

THE ANATOMY OF WASTE AND INEFFICIENCY IN ENGINEERING CONSTRUCTION

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"People must come to accept private enterprise not as a necessary evil, but as an affirmative good."

—EUGENE BLACK

THE ANATOMY OF WASTE AND INEFFICIENCY IN ENGINEERING CONSTRUCTION

By
W. X. MASCARENHAS*

My suggestions have a general application and are not only not directed against any Organisation or Department or any State but are intended as constructive criticism meant not to censure but to ensure greater speed, efficiency and economy in engineering construction.

What I say relates principally to the Public Sector, but also, *mutatis mutandis*, to the Private Sector in so far as engineering construction is concerned.

The principal causes that lead to waste & inefficiency may be listed as under:—

(1) Plans & estimates are rarely, if ever, prepared in complete detail, so that no changes for modifications, except occasionally minimal ones, are necessary for the orderly, systematic and economical completion of the work to a fixed time schedule.

Projects, even large, important and costly ones, are prepared on a crash-programme basis, leading to substantial changes, modifications and alterations

* *The author is a former Chief Engineer of a state, and an eminent engineer. This text is based on a public lecture delivered under the auspices of the Forum of Free Enterprise on February 20, 1970.*

during execution, and the consequent inevitable extra items and claims at inflated rates, that result in serious excesses over estimated and tendered costs and almost certainly failure to get full value for money.

Incidentally this leads to speculative tendering on the part of contractors and builders, and to bickerings and complications all round. To provide against their speculations going wrong, contractors tend to hedge by putting in higher rates than they would, if they knew what precisely was expected of them.

There is also the danger of collusion between the planner and contractor, who to secure a work will quote a low rate for big items and a high rate for small items, having been tipped off that the big items are going to be substantially reduced and the small items substantially increased in actual execution.

The first and invariable rule should, therefore, be that no work should be put to tender until it has been planned down to the last detail, the exact quantities of different items precisely worked out, all possible alternatives carefully considered and the best one chosen finally once and for all. Except for minimal changes then, which could not have been reasonably foreseen, any modification of the project and any excess over the tendered cost should be a bad mark against the officers concerned for slipshod planning. Each such case should be thoroughly examined and appropriate disciplinary action taken. The Agency for such scrutiny and disciplinary action will be suggested further on.

(2) The specifications for many items of work, viz., masonry, plastering, woodwork, etc. are under the conditions prevailing today totally unrealistic in certain situations and certain regions. They are specifications, which were drawn up half a century or

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(2) The specifications for many items of work, viz., masonry, plastering, woodwork, etc. are under the conditions prevailing today totally unrealistic in certain situations and certain regions. They are specifications, which were drawn up half a century or

more ago in the first instance, and then repeated as a matter of course, whenever the Schedules of Rates were revised.

They relate to a time when good building materials and good craftsmen and artificers were readily available, when materials needed as a rule only a cursory and perfunctory examination and pride of craftsmanship animated most skilled workers.

Today so enormous has been the development of constructional activity and so fast and furious its pace, that good building materials are extremely difficult to come by and skilled and conscientious workers even more so.

What is the point in specifying, for instance, in Bombay that bricks shall have clear sharp arrises, and give a metallic sound, when two are struck together? For that matter, the good bricks that conformed to such specifications in the good old days are no longer even required for the walling in R.C.C. framed structures, that are the usual form of high-rise buildings today. I could refer to wood in a similar strain — in fact, where is the wood to talk about at all, save coarse-grained country teak with knots and shakes and other defects, which the specifications strictly exclude?

For that matter, take that commonest of building material, cement concrete. Cement concrete is artificial stone and provided it has a certain crushing strength, density or impermeability to water and in some situations (as in dams) a certain weight, it matters little how it is made. As a matter of experience, with a view to providing useful practical guidelines in its preparation, we specify the proportions of the mix, water-cement ratio etc. We also specify the kind of coarse aggregate, its size and shape (prismoidal), the kind of sand to be used, its

fineness modulus etc. It may, however, be virtually impossible in certain areas and under certain restrictive conditions relating to quarries and crushing plant—the unavailability for instance of granulators or the nature of the rock formation—to get the prismoidal shape of metal prescribed; or the kind of sand that possesses the precise fineness modulus specified may not be available within a reasonable radius of the site of work. And yet it may be perfectly possible to design a mix, giving the crushing strength and other characteristics necessary for the task in hand. Nevertheless how rigidly in the past and all too often even in the present, the specifications regarding shape of aggregate etc. have been and are being enforced.

