trench so as to give an even bearing, which, amongst other benefits dispenses with the chance of settlements.

6. No pipes should be allowed to be covered in until they have been inspected by the inspector, and in order to test the soundness of the joints, fill the drain with water, having first stopped up the end and note if the level of water is maintained.

7. Drains should not pass under buildings if it can be avoided, but if unavoidable they must be buried in good concrete and relieving arches turned to any walls passing over them.

8. Care must be exercised in filling over pipes not to break or injure them.

9. The trap to a house drain should be a syphon with a good cascade action, its position must be guided by circumstances.

10. The drain should end at outside wall of the house and be carried up the wall its full diameter to above the roof for extension, an inlet for fresh air being essential on the house side for the trap, if the drain has to pass under the house it must be similarly carried up on the other side.

11. All waste pipes and overflows to be entirely cut off from connection with any drain, and empty on to special gullies outside the house.

The object of good drainage may be summarized as follows: To ensure that there be no escapes of either liquid or gas from any portion of the drain or soil pipes, that the house is isolated from its neighbor and the main sewer, that a current of fresh air is constantly passing through all the drains and soil pipes.

I would urge the necessity of a register of all the drains being kept that are examined by the engineer's department. This can be done by having a series of numbered note books kept solely for this purpose, and all the information thus acquired must be plotted on the map of the town, if on a sufficiently large scale.

The necessity of correct plans of the drainage of buildings cannot be over estimated, especially for hospitals, asylums, workhouses, schools or public buildings, and even for the smallest dwelling house such a plan would often prove the greatest boon to the occupier or owner, as well as at all times to the engineer, the medical officer of health, and the inspector of nuisances.

A strange commentary on the anxiety of women to possess the franchise is furnished by the city of Boston, the most cultured centre in the United States. The advocates of women's rights in that city are finding it difficult to explain the apathy which exists among the Boston women to make use of their right to vote for School Commissioners. In the year 1888 20,252 women registered as voters, and 19,490 voted at the election. In 1889 only 10,051 voted, 1890 the number had fallen to 7,434, while in 1891 less than 6,000 exercised the franchise. It seems that the women of Massachusetts labored hard for years to secure the right to go to the polls, and yet in the course of three years the number who availed themselves of the new liberty fell from nearly 20,000 to 6,000.

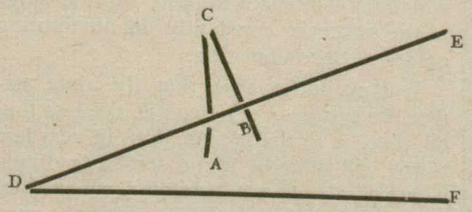
Roads and Roadmaking.

VII.

Loss of Power on Inclinations.

Every road should be perfectly level. If it is not a large portion of the strength of the horses which travel it will be expended in raising the load up the ascent. When a weight is drawn up an inclined plane the resistance of the force of gravity or the weight to be overcome is such a part of the whole weight as the height of the plane is to its length. If, then, a load rises one foot in every twenty of its length, a horse drawing up it a load of one ton is compelled to actually lift up one-twentieth of the whole weight, *i.e.*, one hundred pounds through the whole weight of the ascent, besides overcoming the friction of the entire load.

Let D E, in the following diagram, represent the inclined surface of the road upon which rests a wagon, the centre of gravity of which is supposed to be at C, draw C A perpendicular to the horizon, and C B perpendicular to the surface of the hill. Let C A represent the force of gravity or the weight of the wagon and its load. It is equivalent in magnitude and direction to its two rectangular component forces C B and B A. C B will then represent the force with which the wagon presses on the surface of the road, and A B the resisting force of gravity, *i.e.*, the force (independent of friction) which resists the ascent of the wagon or which tends to drag it down the hill.



To find the amount of this force from the two similar triangles A B C and D E F, we get the proportion:

$$CA : AB :: DE : EF$$

Representing the length of the plane by l, its height by h, and the weight of the wagon and load by W, this proportion becomes:

$$W : AB :: l : h$$

Whence $AB = W\frac{h}{l}$; that is, the resistance of gravity due to the inclination is equal to the whole weight, multiplied by the height of the plane divided by its length. If the inclination be one in twenty, then this resistance is equal to $\frac{1}{20}$W.

In this investigation I have neglected three trifling sources of error, arising from part of the weight being thrown from the front axles to the hind ones, in consequence of the inclination of the traces; from the diminution of the pressure of the weight owing to its standing on an inclined surface; and from the hind wheels bearing more than half of the pressure in consequence of the line of gravity falling nearer them.

The results of experiments fully confirm the deductions of theory as to the great increase of draught upon inclinations.

From the results of experiments the following data is established:

Calling the load which a horse can draw on a level.................1.00

On a rise of	1 in 100	a horse can draw only	.90
"	1 in 50	" "	.81
"	1 in 44	" "	.75
"	1 in 40	" "	.72
"	1 in 30	" "	.64
"	1 in 26	" "	.54
"	1 in 24	" "	.50
"	1 in 20	" "	.40
"	1 in 10	" "	.25

In round numbers, upon a slope of 1 in 44 or 120 feet to a mile, a horse can draw only three-quarters as much as he can upon a level; on a slope of 1 in 24, or 220 feet to the mile, he can draw only half as much; and on a slope of one in ten or 528 feet to the mile only one-quarter as much.

This ratio will, however, vary greatly with the nature and condition of the roads; for although the actual resistance of gravity is always absolutely the same upon the same inclination, whether the road be rough or smooth, yet is relatively less on a rough road and does not form so large a proportional part of the whole resistance.

Thus if the friction upon a road were such as to require, upon a level, a force of draught equal to one-fortieth of the load, the total force required upon an ascent of one in twenty, would be one-fortieth plus one-twentieth, equals three-fortieths. Here, then, the resistence of gravity is two-thirds of the whole.

If the road be less perfect in its surface, so that its friction equals one-twentieth, the total force upon the ascent will be one-twentieth plus one-twentieth, and here, then, the resistance of gravity is one-half of the whole.

If the friction increase to one-tenth, the total resistance is one-tenth plus one-twentieth, and here gravity is only one-third of the whole.

We thus see that on a rough road with a great friction any inclination forms a much smaller part of the resistence than does the same inclination on a smooth road on which it is much more severely felt, and proportionately more injurious; as the gaps and imperfections which would not sensibly impair the value of a common knife renders a fine razor completely useless.

The loss of power on inclinations is indeed even greater than these considerations show, for besides the increase of draught caused by gravity, the power of the horse to overcome it is much diminished upon an ascent and in even a greater ratio than that of man owing to its anatomical formation and its great weight. Though a horse on a level is as strong as five men, yet on a steep hill it is less