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-Tunnel Construction-

Before the work of excavation of a tunnel has progressed very far, the Engineer should check the alignment, measurement and grade by very careful and accurate methods.

After the line has been established it should be preserved by monuments set at both ends, and on the summit or summits.

Before the heading is turned, the cut should be faced up at a point at which the roof will be at a depth of 25 or 30 feet below the surface; Then on the face of the cut, the center-line, roof and spring-line grades and the sides of the tunnel should be marked as a guide to contractors.

In order to keep on line, two points on the center-line are set 10 or 15 apart, and at a convenient distance from the portal.

After the heading has been driven 25 or 30 feet a new pair of centers should be set in the roof of the tunnel from which wires, carrying lights, may be suspended

These centers should be 5 or 10 feet apart and as near the face of the heading as practicable.

In case the tunnel is through a soft rock which requires timbering it is not necessary to set centers in the roof, provided the wall-plates are lined by measurements from centers near their ends.

The wall-plates should also be set at the right elevation or better ½ or 1 inch high, to allow for slight settling, which will invariably take place when the bench is taken out

Tunneling through hard earthy material is done by either side drifts or the open cut method.

In the first case, the alignment is produced, by measuring offsets in the part of the tunnel already timbered, to points within a few inches of the wall-plate, and lining a string over these offset points, and prolonging the line ahead into the side drift. From this line the new wall plate is set.

Where the material is soft and difficult to hold up, the open cut method is more advantageous.

The open cut method consists of making the excavation larger than the tunnel section, timbering up the tunnel area and then covering it over to about the original surface of the ground.

The open cut method offers more security against accidents and delays and also permits of the employment of a larger force in prosecuting the work.

The economy of this method depends upon the depth of tunnel grade below the surface and is unpractiable at any great depths.

When the two headings have been driven to within 50 or 75 feet of each other, the Engineer should carefully check his alignment and grade; but more especially his measurement, as it is very important to just how far apart are the faces of the headings, in order to avoid accident, due to a charge from one heading, blowing thoough to the other, thereby placing in jeopardy the lives of the men working there.

Upon the meeting of the headings, the Engineer should test his alignment and measurement, so that he may correct any small error before the entire section has been removed.

Tunnels through rock which require no lining, should be driven to as near the neat section as possible, and all large or unsightly projections trimmed off.

For the permanent lining of tunnels there are several excellent materials.

Stone bench-walls with brick arch is a commonly used material, and one admirably adapted to the purpose, due to the facility with which it can be put in, and to the permanency of the lining.

Perhaps the material best suited to tunnel lining is concrete.

In the first place, the facility and rapidity with which concrete may be put in is an important factor, and then it adapts itself to the irregularities of the section of the tunnel better than any other material.

Concrete is put into tunnel lining in much the same way in which it is put into any arch.

Centers are erected at safe distances apart, and rigidly connected with wall-plates and pile, the whole being covered with plank, dress to a smooth surface, called pleeting.

The concrete is then shoveled from cars, or boards into the walls, care being taken to keep it well rammed.

A smooth upon the concrete, is formed by a layer of from 1½ to 2 inches of mortar, between the sheeting and the rough concrete,

This is put on by means of wide channel beams, called face plates, built to the required depth, which are placed with the angles against the sheeting thus giving an opening between the sheeting and face-plate This opening is filled with soft mortar, then the concrete shoveled behind the plates until it comes to their tops. The plates are then pulled up, and the concrete well rammed, to insure a bond between the face mortar and the body of the concrete.

This process is repeated until a point on the arch is reached where the face plates can not be used, then a layer of stiff mortar is placed over the sheeting, with a trowel and the concrete shoveled on as before.

Utmost care should be taken in aligning the centers for upon this depends the line of the completed lining.

Expansion joints are usually put in at distances of 150 to 300 apart

Any irregularities or voids in the surface of the concrete can be filled with mortar, and a smooth surface obtained by putting on a coating of neat cement grout. This can be done with a heavy brush.

Respectfully Submitted

Approved.