the whole formula is very easy. In the following table, if the number under *xh* is multiplied by any half space hav­ing the given values of *a* and *c*. It gives points in the curve or values of *g ;* and if more points are wanted, the column log. is the logarithm of the denominator in the formula; hence the numerator only will require computing.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***a*** | *o* | **w** | ***xh*** | Log. |
| Feet. | Feet. | Feet. |  |  |
| 2 | 20 | 3 | ·3217 | 1∙299943 |
|  |  | 4 | ·44 |  |
|  |  | 5 | ·52334 |  |
|  |  | 6 | ·592 |  |
|  |  | 10 | ·766 |  |
|  |  | 15 | ·903 |  |
| 5 | 10 | 6 | ·47064 | ·574286 |
|  |  | 7 | ·65573 |
|  |  | 8 | ·79175 |  |
|  |  | 9 | ·90213 |  |
| 5 | 15 | 6 | ·35304 | ·76552 |
|  |  | 7 | ·49192 |  |
|  |  | 8 | ·59397 |  |
|  |  | 10 | ·75019 |  |
| 5 | 20 | 6 | ·30163 | ·89614 |
|  |  | 7 | ·4201 |  |
|  |  | 10 | ·63823 |  |
|  |  | 15 | ·85424 |  |
| 5 | 23 | 6 | ·27149 | ·995635 |
|  |  | 7 | ·37779 |  |
|  |  | 8 | ·45668 |  |
|  |  | 10 | ·57678 |  |
|  |  | 15 | ·768876 |  |
| 5 | 25 | 6 | ·2815 | ·995591 |
|  |  | 7 | ·37824 |  |
|  |  | 10 | ·57683 |  |
|  |  | 15 | ·76891 |  |
|  |  | 20 | ·90121 |  |
| 20 | 29 | 21 | ·34394 | ·39794 |
|  |  | 22 | ·4841 |  |
|  |  | 23 | ·59117 |  |
|  |  | 26 | ·82253 |  |

Fig. 2. shews this arch with *a* = 2, *c* = 20, and with spans varying from twenty to seventy feet. Those give the result of increase or decrease in that element. Taking now *h* and *c* each = 20, and making *a = 5,* we see in fig. 3, the effect of increasing the road on the arch, keeping the lower curve height of the road the same, having fifteen feet height, and five feet road ; and in the upper curve, where *h* = 20, *a —* 5, and *c* = 23, we see the effect of increasing the road to five feet, and retaining the same height of arch­way, eighteen feet. Fig. 5 is with *h* = 9, *a* = 20, and *c* = 29. This would be the curve for one of the bridges under the London and Birmingham railway, near the Bull Inn, at the Birmingham end of the line. Fig. 9 shews the effect of lowering the crown ; the heights to the road being 10, 15, 20, and 25 respectively, while in each case *h* = 20, and *a —* 5.

These arches of equilibrium are more adapted for brick than stone, owing to the difficulty of making the arch-stones in the latter radiate properly. In elliptic arches, however, this is not always done : they are made to radiate to one centre, sometimes from ignorance, but oftener because, when properly done, each arch-stone requires a mould for one side ; in the curve of equilibrium it will generally be best to assume a centre to the nearest regular figure; otherwise let KD (fig. 1) = *a*, AQ = *t,* DQ = *c*, DP = *x,* and CP = *y,* and \*\*\*\* CP — - then

Hy log. *a -∣- c + »J 2ac* + c2

*a*

the radius of curvature R is \*\*\* R = **~~^~"^~~~~c~~ ~~^b~~ ~~a~~~~—÷. .Φ~~** ; and Q\* + *a + x*

this is a minimum when \*\*\* *x = a∙* The subtan-

1 *—:—ί* ττ i *a + x + ∣y∕2ax 4-xi*

gent is equal to \*\*\* l√ 2α + *x. Hy* log. ! !—- :— .

From any point C in the arch, draw the tangent *cb* (fig. l,) then the pressure on the arch-stone at C*g* is as the se­cant of *bcp* directly and radius inversely. Hence, taking unity as radius, if the depth of the arch-stone at the crown \*\*\*(α. sec. *bcpy'j* is multiplied into the sec. *bcp. It* gives the length of the arch-stone at any point proportioned to its pressure.

The areas being proportional to the weights set off K', the centre of gravity, draw K'N perpendicular to EN, join K'B, then the pressure in the directions K'N and NB, is as these lines, the former to a lever EN, and the latter to a lever EF. Put the area of the arch = *a,* K'N = *b,* EN *= d,* BN = *f*, FG = *g,* and EF = *x,* then *b*/*fda* is the

effort to overturn the pier, and *xa* the resistance ; and \*\*\* —

*^~bd> fx*

*— xa,* or —j *∙ a* is the difference. The height of the pier is *xg,* and its resistance on the lever ½*x* is *xg ∙* ½*x,* or *\*\*\*x1a*

-^-∙, hence for an equilibrium these must be equal, or \*\*\* *⅛⅛a* = ⅛, whence *x =*

The centre of gravity may be found near enough, by drawing equidistant lines parallel to KH, (fig. l,) taking the centre of gravity of each part, and tracing a curve through the points’ lines parallel to KQ, which treated si­milarly, will give another curve, and when this] cuts, the first is the centre of gravity. The area may be found by a corresponding process.

VIALES, in *mythology,* a name given among the Ro­mans to the gods who had the care and guard of the roads and highways.

VIANA, a department or corregimento of the province Entre Duro e Minho in Portugal, extending along the sea­shore to the northward of the river Minho. It comprehends seven towns, 291 villages or parishes, 30,980 dwellings, with about 170,000 inhabitants. The capital is a city of the same name, situated at the mouth of the Minho, a river nearly choked up with sand, and only admitting vessels with a light draught of water to approach the wharfs at the high­est tides. From this circumstance the trade of the city has, of late years, been transferred to Oporto. The chief traffic is in fruits and in some light wines. Viana has an extensive sea fishery, which gives occupation to 300 boats. The city is surrounded with walls defended by bastions, and the entrance from the sea is protected by two forts, St. Jago and Cao. The public buildings are two parochial churches, or religious houses, an hospital, a poor house, and a military school or college. It contains about 2000 houses and 9500 inhabitants. There is a light-house at the en­trance of the river Lerna, whose latitude is in 41° 39' north.

There is another place in Portugal of this name, the town of Viana in the province of Alentejo, which contains 450 houses and 1850 inhabitants.

In the province of Navarre in Spain, is also a Viana, a city near to Estella. It stands on a hill about three miles from the river Ebro. It is surrounded with walls, and is