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"The Conditions of Engineering Contracts." †

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Mr. J. S. Alford wished to emphasize certain points which had been only briefly referred to by the Author.

Under the Association form, all variation orders had to be signed by the Engineer, and no variation could be made by the Contractor without such an order. Under the same form the Resident Engineer had no authority to issue variation orders. Circumstances sometimes arose under which that procedure was difficult. Some relaxation was needed for the authorization of emergency works, more particularly when the headquarters of the Engineer were far removed from the site of the works. In a set of General Conditions, which had been drafted by the late Mr. A. A. Hudson, the Contractor had to produce, at the time when the accounts were made up, orders signed by the Engineer for all alterations. The Engineer was able, under those conditions, to issue orders for extra works retrospectively. The case of Buchan *v.* Feltham Urban District Council illustrated that point. If the Employer should object to such a provision, he should secure protection in the Agreement for Employment and should not seek it in the General Conditions.

Referring to arbitration, he strongly supported the Author's view that that should usually be undertaken by some party other than the Engineer. On small contracts, however, the method of arbitration by an outside person was too cumbersome and expensive and the Engineer might then be the sole arbitrator. He hoped that, in such cases, it would be found possible to modify the usual clause of appointment so as to give the Engineer complete authority over all engineering matters, including payments arising therefrom, whilst reserving to the Contractor the right to take legal proceedings, if he considered the contract documents did not properly represent the work which he had priced. The Contractor could, in that

† Journal Inst. C.E., vol. 11 (1938–39), p. 3 (February 1939).

way, avoid the necessity of making personal and unpleasant allegations against the Engineer in order to obtain a locus when, at the most, a mistake had been made.

Referring to the billing of the general obligations, Mr. Alford considered that it was useful to set out by numbers the whole of the clauses in the General Conditions and Specifications in bill No. 1 of the quantities, thus giving the Contractor an opportunity to price all the various obligations separately by clauses.

On p. 20 § the Author referred to the desirability of putting upon Sub-Contractors the obligations which the Contractor had assumed. In a civil engineering contract where there was a civil engineering sub-contract that was practicable, but where the Contractor had to make a sub-contract for the supply of machinery it was not, as a rule, practicable. In such cases the Contractor might be given an item in the bill of quantities to enable him to price the obligations which he could not transfer.

Mr. Fred Lavis, of New York, observed that the forms of contract in the United States since 1914 had tended to eliminate the assumption by the Contractor of undue or unforeseeable risks. In the earlier forms of contract, especially those for the construction of railways, the clauses giving the Engineer complete and final authority were so stringent that full compliance with both the literal aspects of the contract and with what the Engineer might decide, might easily have completely ruined the Contractor. Those forms of contract had been built up in course of time by engineers and lawyers as a defence against sharp practices by unscrupulous and not entirely responsible contractors during the era of expansion. Any Contractor who undertook a contract under such a form was, therefore, almost entirely at the mercy of the Engineer, and the profession could well be congratulated that its members generally exercised their powers fairly and with wisdom.

Dating from the beginning of the twentieth century, however, with many more responsible and established contracting firms, who had their own responsible engineering staffs and competent direction, the tendency had been to develop forms of contract suitable to agreements between more or less equally responsible and competent contracting parties. In tunnelling, for instance, the Contractor might be paid for " over-breakage " for a specified distance beyond the line of minimum section " neat line ", but all " over-breakage " beyond that zone was not only for the Contractor's account but he had to back-fill carefully the space with suitable material. That sort of provision still required careful work by the Contractor but recognized the impracticability of hewing to a given line in a rock tunnel, and minimized the risk for ordinary reasonable "over-breakage."

In the case of foundations, even where careful borings had been taken,

§ Page numbers so marked refer to the Paper. Footnote (†), p. 373.—Sec. Inst. C.E.

the Contractor, whilst not relieved of all responsibility or troubles due to lack of experience or carelessly conducted work, could be relieved of some of the responsibility for unusual and unforeseen developments which might involve expense or increased time (under a time-penalty clause).

The courts of the United States had been very jealous, under the terms of the English common law, of guarding the rights of Contractors who had cause of complaint against what were considered unfair decisions by the Engineer, even in contracts where it had been agreed that the decision of the Engineer should be final.

