

the shire who were opposed to these councillors, and they in return took every opportunity of injuring him, even at the expense of the Engineer. They professed to believe that he acted as he did from an unfriendly feeling towards them; and, indeed, one of them told him: "That he was not keeping in with the strongest party in the shire."

The opinion as to his position as expressed to the author by a shire engineer, who was also an M.I.C.E., was that certain of the councillors were always setting traps to catch him, and that they made it a regular hell-upon-earth for him.

In another instance an Associate M.I.C.E. who had been appointed to a shire, told the author he had to give it up after a few months' trial, for if a new road was to be set out it must go past the Mayor's property, if a wharf had to be made it was to face each several councillors' store or house, and he could not make that state of things work smoothly.

And, lastly, a near relative of an eminent city engineer, who died in office, told the author that the worrying of the councillors killed him. Now these are just a few cases taken at random, and every shire engineer could furnish many more.

A good *prima facie* proof that the present relation between shire councils and their officers is not what could be wished, may be found in the fact that the average period for which a shire engineer remains in office is only about two years; now the reason for this is because of the trouble and friction spoken of, and it is all caused by the fact that though it is his duty to obey the orders of the majority, at the same time he must not run counter to the wishes of the minority.

Now, it may be said that these are trivial matters, and so they are; it is their very triviality that leads to serious results, and this is just because a man is much more likely to be worried out of his position, than forced to leave it through any fault of his own.

It is no sign that an engineer is doing his work well if they want to retain him, or badly if they wish to dismiss him, for in

certain cases his very zeal and efficiency tell against him, and the assiduity with which he performs some of his duties may be an unpardonable sin in the eyes of an influential minority, who may soon become a majority, of his masters. His statements of facts may touch the interests of some, his suggestions of remedies may excite the displeasure of others; and if the soundness of his position cannot be assailed by reasoning, passion may suggest—as it has before now both suggested and carried out—a reduction of salary or a threat of dismissal. And not only is this disgraceful system of persecution confined to the councillors, but the same form of pressure may be brought to bear upon them by aggrieved persons outside the council, to make them press hard upon the officer, when perhaps if left alone they might be inclined to side with him.

As showing what are the views held upon this subject by one of the best authorities in England, I will quote Mr. Lewis Angell, who, in his address to the Association of Municipal and Sanitary Engineers on the occasion of their inauguration in the year 1873, says:—

“The town surveyor, according to his opportunities, has done the country good service, but, surrounded as we have been with obstructions and difficulties, cramped and restricted by popular prejudices and private interests, subject to clamour and attack, without protection and without appeal it is indeed surprising that we have accomplished so much. Had such officers been from the first judiciously selected, adequately remunerated, properly supported and duly protected, our progress would have been more conspicuous, and our office better appreciated.”

Again in advocating proper protection of the officers by the Government, he further says:

“Do not let me be misunderstood, I do not mean centralization, or the removal of that proper control which every local authority should maintain over its own officers. I would uphold intact the great principal of local government, which has been the bulwark of our political freedom. But local government may degenerate, and in small towns deteriorate into littleness. Local affairs are too frequently avoided by those who are most fitted by intelligence and social standing to take part therein. I would simply control in the most constitutional manner the shortcomings or excesses of local government as is already done in various other departments. I would require that local officers should be properly qualified and adequately remunerated, that in the honest discharge of their

duties, and during good behaviour, they should be protected from the effects of ignorance, narrow prejudices and interested clamour, and that they should have an appeal to a disinterested and judicial body superior to local feeling. The demand is reasonable—I ask no more.”

To these admirable remarks of Mr. Angell, as to the position of the town surveyor, which apply with even greater force to that of the shire engineer, the author can add nothing, as they express his views on this part of the subject in a much better manner than he can hope to do.

The author believes the reason why the shire engineer is not protected and rendered more secure in his position, is that it is considered better for the council to have the means of at once removing him if he does not agree with them, or act in accordance with its wishes, and it is quite right that they should have that power, but in using it they should distinctly specify for what action or series of actions committed by him the charges are brought against him, and further they should not try the case themselves, but as Mr. Angell says : let it come before a “disinterested and judicial body superior to local feeling.”

