If arch sheeting is of brick a greater depth must be allowed usually than for stone, unless the brick is of very good quality and well bonded, and as bricks are not usually made bevelled unless for a very large contract, and are all of a uniform size, the bonding of the several rings of brick in arch sheeting of several bricks in depth is not possible except at arbitrary intervals, depending on

Plate X

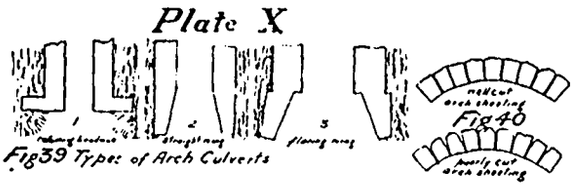

Fig39 Types of Arch Culverts

Fig40

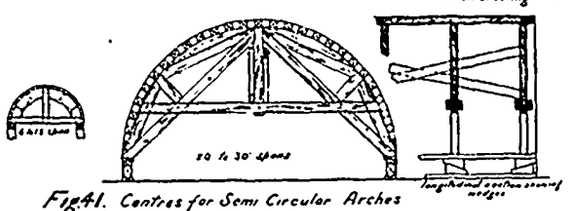

Fig41. Centres for Semi Circular Arches

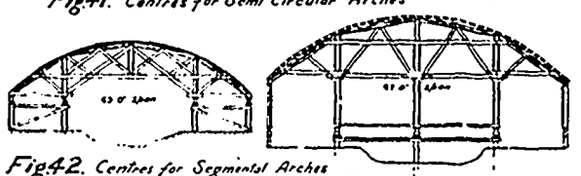

Fig42. Centres for Segmental Arches

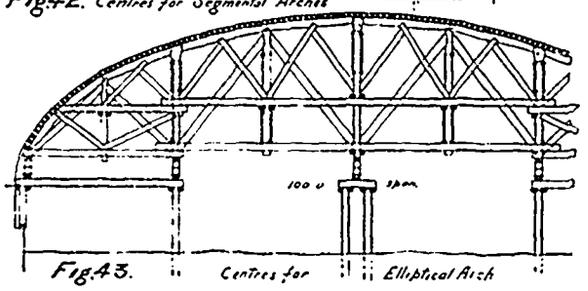

Fig43. Centres for Elliptical Arch

the curvature, when the outer ring is one brick thickness behind the ring inside it, at which point a header is inserted; for a circular arch this is about once every 33° of arc and is independent of the span. Longitudinally both brick and stone arch sheeting should be well bonded also, and after the arch has been completed and the centres removed, a heavy coat of cement mortar (1 to 1) should be plastered over the back of the arch down over the haunches or spandrel filling so as to prevent percolation through the joints. In construction of the arch and spandrel masonry the two sides should be carried up at about equal rates, as a heavier load on one side will tend to push over the timber centres.

(c) Arch abutments need not be made of such an expensive class of masonry as that of the arch sheeting. A rock-faced ashlar about equal to second class bridge masonry is suitable, and in designing their dimensions due regard must be had to the character of the filling behind the abutments and the depth of filling over the crown.

There cannot be said to be any fixed law by which the dimensions can be determined. The various theories advanced disagree in vital points. Some take account of the horizontal thrusts tending to increase the stability of the abutments, and some do not; some attempt to allow for rolling loads, and others use only a uniform quiescent load. It may be said in general, that for small arches where there is a large margin of safety allowed, and under heavy banks where rolling loads have little effect, the dimensions as given by Trautwine are satisfactory, but where it is deemed necessary to construct a curve of pressures, Scheffler's theory of least crown thrust and neglecting horizontal forces errs on the side of safety and is easy of application; and in constructing curves of pressure taking the point of rupture as the critical point it will be noticed that these curves pass rapidly toward the back of the arch sheeting into the haunch filling before they reach the springing line, when a uniform depth of sheeting is used equal to the depth necessary at the keystone, or slightly greater; this makes it evident that there is no such thing as a semi-circular arch, but that a segment of about 120° (60° on each side of the vertical) is a true arch and the remainder is really a part of the abutment, and for this reason the spandrel (haunch filling) masonry should be carefully constructed near the springing line and of as good a class of masonry as the face walls; higher up, however, it may be of rubble masonry as its weight is its only function.

The foundations of arch abutments are a very important consideration, as a very slight settlement will derange the curve of the arch and endanger its stability. If the foundation bed is not found to be uniformly good after careful testing with an iron bar, the best way to distribute the pressure is to lay a foundation course of concrete, or

Plate XI

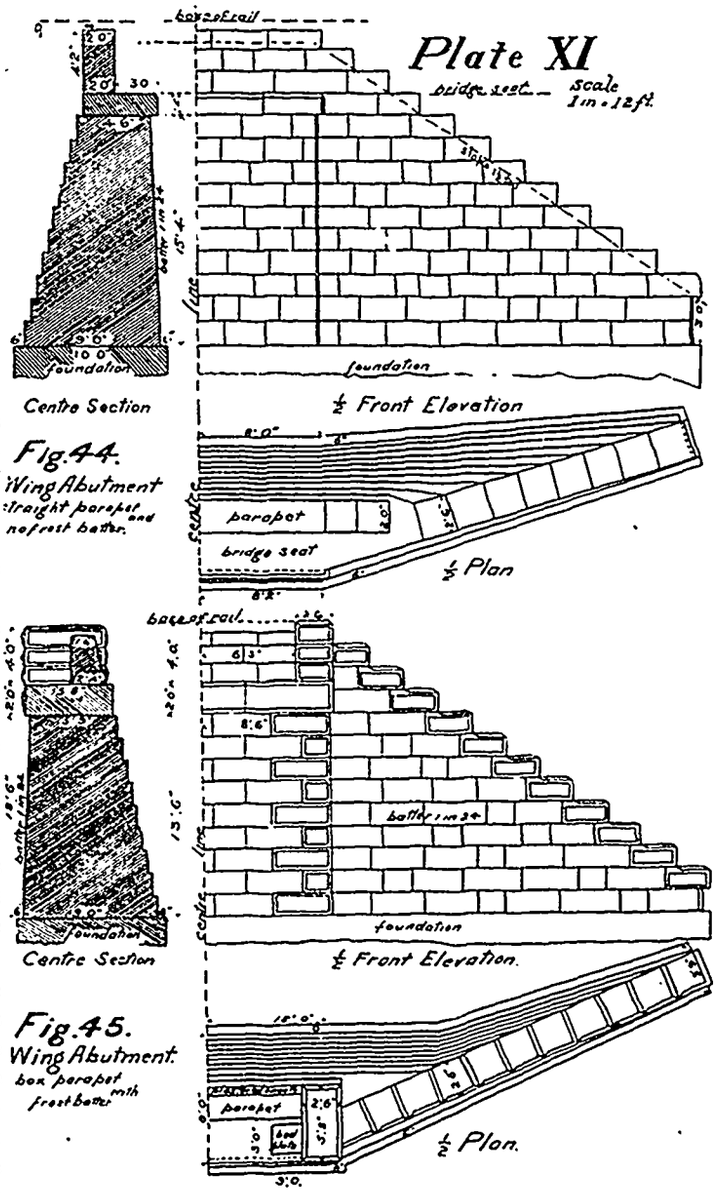

Fig.44. Wing Abutment straight parapet and no frost batter.

Fig.45. Wing Abutment box parapet with frost batter

piles and concrete, if the bearing power of the soil is not found sufficient.

ARCH CENTRES.

To support the arch sheeting during construction and give the correct form to the arch a series of timber seg-