I could multiply such instances almost indefinitely. The point is that all specifications need to be re-drafted to suit materials as at present available, the workmanship that can now be commanded and the basic requirements as regards strength etc. that are essential for sound work. For extra-special materials or workmanship, extra-special specifications should apply and the enhanced cost fully taken into account.

Keeping the present 50-year old or older specifications, simply leaves a powerful lever in the hands of corrupt or just wooden-headed officials for harassing contractors and builders endlessly.

By merely taking the present specifications in hand, a minor official like an overseer can terrorise the average contractor and by stopping the work even for a day or two occasion him serious loss.

Such power and the all-too-frequent abuse of it must not remain in the hands of minor officials. The specifications should be realistic and practical. A further safeguard will be suggested presently.

At this point I would strongly urge that our existing I.T.I's should enlarge their scope and offer suitable courses for training non-English knowing artificers, such as masons, plasterers, carpenters and r.c.c. mechanics, versed in the techniques of bar-bending and placement, r.c.c. form-work and shuttering and the vibrating and curing of concrete.

Particular attention needs to be paid to all scaffolding, shuttering and form-work. Curiously enough the tender documents rarely, if ever, contain specifications relating to them. It is surely better to turn out good work in the first instance than to rectify defects in a badly furnished work afterwards.

(3) A third potent cause of waste and inefficiency is, paradoxically enough, the generally prevalent rule of accepting the lowest tender, specially when tenders are invited from registered contractors of the approved class or category.

The somewhat naive and facile assumption underlying this rule is that a registered contractor can be depended on to execute a project at his own tendered rates in strict accordance with the specifications, since the contract provides ample sanctions to ensure this, any failure on the contractor's part being punished by the imposition of heavy penalties, and in the ultimate resort by a rescinding of the contract and the completion of the work to the required standard through other agencies, at the original contractor's risk and cost.

In actual practice, substandard work is sometimes devalued, fines are often imposed but in only extremely rare cases is a contract rescinded, for the simple reason that, as all practising engineers know, the rescinding of a contract entails endless trouble and worry for the engineers in charge.

Audit is, of course, largely responsible for this

utterly unrealistic and unworkable rule, because of its pathetic faith in paper sanctions.

It is not an engineer's business to punish contractors or to push them out altogether. It is his business to secure the services of contractors who quote reasonable rates, ensuring a reasonable margin of profit for themselves, and can be depended on to finish the work to the specified standard, with reasonable supervision, within the quoted contracted figure and the prescribed period for completion.

In some countries, the contract is awarded to the tenderer whose quotation approximates most closely to the average of the quotations received, fantastically high and unworkably low quotations being excluded in arriving at the average. This system could, in my opinion, be adopted in this country and would greatly improve the quality of the work and eliminate or greatly reduce the temptation to create extra claims.

That the function of an engineer is not to punish but to secure good performance will be clear if we take the analogy of the function of a bank, which makes loans primarily on the credit-worthiness of a client and not on the collateral security offered. This is evident from the very term collateral security, meaning security on the side or subordinate security.

The Audit & Accounts Department must be made to appreciate this elementary fact and adjust its procedure accordingly.

Incidentally, inordinate delays in the acceptance of tenders are the order of the day, thus leading to considerable infructuous expenditure on the part of the tenderers, which naturally affects their rate structure. No more than a few weeks' time, say

6 to 8 weeks, should be the utmost required for an authority to make up its mind as to which tender should be accepted. If the plans and estimates are detailed and exhaustive and the specifications realistic and precise, the tenders received will not need to be conditional as they usually are at present and more time will not be necessary.

(4) Delay in the payment of Running Account Bills is one of the most vexatious and weighty factors that put up the ultimate cost of works. If money is the sinews of war, it is even more so of contracting. It should be realised that the working capital of a contractor is strictly limited and any delay in the realisation of his bills forces him to borrow money, often at usurious rates, to keep his labour force going and pay for his stores and building materials. In these circumstances, the repercussion on contract rates is inevitably going to be to push them up substantially.

Delay in the settlement of the Final Bill can be even more disastrous to a contractor's finances and ultimately put up contract rates still further.

I have known inordinate delays in the payment of R.A. Bills and delays of as much as three and four years in the settlement of the Final Bill. This is sometimes due to the venality of the officials concerned but more often to a stiff, wholly misguided bureaucratic attitude on their part and last but not least to the reluctance of engineers, even in the upper ranks, to make decisions and assume responsibility.