Mr. Lavis emphasized that where the risks were modified for the Contractor, not only was the contract a much fairer instrument, liable to be upheld by the courts, in case of need, but also lower prices usually resulted.

The Engineer had, of course, to protect himself and his client fully, and the forms of contract minimizing the risk to the Contractor probably required much more care and skill in their preparation than did contracts of a more arbitrary nature. That care and skill, however, was what the Engineer's client was entitled to expect (together with the resulting lower prices), and should be furnished if the Engineer were fully competent and careful.

Mr. E. J. McKaig observed that the impression left by some of the impractical and one-sided conditions frequently embodied in engineering contracts was that they might be due to the intervention of the legal mind. That impression was supported by the fact that, more often than not, the more unreasonable the terms the more legal the phraseology. Sir Lynden Macassey suggested that conditions which savoured of sharp practice might be due to the too-willing assistance of lawyers. Whether or not that were true, there were many quite usual conditions which would not bear examination from the point of view of common sense and equity.

Referring to the Contractor's liability for all damage (p. 13 §), the Author stated that there was such a heavy risk that it seemed surprising that business men had been willing to take it. In the quotation from Lord Justice Bowen's judgement (p. 24 §) similar sentiments were expressed. The inference was that the Contractor entered into the undertaking fully aware of the magnitude of these risks. That was, however, not quite true: usually, before the Contractor could examine the documents governing the contract, he had to pay a deposit (returnable on receipt of a bona-fide tender). It was not, therefore, until he was involved to the extent of the deposit (small though it might be), and so was considered as a potential Contractor, that he was aware of some of the conditions, which, if enforced, could easily make the position impossible so far as any profit was concerned.

Mr. McKaig had in mind two Specifications, Conditions of Contract, and Bills of Quantities, for contemporary works of considerable size.

§ *Ibid.*

They were issued by different engineers, and the works were for public authorities made possible by unemployment grants. The one was completed without any serious dispute ; in the other, disputes arose quite early as a result of the more or less impossible terms, and ended in a long and costly arbitration.

It might be said that, since the first case was satisfactorily completed under those conditions without dispute, there could be little wrong with them. They had functioned satisfactorily. In the second case, however, it might be said that although the disputes were based on certain conditions of the contract, they arose in fact, from the temperament and character of the Contractor. He was a litigious person and would have found cause for dispute in any case : was that so ?

In the first case the Bills of Quantities described a large quantity of Portland-cement concrete. The Specification and General Conditions called for the British Standard Specification for Portland cement. Further on in the same document was a clause : " Rapid hardening cement shall be used if directed by the engineer." That sounded quite simple, but what did it mean ? In making his tender, the only item the Contractor had to price was Portland-cement concrete ; but he was under the liability of having to use a cement which cost more per ton, and could not be stored for the same length of time as ordinary Portland cement. Was he to quote for the more expensive, rapid-hardening cement, which he might never be called upon to use, or was he to quote on the basis of the cheaper cement and take the risk of a loss throughout the work ?

The quantities in that case clearly described the concrete required, but the Conditions gave the Engineer the right to vary that description, without making any provision for the Contractor to recover the increased cost of the variation.

A further clause stated : " The Contractor shall guarantee the stability of the works and be responsible for accidents from whatever cause." That might appear reasonable except for the words " whatever cause." If the Contractor were to be responsible for anything that might happen, whatever the cause, it was necessary to examine the various causes of instability of works. Omitting matters such as erection, and machinery, and the sort of accidents that, unfortunately, did happen from time to time and were risks which the Contractor always carried, the probable causes of instability might be taken as the following :—

1. The design of the works being inadequate to the conditions or duty for which they were designed.
2. The type and quality of materials specified being unsuitable and inadequate to the design.
3. Bad workmanship.
4. Failure of the site.

