by means of a chute should be permitted, as segregation will occur.

Only continued experience will enable a paving inspector to visually recognize poor concrete. A slump test is the only sure method of checking. This, coupled with an eye on the workability of the concrete, should give desired results. Occasional adjustments in the amounts of materials are made by the batch plant inspector as the character of the materials change. The paving inspector should be in close communication with him to be aware of these changes.

FINISH:

Transverse Screed and Hand Finishing - Ideally, the laborers and cement finishers should have little to do if the machines are operating properly. If the laborers are constantly scurrying around, carrying shovelsful of concrete back to the finishers, it means that the screed boards are not set right. They should be reset.

In general, when rain lets up, some acceptable finishing can be accomplished to finish concrete. In any event, paving should be stopped until previously poured panels are completed. Then recheck grade and forms and, if weather permits, continue. During fall paving, when occasional evening temperature drops below freezing, salt hay or thermal blankets are frequently used over paper to prevent freezing of concrete. In all cases, the decision and policy of the engineer-in-charge is to be followed.

1. Joints are critical. Great pains should be taken that there is no depression, no matter how slight, at a joint.
2. Immediately after smoothing operations have been completed and prior to the application of the curing compound, tinning should be done perpendicular to the center line of pavement. Check the depth of tinning.
3. Straight edge the concrete, both transversely and longitudinally. Correct high or low spots.

CURING:

1. Curing method, etc. as per specifications.
2. If white pigmented membrane curing compound is used, a self-propelled mechanical sprayer shall be employed.

PROFILOGRAPH:

1. Make sure that the contractor has a profilograph on the job well in advance of the start of concrete paving.
2. The profilograph and recorder must be inspected, calibrated and approved by the Deputy Chief Engineer, Technical Services, or his representative.
3. A Final Daily Profile Index shall be determined for each day's paving. You must have 1,000 feet of paving completed on any day to use the profilograph. Anything less will be included with the subsequent day's entire production until a minimum of 1,000 linear feet of pavement is obtained.
4. Profilograph operations will be in accordance with Material Method 24.
5. The profilograph will be operated in the wheel paths of the mainline pavement (3 feet + ½ inch inside all lane edges).
6. The profilograph is to be operated in the same direction that the pavement was placed.
7. It is extremely important that the profilograph is operated at a speed as slow as possible.

STRUCTURAL STEEL:

The New York State Steel Construction Manual is incorporated in the specification by reference and describes minimum requirements for erection, testing and inspection of structural metals. The inspector should be thoroughly familiar with its contents.

HANDLING AND STORING:

1. Steel members shall be shipped, trucked and handled so that there is no danger of permanent injury or deflection. Lifting and support points are shown on the erection and/or shop drawings. Shop painted members should be checked for defects and be properly protected.
2. Skids or rollers shall be used and no material shall be dropped, thrown or dragged over the ground.
3. Material to be stored shall be placed on skids off the ground.
4. Girders and beams should be stored in an upright position and shored, being careful to maintain shop camber.
5. Girders are not to be transported while lying flat.
6. Steel members must be checked for compliance with dimensional tolerances as shown in the New York State Steel Construction Manual. The most common checks made during and after steel erection include camber, deviation from horizontal alignment (sweep), deviation from vertical alignment of girder webs, etc.
7. After erection check for minimum vertical clearance between the bottom of the steel and the top of roadway as shown on the plans. Recheck after all bridge loads are applied.

PRIOR TO ACTUAL STEEL ERECTION:

1. Become familiar with the contract steel drawings, paying special attention to all notes and erection procedures.
2. Become familiar with the specifications for the items involved.
3. Become familiar with the steel shop drawings which are approved by the Deputy Chief Engineer. Shown on these drawings are the following:
    a. All details for the fabrication of each structural member.
    b. The exact location of every piece of steel and its identification number.
4. Become familiar with the steel erection drawings. These contain the approved field procedure in erecting steel.
5. Set up a procedure for keeping records:
    a. Bring into the field a copy of the approved drawings.
    b. As a member is erected, find its identification number from the drawings and note this number on your I.D.R.; at the same time, color in red that member on your drawings, noting the date alongside the member. One advantage with this method is that it provides a very quick and accurate means of determining what steel has been placed and paid for, and what steel is still to be erected.

6. Become familiar with the New York State Steel Construction Manual, specifications, etc.

GIRDERS:

When the girders are placed down on the bearings, it should be certain that all surfaces coming in contact are clean and free of foreign material. Check the contract plans and shop drawings to determine the exact position of the girder on the bearing.

When only one girder is placed in position, care must be taken that it is properly shorted to prevent movement until the second girder is placed and a few diaphragms are bolted in place. A minimum of 50% of the holes must be filled with approved high strength bolts and full size erection pins before the external support systems are released.

All diaphragms should be placed uniformly during erection (i.e. all on the left or right side of the stiffener).