Having now seen how the shire engineer has been appointed, and what are the surroundings of his office, we will proceed to inquire into the question of duties attached to it, and, in doing so, we will deal more particularly with the carrying out of works connected with roads and bridges.

Now there can be no doubt but that the laying out and construction of roads are by far the most important duties required to be performed by any shire engineer, and of these two subdivisions the first is by far the most important. He may have larger contracts, expensive and imposing structures requiring much skill and forethought on his part; but, if we consider the matter, we shall see that the laying out of a road, at least between two important centres, completely overshadows all other works. The reason is just this—a bridge, a culvert, even the construction of a road may not be carried out in the best

possible manner, still the work is most likely cheap, and will at least serve its purpose, and even if it has to be entirely reconstructed the cost will not probably be very great. But how different it is with badly laid-out roads, in this case the work is bad from the first, and to set it right the whole survey may have to be altered, at very great expense, because of the vested interests which have sprung up along its course, and for many other reasons.

The importance of road-making cannot be over-estimated, they are as Gillespie says :—

“An accurate and certain test of the degree of civilization of a country, their construction is one of the first indications of the emergence of its people from the savage state, and their improvement keeps pace with the advance of the nation in numbers, wealth, industry and science, of all of which it is at once an element and an evidence.”

And we find that this opinion as to the primary importance of roads over all other forms of works and undertakings is supported by such a high authority as that of the well-known historian of the engineers.

“The road,” says Smiles, “is so necessary an instrument of social well being, that in every new colony it is one of the first things thought of. First roads, then commerce, institutions, schools, churches, newspapers, &c. The new country as well as the old, can only be effectually ‘opened up’ by roads, and until these are made, it is virtually closed.”

If time permitted it would be very interesting to trace the history of roads from the earliest times down to the present, but to do that would require another paper at least as long as this one. The author can only say here that the roads in England, even in and round London, down to quite recent times, were in the worst possible condition, and as late as 1736 we find Lord Hervey writing from Kensington, complaining that “the road between this place and London was so infamously bad that we live here in the same solitude as we would do if cast on a rock in the middle of the ocean, and all Londoners tell us that there is between them and us an impassable gulf of mud.” The first person who wrote upon the science of road-making seems

to have been Thomas Mace, who published a pamphlet in 1675 with the following curious, if rather long-winded title:—

“The profit, convenience, and pleasure for the whole nation, being a short national discourse lately presented to His Majesty (Charles II.), concerning the highways of England, their badness, the causes thereof, the reasons of their causes, the impossibility of ever having them mended according to the old way of mending, but may most certainly be done and for ever so maintained (according to this new way) substantially and with very much ease, &c., &c. Printed for the public good in the year 1675.”

Part of the advice is given in rhyme, which is not so good as the advice—

“First let the ways be regularly brought
To artificial form and truly wrought,
So that we can suppose them firmly mended,
And in all parts the work well ended,
That not a stone’s amiss, but all complete,
All lying smooth, sound, firm and wondrous neat.”

And then he adds this couplet which might be added to the description of a good many contrivances, and resolves—

“There’s only *one thing* yet worth thinking on
Which is to put this work in execution.”

If in the laying out of a new road by the engineer, either from his want of skill or foresight, or still worse if he be in any way coerced into doing what he knows is not strictly correct, and he takes it along an unsuitable line of country so that the rise or length is more than it ought to be, then the yearly and constantly recurring losses to the community will be very great, as will be readily understood when we remember that extra vertical height ascended or distance traversed is so much useless work done.

An instance of this defect in road-engineering is quoted by Simms in his work on levelling. The old road through the Isle of Anglesea was 339 feet above the water level. The new road constructed by Telford only attained a height of 193 feet above the same level, it being 146 feet lower than the other, while it was over two miles shorter. The author knows many roads in Victoria at the present time, on which are grades so steep as to seriously interfere with the carriage of goods, and which

could easily have been avoided, and of other roads in which some of the grades have been altered three times.

It is an old saying that the shortest cut across is often longer than the longest way round; it is often so in road-making, and we may find that either because of the bad condition or of the gradients of the shorter one, we may be forced to expend much more time and labour in travelling over it than over the longer one.

For example, suppose there are two towns ten miles apart, and it is required to set out the best possible road between them, having regard to its first course, the cost of maintaining it, and also of the cost of traction upon it.