Of those four items, Nos. 1, 2, and 4 were beyond the control of the

Contractor. He neither designed the works, specified the materials, nor chose the site. Workmanship, however, was the Contractor's responsibility, although that was usually very carefully watched and controlled by the Engineer and his inspectors. Nevertheless, if any failure or damage were to arise because of bad workmanship, it was reasonable to make it the liability of the Contractor. The Contractor engaged on that contract, on being asked whether he realized the grave liabilities embraced by the General Conditions of Contract, stated that he was quite aware of the unreasonableness and absurdity of many of the terms; since, however, a number of other Contractors had willingly tendered to them he had done so and he felt sure that there was no intention of enforcing or even attempting to enforce them. If the Contractor were correct in his surmise, there was no justification for such Clauses appearing at all. The contract which contained many such conditions carrying heavy risk was completed without dispute. It would have to be admitted, however, that the work was attended by a certain amount of good fortune.

Mr. McKaig then referred to the second case in which disputes did arise. One of the claims was based on the clause which stated :—" The Contractor shall satisfy himself or shall be deemed to have satisfied himself as to the nature of the ground, dimensions, levels, character and nature of sewers, drains, etc., which can in any way influence his tender, and no claims for extra works or otherwise will be allowed in consequence of any incorrect information on these points or any inaccuracies with reference thereto which may appear on the drawings or in this specification. Nor shall the Contract be nullified in consequence of any error, incorrect information or inaccuracies." Considering first only the part referring to the nature of the ground and surroundings, that might be reasonable for certain works, but it would be dangerous to make it a hard and fast rule. It could only mean that contractors tendering should make a survey of the site, both geographical and geological, regardless of the fact that before the drawings and specification could have been prepared, the Engineer (who was presumably the author of the clause) had necessarily undertaken such a survey. The necessary investigation might be quite a small matter, but equally it might mean costly and lengthy operations such as boreholes and trial pits. Then it had to be considered whether there was sufficient time, between the invitation to tender and the closing date, to carry out any exploration that would yield reliable information. Such a survey, especially one involving excavations which might (in the same way as the contract Mr. McKaig had in mind) affect a main thoroughfare, would be impossible if there were a number of contractors wishing to tender. Such a project became ridiculous when it was considered that the information sought was already in the possession of the Engineer.

A clause of that kind suggested that the Engineer was attempting to unload the burden of any possible shortcomings of his design on to the Contractor. The Engineer might even be aware that the final cost would

be very much greater than the sum indicated by his drawings and specification, and therefore that much greater than the amount which he had led his employers to expect. The appearance of such a clause would at once arouse suspicion that the conditions of the site might not be as shown on the drawings, and were the Contractors, before tendering, to make investigations at the site proving it was not of such nature as the drawings would lead them to suppose, what course was open to them ? Could they amend the drawings, and introduce appropriate items into the quantities to meet the case ? Or could they, on the other hand, tender in the prescribed form, knowing full well that the work could not be performed to them ?

The latter part of the clause referring to incorrect information and inaccuracies might, of course, be a safeguard to provide against accidental errors and oversights, but there was nothing to show that deliberate misrepresentation was excluded.

Following the clause that the Contractor should satisfy himself as to the nature of the ground, were two stipulations that were more or less corollaries to it :

1. " The Contractor shall reconstruct at his own cost any work he may have erected upon an insecure or insufficient foundation."
2. " No foundation shall be placed until the engineer has inspected the excavation and given his approval in writing as to its suitability, but even that approval will not relieve the Contractor from his responsibility for the stability of the work."

However practical those stipulations might be, there appeared to be some redundancy about them. If the Engineer's approval in writing did not relieve the Contractor of any liability, then at the best it was a valueless document and might be dispensed with.

In the contract to which those stipulations related, disputes did arise, and one claim was contested on the basis of the clauses quoted. During the course of the work the Contractor found the conditions of the ground at one part of the site to be such that it was obvious that the structure, as designed and shown on the contract drawings, could not remain stable for long, if in fact it would be possible to construct it. The information was at once communicated to the Engineer with suggestions showing how the difficulty could be met. The suggested amendment involved some additional expense. The Engineer, however, would not give any order for the extra work or variation and relied on the clauses which subsequently caused so much controversy.