1. When setting steel on an expansion bearing, care should be taken to set the girder at the proper location on the bearing. This information is included in the steel contractor's shop drawings, plans and/or specifications.
2. Most often it is required that the final adjustments of the expansion bearings are made after the full bridge dead load is applied to the girder. This is done by jacking up the girders and adjusting the bearings in accordance with temperature requirements. At this time, deflection or camber loss due to dead load has been completed.

HIGH STRENGTH BOLTS

DESCRIPTION:

A medium carbon heat-treated steel bolt, ASTM designation A325, identified by three radial lines on the top of the head 120 Degrees apart, usually used in conjunction with a hardened round flat washer under the turned element. The Steel Construction Manual defined the different material specifications for painted, unpainted and galvanized applications.

ELEMENTARY THEORY:

A riveted connection is designed to transfer load by shear in the rivets, although it has been known that load transfer is primarily by friction between the component parts of the connection. The reason for this is that when the hot driven rivets in a connection cooled, they contracted, drawing the components of the connection into intimate contact and thereby developing friction. The amount of contraction of the rivets; that is, the amount of tension in the rivets, varied so much that it was impossible to consider in design and was therefore neglected.

This concept of transferring load primarily by friction leg to the development of high strength bolts. The reason for this is that care can be taken to tighten each bolt to a specific tension, thereby providing designers with enough information to use the friction developed in their design.

NOTE: Some types of connections using high strength bolts are bearing types, that is, transfer of load is primarily by bearing. However, the same specifications are given for friction type connections because the joint will be more rigid and the joint will not become loose.

BOLTED CONNECTIONS:

1. The inspector should always assume that connections are friction type and, therefore, contact surfaces should be inspected to insure that they are free of shop paint, grease, or any material that may impair the development of friction in the joint. If the contact surfaces becomes rusted, a thorough wire brushing is all that will be necessary. Rusted surfaces which have been well cleaned provide up to two times as much resistance to slip. However on critical connections and when using ASTM A588 Steel, the contact surfaces must be blasted clean per the Steel Construction Manual.
2. It is common practice when bolting a point for the contractor to use cylindrical erection pins to align the bolt holes in the point. These pins are driven manually by the steel worker with a hammer. This method of alignment is satisfactory providing the pins do not enlarge the holes or distort the metal.
3. Another method of aligning a connection is by using the high strength bolts of a connection as "jacks." This condition occurs whenever the tightening of a high strength bolt or bolts is used to draw the components of a connection into contact. This method is satisfactory provided the bolts are not over tensioned. In order to insure that this is not the case, have the contractor - after the connection has been made - remove one of these "jacked" bolts. Take the bolt and the nut and try to spin the nut onto the bolt. The nut should spin all the way down on the bolt with little effort. If this cannot be done, reject the bolt. Repeat this test for all the bolts used as jacks.
4. Defer taking elevations on steel beams until all bolts in that span are tightened.
5. For bolts installed in a vertical position, the heads should be on top to prevent fall out if nuts should loosen.

BOLT TENSION:

High strength bolts are tightened to a minimum tension by using either calibrated wrenches or the turn-of-a-nut method.

1. Calibrated Wrenches: Usually they are power wrenches or manual torque wrenches. The contractor is required by the specifications to have on the job a device, called a Skidmore, capable of indicating actual bolt tension. Calibration is then done as follows:
    a. Power Wrenches: Three typical bolts of each length and diameter used on the job are tightened in the above device to the desirable tension. The power wrenches are then set

to stall or cut out at this tension.

b. Manual Torque Wrenches: The same calibration procedure used for power wrenches is to be followed except that the torque, indicated on the wrench corresponding to the desirable tension, is noted and then all bolts are torqued to this noted value.

2. Turn of Nut Method: Bolts should be inserted into all holes of a connection not used for pinning. They should then be brought into a "snug tight" position. This is the only method of insuring that all parts of the connection are in full contact with each other. "Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. When the above condition is met, each nut is given an additional turn corresponding to the table found in the Steel Construction Manual. Tightening the bolts should start at the most rigid part of the connection and progress to the free edges. This insures that the contact surfaces within the joint have full bearing.

TESTING:

No matter what method is used to tighten high strength bolts, they will be tested for proper tension by use of manual torque wrenches, supplied by the steel contractor. These wrenches will be calibrated according to the procedure described in the Steel Construction Manual.

The actual testing is fairly straightforward. The wrench is applied to the nut. Then a gradual pressure (do not jerk the wrench) is applied to set the nut in motion. It is at this point when the nut is in motion that the torque is read.

It has been previously mentioned that a high strength bolt can be over tightened. If the torque wrench readings are more than 1.5 times the minimum job testing torque, check the bolts by removing and spinning the nut onto the bolt. If the nut will not spin all the way down, replace the bolt and nut.

All bolts in critical connections should be tested. Examples of important connections are:

1. Stringer and girder splices.
2. Stringer and girder direct support connections.
3. All main member connections in trusses and arches.

In less important connections; such as diaphragm connections, a minimum of 10% of the bolts, but not less than two bolts in each connection, should be tested. Samples to be taken for testing in Albany: Two bolts from each lot should be obtained and sent with the necessary BR-240 to Albany for testing.