

keepers, clerks and stenographers reporting to and under the authority of the secretary. Legal counsel may be generally advisable and should report directly to the board or its chairman. A right of way agent may be necessary and he may report to the counsel or to the secretary, as deemed advisable. The chief engineer should be the chief executive officer of the board, and he should be given all the authority necessary to make this fact fully and finally realized. As such, his responsibility to the board would be definite and the board should do nothing to muddy the waters of this situation.

The speaker wishes to say here that it seems to him that more inefficiency, with its waste of money and unsatisfactory results, has come from division or lack of clearness in responsibility than from incompetence.

In such a position as above described, a chief engineer can not only afford to be perfectly open and frank in expressing his opinions to his board, but he is encouraged to do so to the extremes of his ability. The board may then act more intelligently. In cases, where in its opinion the other considerations outweigh the engineering ones and the decision seems to be against the recommendations of the chief engineer, the latter feels his relief from the responsibility, and his efforts to properly carry out the decision of the board should, and probably will, be more earnest and effective.

Under the chief engineer should be two assistant engineers selected by him—as, it might be said here once and for all, should all the employees of the engineering department. One should be in charge of the construction, the other of the surveying and planning. But the plans should always go up to the chief engineer through the assistant in charge of construction. The benefit of criticisms from the workers in the field will then be had before it is too late to make changes without complications or serious expense and many of the routine difficulties of execution will thus be avoided.

As soon as the completed construction has reached an aggregate to justify it, the establishment of a maintenance division and the selection of an assistant engineer for its head should be had. Preferably this important step should be taken before it is clearly justified, rather than after.

The vast importance of proper maintenance of roads is beginning at last to be recognized by the states. One, at least, of the reasons for the better maintenance of European roads is unquestionably the absence, to a great extent, from the minds of those in authority over the roads there, of construction problems and consequently the concentration there possible on the minute, tedious, and recurrent details of maintenance. The proper solution of construction problems is not only of interest to almost all, but is also generally accompanied by early and shining rewards. That of the maintenance problem seldom, if ever, is quick or spectacular. Naturally construction problems attract, while those of maintenance seem drudgery. Long, persistent effort in little ordinary matters is demanded of the maintenance division. No greater mistake can, in the speaker's opinion, be made than to expect the maintenance to be satisfactory where the engineer in charge of construction is required to look after it also. This holds good surely above the point when the maintenance expenditures are up to 10 per cent. of its construction expenditures annually.

Division engineers, resident engineers and inspectors will be arranged and needed according to the territory to be covered and the amount of work going on. Probably also, facilities for testing materials will have to be provided and the man in charge of such should report to the head of the construction of maintenance division according to the

amount of work being done for each by him; or, he may report to both under some circumstances.

Under the assistant in charge of the surveying and planning will be needed one or more survey parties, draftsmen, calculators, etc., the number of each depending on circumstances, as may readily be seen.

If the amount of work to be done annually is large, scattered and complex, the chief engineer will also need clerical assistance in the shape of a chief clerk or secretary, possibly a purchasing agent for materials for force account work, clerks and stenographers. The purchasing agent may report to the assistant in charge of construction or to the chief engineer directly, as deemed best. The chief clerk should report to the chief engineer directly and the clerks and stenographers to the chief clerk.

The responsibility for the entire engineering department resting clearly on the chief engineer, should be delegated by him only as may be warranted by the exigencies of the situation, and when so delegated, it should be done so clearly and definitely that there can be no doubt nor failure in the mind of anyone having business with the organization in understanding just what authority the subordinates have, at least so far as it concerns their business. There should be left no opportunity for a contractor to say that certain work or materials should be paid for in full "because the inspector or resident engineer saw it go in," nor should a contractor be able to say he was referred from one party to another for a decision on a point and, unable to get anything definite, he "had to do the best he could."

The delegation of authority, especially in a newly organized state highway department, must be made conservatively. The commission and its chief engineer may be new to the work or to the situation, even if the engineer has been trained in similar work elsewhere. Naturally the public will look to them personally for decisions and for locating responsibility, and at first surely demand their personal, physical presence in many cases. The customary requirement for the employment as far as possible of local men for the subordinate positions, at least, will render it advisable for the chief engineer to take on many bright and otherwise admirable young men except that they may be deficient in experience with modern highway work.

The rapid progress in the underlying science and the art of such work, makes it difficult for many beside the chief engineer to keep up-to-date in it, and, therefore, necessary for him to retain, until his subordinates become fully trained as regards the fundamentals of their work at least, sufficient authority, in perhaps a slight excess, for the best results. Further, the speaker has found that far less difficulties with contractors over points arising in connection with their work under the specifications become serious when considered and decided by the chief engineer in person than in cases where such decisions are left to younger and more inexperienced men. In fact many of these points are never raised when contractors know that the chief engineer himself will decide them and can be counted on to abide fairly by the specifications. Of course, unless the commission leaves the decisions provided by the contracts to be made by the chief engineer in the hands of the latter, and supports him in such, those contractors or others anxious to have their claims arbitrated by inexperienced or prejudiced parties may create, by appealing to the commission for decisions, an even worse situation than that in which the authority of the chief engineer's subordinates is not clearly defined or too much delegation of authority has been made to them. But relief from such a situation is from outside the remedies of organization.