After some difficulty that part of the work was completed, and, as had been obvious, within a few weeks it collapsed. The Contractor considered he had fulfilled his part of the contract since he had warned the Engineer of what would happen. The Engineer, however, pointed out that under the terms of the Contract the Contractor was responsible for the site being suitable for the work, that was to say, no extra payment would be made

for anything that might be necessary for the stability of the work. The matter went to Arbitration. The Arbitrator, who was an engineer, awarded against the Contractor, who had to construct the work to an amended design. It was therefore not quite true to say that some of the harsh and one-sided stipulations were a provisional defence against the unscrupulous and dishonest contractor, and would not in the ordinary way be enforced, or that they were not intended to be interpreted so that an unfair advantage over the Contractor could be obtained.

Mr. McKaig offered the information that he himself was not a contractor: the documents quoted were obtained through the good offices of the engineer in the one instance, and from the contractor in the other.

Mr. John Pollock, of Nairobi, suggested that there should be compiled a "Standard General Conditions of Contract", applicable to all contracts. The conditions for each individual contract could be modified by the addition of clauses for "Special Conditions" which would be the responsibility of the Engineer-in-Charge. Referring to the amount of time spent in petty work such as clearing up the site after the main structure was completed, he thought that the time clause should take account of the "Substantial Completion of Contract."

It seemed unreasonable to ask contractors to carry out works 50 per cent. or more over the schedule quantities at schedule rates: from 15 to 20 per cent. was a fair limit to place on quantity variations; anything over that limit should be subject to a revision of the schedule rate.

Mr. Pollok suggested that the appointment of the Engineer as arbitrator was not fair to the Contractor, since the Engineer, by virtue of his position, would find it difficult to judge any dispute with an unbiased mind. The institution of a "Standard General Conditions of Contract" would indicate to many Engineers that their legal position was not as strong as they had hitherto believed, and so would reduce the number of disputes which required arbitration.

Mr. E. G. Walker supported the Author's views (pp. 6 and 7 §) regarding temporary works. In the majority of cases the aggregate amount of practical experience of execution of works available to the Contractor was greater than that available to the Engineer, although the latter was in a better position to assess the ultimate results which he wished to attain. Unfortunately, in civil engineering contracts the two functions of design and construction could not always be separated completely, and details of design frequently had to be modified to suit exigencies of construction. The responsibility and financial risk in the execution of the works, however, fell upon the Contractor. The Engineer who specified in too much detail how the works were to be carried out might run needless risks by so doing, in that he was taking on himself responsibilities which the Contractor was paid to carry. The freest possible hand should be given to the Con-

§ *Ibid.*

tractor, reserving only to the Engineer that over-riding control which it was essential he should possess, though not always exert.

The Author's suggestion for discriminating more clearly between a "bill of quantities" and a "schedule of prices" was good and should be adopted. Unfortunately, works varied very much in character, and individuals differed very much in their views as to what constituted an adequate statement of the details of the work; to obtain a general standardization of practice was likely to prove difficult. At the same time, there was no reason why the Author's definition of the two terms "bill of quantities" and "schedule of prices" should not be adopted. An incidental advantage of a rigid demarcation between the two would probably be that in the preparation of his contract documents, the Engineer would, by having his attention directed to the two classes of price covered by them, be more likely to prepare a more complete schedule and thus avoid the not infrequent difficulties, in the absence of basic data, of having to adjust prices purely by a process of bargaining.

The Author drew attention to the difficulties arising from the variation in practice in regard to pricing preliminary items. Individual contractors often differed widely in their treatment of preliminaries and so added another complication to the Engineer's task of comparing tenders. In many contracts, particularly those emanating from public authorities, there was a considerable elaboration of preliminary items, though often few of those items were actually priced in the tenders. The question arose of how far many of those items were necessary in the bill of quantities. A proper specification and set of contract conditions should describe fully the circumstances under which the works were to be executed and the responsibilities of the Contractor in relation thereto. In many cases, therefore, it would appear unnecessary to refer to them again in the bill, particularly as many contractors preferred to spread overhead charges over the construction items of the bill rather than to price them separately.