(5) As regards Earnest Money and Security Deposit, it would help enormously if all contractors working for Government P.W.Ds. (or corresponding Departments) are required compulsorily to deposit a fixed sum in the form of Government securities with the State or Central P.W.D. (or Corresponding De-

partment), this fixed sum depending on the classification under which the contractors are registered, and are thereafter exempt from furnishing any Earnest Money whatsoever. The Security Deposit should also invariably be in the form of a Bank Guarantee covering two-thirds to three-quarters of the amount involved, the remaining one-third or quarter being made up by *pro rata* deductions from the Running Account Bills.

A similar arrangement should apply in the case of the M.E.S., Railways, and quasi-Government agencies and Corporations.

Further the construction industry should be regarded on a par with manufacturing industries or the hotel industry and be eligible for loans and financial assistance on the same terms as these latter industries. The registration of contractors should be, of course, first tightened up.

(6) To my mind the tap root of waste, inefficiency and corruption is one-sided nature of the contract, which makes the Owner — I am speaking now of Government and quasi-Government authorities — the complainant, prosecutor and judge in any dispute or difference that may arise with a contractor. Even when the contract provides for arbitration, it almost invariably envisages the appointment of a single arbitrator, who shall be the nominee of the Chief Engineer of the Department or Chairman of the Corporation as the case may be, and can be and usually is an Officer of the same Department or Corporation. Far be it from me to cast any aspersions on the impartiality of the official nominee, but there is a possibility that the official nominee may be conditioned by long training and a natural, or a sub-conscious, prepossession to believing that the official view is the only correct and reasonable one.

All contracts should provide for arbitration under the provisions of the Indian Arbitration Act but to prevent any abuse of this system, the Government should draw up a Panel of Arbitrators from among experienced engineers of repute and high standing in the profession who are not serving officers. They should at the same time obviously not be the employees, part-time or full-time, of any contractor.

I have referred to the one-sided nature of the contracts governing relations between owners and builders. All these contract documents need to be revised and in fact the Planning Commission appointed a special Panel to effect this revision, but we have yet to know if any concrete results have been achieved.

I have earlier mentioned — in connection with our present unrealistic specifications — a safeguard to prevent the abuse of power that now vests in relatively minor officials in this regard. At present many Government Departments, including the State and Central P.W.D., the M.E.S., Railways, etc. have a Technical Examiner's cell, comprising Officers and subordinates of the Department concerned, who can inspect any work at any time and check on the materials and workmanship going into it. The cell is obviously intended to safeguard the Department's interests but can quite easily degenerate into another instrument of harassment and provide other points of leakage of the Department's funds.

The safeguard is this — Government should create a Public Works Commission comprising senior engineers of wide and varied experience and unimpeachable character recruited from the open market or existing P.W.D. and other cadres, who will serve on an attractive salary for a period of 10 years or for such time as they attain the age of 60 years, whichever is less but be thereafter statutorily per-

manently debarred from all Government office and equally from obtaining part or full-time employment with contractors for a period of 7 years after retirement from the Commission.

This Commission's function will be to take over the duties of the Technical Examiner's cell as well as check on the regularity or otherwise of R. A. Bill payments and the timely settlement of Final Bills and the efficacy of planning as explained earlier. It should be the function of Audit to bring all cases of substantial excesses to the Commission's notice and, of course, contractors can appeal to them for redress, whenever their payments are delayed.

I am confident that such a Commission will have a salutary effect on all malpractices, whether of the Department's engineers or contractors, and profoundly affect the rate structure and bring down prices.

I have confined myself so far to Waste and Inefficiency in Engineering Construction arising from procedural and administrative defects and deficiencies. Purely technical defects and deficiencies can also cause enormous waste. Some shortcomings of this nature deserve immediate attention and rectification.

The Structural Engineering Research Centre at Roorkee pointed out some four years ago, what progressive designers in this country already knew, that reinforced cement concrete is not an elastic material and r.c.c. design cannot, therefore, be based on the elastic theory. Voluminous research carried out over a long period of years in the U.S.A., U.S.S.R., U.K., France, Germany and other countries have thrown sharp light on the defects and limitations of the conventional working-stress method based on the usual assumption of linear stress-strain distribution.

Ultimate strength procedures are, therefore, in-

variably followed in these countries for the design of reinforced sections.

A case-study of a six-storey framed structure carried out by the Centre showed that with the adoption of ultimate design procedures and the use of medium tensile deformed bars in place of the ordinary smooth mild steel bars, a saving in steel of as high as 42% could be achieved. There is no reason why these procedures and these deformed bars should not be universally adopted. But are they?

