troversies the true reputation of a consultant emerges. The writer has been dismayed on occasion to discover that the "opposition" had retained a particular consultant because he knew the consultant's opinion would reflect the desires of the opposing party. On other occasions, the writer has been delighted to learn that a different consultant was on the opposite side of a controversy, even though that consultant was a highly competent individual, because he knew that the facts would be fairly and dispassionately used. A consultant can hardly have a more enviable reputation than to be desired as an opponent in spite of his great professional competence.

Finally, the writer would suggest that the consultant should be wary of making non-technical judgments. He is not a lawyer. He is often not called into a controversy until the battle lines are drawn. If he ventures out of his technical specialty, he may become unwillingly a pawn in the struggle.

## Discussion

By Frank A. Marston,* *Member*

I recall seeing a bas relief copied from an Italian church, of some centuries old, which depicted the head and shoulders of the architect, the contractor and the owner, in that order. The contractor was thumbing his nose at the other two. Apparently some of the problems of today in the field of construction are not new, particularly as regards human relations and responsibilities. Dr. Terzaghi's paper is worthy of thoughtful consideration. His understanding of the problems and experiences of a consultant in civil engineering can be appreciated sympathetically by any engineer who has practised in that field over a period of years.

There is no question but that the consulting engineer who can carry on his professional practise with a small office and only a few associates may have fewer worries than another who practises as part of a large organization. On the other hand, the former may not have the thrill and the satisfaction of accomplishment that comes to the latter, who not only consults with others, but is closely identified with all stages of the design and construction of important projects.

Much of the paper could have been titled, "The Importance of

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Soil Mechanics in Foundation Engineering", but the experiences cited are effectively used to demonstrate the value of competent advice from a consultant, and his relations to the project.

Inexperienced officials are sometimes led to select an engineer for a project because of a proposed low fee, rather than on the basis of qualifications. Such an engineer may prepare designs which are unsuitable for the soil conditions actually encountered. Such officials may object to expending funds for adequate subsurface investigations by means of borings, test pits and geological studies. To employ a consultant to advise during the design and construction stages may be considered too expensive. Then again the contractor may conduct his operations in a manner contrary to the specifications or at variance with the assumptions of design. Thus, conditions result which seriously affect the interests of the engineer, the client and the contractor.

In building a sewer system, where sewer pipes are to be laid in deep cuts, if the plans and specifications require that only narrow trenches be excavated and the contractor is allowed to dig wide, V-shaped trenches, as with a power shovel and without sheeting or bracing, the loads coming on the pipe may be greatly increased and result in the destruction of the pipe. Such a situation may bring criticism by the client of both the engineer and the contractor.

Another example concerned the building of a large reinforced concrete sewer in a deep trench. The excavation was made in open cut with steeply sloping sides. The concrete was poured during cold weather. Before the concrete had attained its strength the contractor backfilled the trench by pushing excavated material over the edge of the trench and by dropping material into the trench from a clam shell bucket attached to a crane boom. The heavy eccentric loading which resulted caused the sewer to crack. Furthermore, an attempt was made during the backfilling to consolidate the backfill material between the sides of the sewer and the sides of the trench by dropping the bucket on the fill as it was placed. Cold weather, rain and clayey soil helped to aggravate conditions. Both the engineer and the contractor were criticized.

A consulting engineer can be of material service to a city engineer, or other local official, by carrying the responsibility for a project, thereby relieving the local official of that burden.

The method of making a boring to determine the character of subsurface conditions may have an important bearing on the samples

obtained and conclusions reached. Information can be highly misleading if an unsuitable method is used. Here again the engineer may be subject to criticism.

The paper points to the importance of close cooperation that is needed between those making preliminary field surveys, the design group, and the construction supervision group. The project engineer who has charge of the design should be thoroughly familiar with the work of the other two groups and in close contact with them. One prominent consulting engineer made a practise of declining to design work unless he was given general supervision of construction of it, including an opportunity to visit the construction whenever he deemed it essential to do so. There is merit in such a position, particularly as regards foundations and structural features.

The paper refers to the case where a consultant is hired for preliminary studies only so as to get the value of his name as "window dressing". One way to discourage that practise is to require that a stated fee be paid for a specific time regardless of how much service is requested, or a percentage fee might be appropriate.

The services of a competent consulting engineer will be valuable in the event of a structural failure even though he may have had no contact with the project prior to the failure. In such a case it is essential to determine the facts, insofar as possible. On the basis of his report it may be possible to settle the controversy without court action. However, it would be better to have had the benefit of the consultant's advice throughout the several stages of the project.

Competent inspection of construction work is of benefit to all concerned even though there may be no legal obligation for the client to provide it. The resident engineer and inspectors should not be paid by the contractor and should not be obligated to him. When the client is not a public authority and the contractor can be selected for his experience, ability and integrity, it should be practicable to reduce the cost of inspection. However, the engineer responsible for the design should have frequent contacts with the progress of construction to be sure that no unforeseen conditions develop that might conflict with the design.

A consultant should so conduct himself as to have the respect of his fellow engineers. He will do well to conform to the "Canons of Ethics" formulated by the Engineers' Council for Professional Development. If he is a member of the American Society of Civil Engineers

he should be guided by its "Code of Ethics", as well. Similarly, members of the Boston Society of Civil Engineers are obligated to conform to its "Code of Ethics".[1]

I commend Dr. Terzaghi's paper to all engineers engaged in private practise and to those who employ their services.

## Discussion

By Carlton S. Proctor*

Dr. Terzaghi's highly interesting paper, reminiscent of his brilliant professional and pedagogical career, points out many of the pitfalls that beset the client of the "package deal" engineering-construction procedure. His paper makes clear the fact that such pitfalls are inherent to "package deals", whether practiced by the engineering-construction departments of the client organization or by an independent contractor.

While his paper primarily depicts a situation where the engineering-construction work is performed by the Owners' engineering-construction departments, the same arguments apply with equal or greater force to the situation where the work is performed under a package contract by contractors whose services include both design and construction. In the latter case, the situation is additionally weakened by top management pressures to produce designs fitting into requirements for the use of the contractor's own equipment and limited to the contractor's experience.

The writer's experience over the past 39 years, as a member of a firm of Consulting Engineers specializing in substructure, marine, dam and other "heavy" engineering, completely endorses such conclusions.

Dr. Terzaghi's paper presents the case for the independent consultant, unencumbered by an engineering organization; but it ignores the obvious fact that few independent consultants have acquired his pre-eminence as expert in his field. Hence this paper cites examples of potential and actual failures and engineering mistakes which would not normally be discovered in time by a lone consultant but which would have been precluded under standard professional provisions by

1Jour. BSCE, Vol. 38, July 1951, p. 331.

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