There existed far too great a tendency for Employers to expect Contractors to carry risks which were the legitimate risks of the Employers. The Author referred to that matter in some detail on p. 13 §. His solution for the difficulty that might arise from the materialization of a risk of that sort was the issue of the extra-works order by the Engineer. Whilst that might be an immediate practical solution, it was one that, in most cases, placed the Engineer in an arbitrary position in which he had to assess the liability involved and to decide whether it should be borne by the Employer or Contractor. Such a position was easier for an independent practising engineer who, himself, had a contract with the Employer to design and supervise the construction of the works, than it was for an engineer who was the paid servant of the Employer. The present-day tendency for expenditure on civil engineering works to come more and more within the

§ *Ibid.*

control of public administrations or very large commercial combines, all of which employed their own technical staffs, was resulting more and more in the administration of works contracts being in the hands of employees of the Employer. That condition did not arise when, as was the practice in the earlier days of civil engineering, the contract was administered by an engineer practising independently. Such a practice was a far better way of maintaining a balance between the Employer and the Contractor. A contract which could be administered equitably under those circumstances might need considerable alteration to provide for an equal degree of fairness under the more modern conditions. It was remarkable that, whilst modern arbitration law provided so very carefully for the complete independence of the Arbitrator, there were so many engineering contracts which left the settlement of large possible differences in the hands of one of the parties acting through his own employee.

Mr. Walker endorsed the Author's view of the desirability of attempting some closer standardization of the form of civil engineering contracts than now existed. Admittedly it was a subject which had its full measure of difficulties. Already a certain amount of work had been done. The Author referred to the Conditions drawn up by the Association of Consulting Engineers. The Institution of Electrical Engineers had drawn up a standard for electrical contracts and the Institution of Mechanical Engineers had the subject under consideration in relation to mechanical engineering. The standards of the Royal Institute of British Architects had been in general use for building work for a number of years. There was every reason for making a co-ordinated study of the subject of contracts for civil engineering works and for endeavouring to evolve standard forms applicable to the various conditions under which such contracts were carried out. The range of contracts embraced under the title of civil engineering, using the term in its more restricted sense, was greater perhaps than that of mechanical and electrical engineering contracts, which normally had to cover only the supply and installation of machinery and plant, and therefore the subject might well be found to require more detailed study.

The Author, in reply, emphasized the importance of the Engineer's right to order extra work retrospectively. The case referred to by Mr. Alford clearly showed that unless the Engineer had power to implement an oral agreement with the Contractor by a subsequent order in writing, the Employer might escape payment for extra work, or might refuse to be bound by the Engineer's certificates on the ground that the order given was not in writing at the proper time. The right of the Engineer to waive merely technical conditions precedent to payment would appear to be reasonable.

The question of the nature and extent of preliminary items of Bills of Quantities was referred to by Messrs. Alford and Walker. The Author considered that the Bill should not attempt to restate the general obliga-

tions and liabilities set out in the General Conditions and Specifications, but should merely set out those items which necessitated work (lighting, watching, cleaning up, etc.) or a payment by the Contractor (insurances, damages for surface disturbances, fees, dues, etc.). General liabilities were not, in his opinion, the proper subject of item charges in the Bill, though the Contractor might be given the opportunity, if he thought fit, of inserting items of a general nature. Otherwise, they should be proportionately distributed throughout the items. The setting out of a series of clause numbers from the General Conditions and Specifications could not make the Contractor's liability any more definite, although a note to the effect that the prices in the Bill were to cover all obligations and liabilities set forth in any of the Contract documents was perhaps desirable.

Paper No. 5179.

"The Properties of Composite Beams, consisting of Steel Joists Encased in Concrete, under Direct and Sustained Loading." †

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Dr. Kálmán Hajnal-Kónyi observed that it was interesting to compare the total moments, at failure, for similar beams in the two groups with mix (*a*) and mix (*b*) in Part I of the Paper. It was stated (pp. 63, 64 §) that the specimens of the second series were made with a stronger mix of concrete and a greater cover over the compression flange of the joists; otherwise Nos. 8 and 9 were similar to the beams in the first series. It was, therefore, remarkable that the total bending moment at failure (Table II, p. 78 §) in beams Nos. 1 and 2 was 527,000 and 579,000 lb.-inches respectively (average: 553,000 lb.-inches), whereas in beams Nos. 8 and 9 it was only 488,000 and 501,000 lb.-inches (average: 494,500 lb.-inches). That was

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† Journal Inst. C.E., vol. 11 (1938–39), p. 61 (February 1939).

§ Page numbers so marked refer to the Paper. (Footnote (†) above).—SEC. INST. C.E.