Another technical improvement that is long overdue is the use of light-weight concrete. In this connection, it is a matter for gratification that the Government of Maharashtra have actually agreed to equity participation in a project for the manufacture and use of Siporex in the country. Siporex is a Swedish invention and is extensively used in foreign countries and can effect very considerable economies in cost as compared with conventional R.C.C. These economies are of the order of 25% to 30%. It is regrettable that it should have required some four years for the collaboration agreement to be finally approved by the Government of India. It is to be hoped that engineers all over the country will take advantage of this and similar material in all cases where cost comparisons are clearly in their favour.

Yet another technical improvement that is long overdue is that of quality control and mechanisation, wherever feasible, of the construction process. Take, for instance, the question of asphaltic road surfaces. Every engineer knows that only a hot mix can give full value for money and yet we go on, at least in the rural areas, year after year, mile after mile, following the old methods of mixing unheated aggregates and filler materials with the bitumen and thus obtain only a fraction of the value of our money—in my opinion, not more than 60 paise in a rupee, under the best conditions.

Our attitude to taking calculated risks should change and engineers should be encouraged to take such risks even if there are occasional failures. It is only from failures that we learn and when these risks are calculated ones, we should be prepared for things going occasionally wrong as the price for learning better and more efficient and economical method of construction.

In this connection my own experience has been most disappointing and frustrating. I was instrumental in introducing tetrapods into this country for the armouring of breakwaters and sea-walls. I am not the inventor of the tetrapod and have no financial interest in its use but though it proved eminently successful in protecting the sea-wall of Marine Drive in Bombay, it was not till some 10 years later that its efficiency and economy was generally recognised — such is the invincible conservatism and reluctance of our engineers to try out innovations.

I have also been instrumental in introducing the collector well with radial slotted drains for the tapping of underground water in alluvial soils, but here again I have run up against a strange and to me incomprehensible opposition on the part of Government and Municipal Engineers to the adoption of the system. It would almost appear as if they expected the system to *create* water instead of merely *tapping* it.

Then take the Tarapore Truss, which Prof. Taraporevala has invented. It pains me to see how the new design is brushed aside by Government engineers, even when it is substantially cheaper than the standard prestressed r.c.c. designs.

Two bridges have already been constructed with the "Tarapore" Truss by the Baroda Municipal Corporation — (1) carrying two water-mains of 2' dia. over 7 spans of 165' each, and (2) a road bridge

designed to carry 'B' Class loading as well as the above-mentioned pipelines. The road bridge has a span of 135 ft. But apparently the Government engineers are waiting for a Government bridge to be put up, and to be in successful use for a number of years before they take up the responsibility of putting one themselves. But how can a Government bridge come up anywhere, if each Government engineer waits for some other Government engineer to build it?

Housing is in chronically short supply. Both the cost of housing, specially low-cost housing, can be reduced and the pace at which it is put up greatly hastened by the more widespread use of the pre-cast units. More factories for the manufacture of these units under controlled conditions, specially beams, slabs, and lintels, should be set up in suitable locations. Much useful work has been done in the field of economy housing by the National Building Organisation etc. but the key question, as always in this country, is that of the speedy application of their findings and recommendations in actual building. The State Government can give a lead to the industry in the matter of the use of new materials, instead of the traditional ones, and of new modes of construction, including mechanised construction.

Finally engineering construction calls for management skills of a high order. This applies equally to Government and quasi-Government authorities and construction agencies, perhaps even more to the latter. It would, therefore, pay both parties and benefit the national economy, if classes in construction management were organised, preferably under Government auspices, to which the various Government and quasi-Government Departments and private construction agencies could depute their trainees to acquaint themselves with the latest building techniques, and learn the essentials of phased programmes

and schedules, and the close inter-dependence and inter-relationships that exist between architects; structural specialists; site engineers; contractors, sub-contractors, and piece-rate workers; manufacturers of engineering stores and materials; plant and equipment manufacturers, distributors and service men; the different classes of skilled workers and artisans, mistries and foremen, and last but not least accounts and audit procedures and their snares and pit-falls.

Nothing that I have pointed out is new or revolutionary. It has been said before in one form or another, at different times by different persons. It has all fallen within my own experience and I am convinced that if the suggestions made are speedily implemented the over-all economy in costs will be of a very high order — nothing less than 10% to 15%. Not only will waste and inefficiency and corruption be reduced in striking measure, but there will be a general enlargement and speeding up of development programmes and general satisfaction of the trade and the public at large.

(The views expressed in this booklet are not necessarily the views of the Forum of Free Enterprise.)

**“Free Enterprise was born with man
and shall survive as long as man
survives.”**

**—A. D. SHROFF
(1899-1965)
Founder-President,
Forum of Free Enterprise.**

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