Now, first as to the condition of its surface, from the following formulæ published by Sir John McNiell, we find that the force required to move a vehicle varies enormously with the state of its surface—

$$R = \frac{W + w}{100} + \frac{w}{40} + CV$$

When R is the force required to move the coach; W , weight of coach; w , weight of load; V , velocity in feet per second, and C a constant depending for its magnitude upon the character of the road's surface, and which varies from two on a paved road to thirty-two on a wet muddy ground road, its value for a good dry macadamized road being about five. From which we gather that the forces necessary to move a coach weighing, say 2,400 lbs., with a load of 2,000 lbs., at a speed of 6 feet per second along a paved road and along a muddy gravel road are respectively 106 lbs. and 286 lbs. Secondly, as regards gradients, suppose we take three trial lines across the country:—The first, three miles of a grade of one in twenty, and the rest level, each mile of the three miles at the given grade will be equal to about two miles on the level; the total distance is therefore equivalent to thirteen miles. The road to be used for a coach weighing three tons, travelling

at six miles per hour. The next line gives us three miles of 1 in 30 grade and the next level. The total equivalent distance of this will be $1.6 \times 3 \div 7 = 11.8$ miles.

The last line gives three miles of 1 in 100 grade and rest level, this gives an equivalent to $1.185 \times 3 \times 7 = 10.55$ miles.

So we see that it would pay us to go round two-and-a-half miles to get this last grade. But instead of a coach, if our calculations had been based on waggons weighing six tons, travelling at a rate of three miles per hour, the equivalent distance for the 1 in 30 grade would be $17\frac{1}{2}$, and for the 1 in 100 grade 14.5, a difference of three miles.

We see then how the distances are practically modified by the grade, so that for example, if two roads rise, the one, 1 in 15, and the other, 1 in 35, the same expenditure of power would move the the load through 15 feet of one road and 35 feet of the other at the same rate.

In general, the grade should not be less than the angle of repose, which is the angle of the slope, upon which a vehicle would just not roll down the hill. The proper grade should be the ratio between the force necessary to draw the load and the load itself upon the same road when level.

There is a curious fallacy with regard to undulating roads, as to the benefits to horses travelling upon them. The theory is that the up-and-down grades give some of the muscles a rest whilst the others are working. This idea, though it has the appearance of great plausibility, is a mere popular error unable to withstand the test of intelligent investigation. Dr. Barclay, of Edinburgh, when asked his opinion upon this matter by Stephenson, said "it was demonstrably a false idea that the muscles can alternately rest and come into action."

At the same time if we have a long incline which is steeper than the angle of repose, it is well to make some resting places for horses of a slope rather less than that angle.

Another question arises with reference to the setting out of roads, and that is their line of route when passing through, or

connecting several towns or settlements. If the terminal towns are much more important than the others, one straight connecting road should be constructed with branch roads to the other places. But if all the towns be somewhat of the same size and standing, it will be better to make one deviating road passing through each. In the first case the total length of the roads to be constructed will be longer, but on the other hand the great bulk of goods carried will go straight to their destination, whilst, in the other case, the total length of road will be much shorter, but a certain proportion of the goods will have to be carried further than is absolutely necessary.

The engineer will then have to consider if the payment of the interest upon the money expended in constructing the longer road will be compensated for by the saving effected in the direct carriage of the bulk of the goods between the terminal towns. It is as regards such matters as this that a good deal of the prosperity or otherwise of country towns depends, and it is in dealing with them that the engineer may exhibit his practical and theoretical knowledge.

In the very first stage of opening up country roads large sums of money are often expended badly, and often worse than uselessly. He referred to the clearing of the timber from them. Sometimes to save expenses in the first instance the trees are merely cut down to the ground level; now nothing can be worse than this, for very soon the ground surrounding the stumps falls away, and then they are left in their bare nakedness to jolt the lives out of unoffending coach or buggy passengers. The money voted for the road has all been expended, and the only result is that its last state is worse than the first. By all means let the trees be grubbed out completely for at least two feet below the surface—for Yankee grubbing, which consists in cutting the stumps some inches below the ground and filling over them, is almost as bad as the first plan. By means of grubbing we get rid of the tree, branch and root, and, remember, if we do not get the leverage of the tree to get up the