

# Comparative performance study of different building contract systems

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The performance of any contracting system depends upon the completion time and cost, ease of operation and incidence of disputes. An analysis of the performance of various contracting systems in use can be very helpful in selecting the appropriate type of contract to obtain maximum economy in cost of construction. Based on the analyses of a number of completed housing projects, the paper describes, in quantitative terms, the comparative performance of the lumpsum, the percentage rate and the item rate contract respectively. The study reveals the lumpsum contract to be a more efficient contracting system.

In India, construction works of all types account for about half of the total outlay in any of the five-year plans. The building construction industry alone accounts for almost half the expenditure. This enormous expenditure on building construction makes it all the more necessary that resources be utilised in the most economical way. One of the important factors for the effective utilisation of resources is an appropriate system employed for the execution of building works.

Out of two major classification of construction works, namely, public works and private works, the former is generally undertaken by contractors on the basis of open competitive tendering. Private work is generally executed either through constructors or by day labour/labour contract method depending upon the suitability, convenience and understanding with the owner.

For public works, indiscriminate use of a particular type of contracting system has given rise to varying degree of performance and success, leading to difficulties during construction, loss of time and cost and in cases, ending in lengthy litigation. In view of this it was felt that standardisation of practice for different situations is required in order to achieve satisfactory completion of work and economy of construction. Due to new large-scale projects being built, and also due to rapid increase in the cost of materials and labour, selection of construction contracts is assuming priority with surveyors, engineers and architects. The present paper is based on studies undertaken by the Central Building Research Institute to evaluate the comparative performance of various types of contracting systems widely used in the country, and attempts to identify and clarify necessary criteria to be adopted in selecting any specific system.

## Types of contracts

Construction by contract is the predominant method used in major construction projects in the country. The types of contracting systems found to be widely used are:

- (i) lumpsum contract, and
- (ii) measurement contract, which in turn is based on (a) item rate or (b) percentage rate

**Lumpsum contract:** Lumpsum contract is generally used by the Military Engineering Services while other types of contract is used by the various public works departments, housing boards, public enterprises, etc. Lumpsum contracts are based on a fixed price agreed upon in advance and the contractor has to complete

the work in accordance with the plans, specifications, construction details and other contract documents which are supplied to him in advance. The profit of the contractor also is included in the lumpsum amount.

**Measurement contract:** In both types of measurement contracts, namely item rate contract and percentage rate contract, bills of quantities are prepared of all the anticipated items. In case of item rate contract, the items are priced by the contractor and subject to acceptance by the owner; payments are made for the amount of work actually carried out. In percentage rate contract, the contractor quotes on a percentage basis on the standard schedule of rates of the department net, or with a percentage 'on'. Here also, the payment is made item-wise on the basis of amount of work actually carried out.

## Comparative merits/demerits of different contract systems

The lumpsum contract system for buildings is preferred for traditional and repetitive type of construction. The nature and extent of work is indicated on drawings and specifications, with or without bills of quantities. The significant features of this type of contract system are:

- (i) commitments are known in advance
- (ii) quick interim and final payments
- (iii) better and easier cost control
- (iv) reduction in administrative work during construction period resulting in better supervision
- (v) higher efficiency and speed in construction leading to increased profit for the contractor
- (vi) preparation of plans, construction details and specifications possible in advance
- (vii) contractors can quote higher rates to cover unforeseen risks

For work which entails large estimates using relatively few methods of construction and where the volume of work cannot be exactly determined in advance, the measurement contracts are used. The significant features of this system are:

- (i) a reasonably accurate estimate is a prerequisite for good results
- (ii) provides for more variation
- (iii) complete drawings and specifications not required in advance
- (iv) possibility of over-payment to contractor due to computation and book keeping reduced

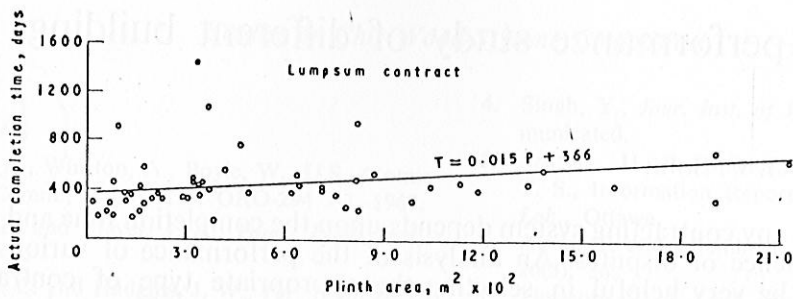


Fig 1 Relation between plinth area and actual completion time for lumpsum contract

- (v) proper planning in advance not possible
- (vi) overrunning of time and cost due to delayed decision on drawing details and specifications possible

The above analysis is qualitative and the subject of occasional controversy. A quantitative study of specific performance parameters of the various contracting systems constituted a major portion of the study undertaken by the Institute.

#### Performance parameters

The comparative performance of various contracting systems can best be judged by studying the following parameters:

- (i) completion time
- (ii) completion cost
- (iii) variations—both in time and cost
- (iv) disputes

In order to study the performance parameters of any contracting system two approaches were studied. The first approach consisted of studying the performance of similar buildings executed by the same department using different contracting systems. The second approach comprised of studying similar buildings executed by different departments using different contracting systems. In India since it is not normal practice in any department to use different contracting systems for similar construction, projects it was, therefore, decided to adopt the second approach to investigate this problem.

The data regarding stipulated and actual completion time, the cost, as well as payments and data of disputes was collected from various organisations for 165 completed housing projects costing about Rs 20 crores. The study was restricted to residential projects upto four-storeyed buildings keeping in view the complexity of the problem.

*Statistical relationships:* In order to study and compare the performance with regard to time and cost it was preferred to establish statistical relationships between each of these variables and the total plinth area of the project. This ensured minimising the differences arising due to the nature of supervisory personnel and those of individual contracting firms. In other words, it was assured that the proposed relations, will represent a comparative general trend of performance.

*Completion time:* The statistical relationships between actual completion time and total plinth area of completed projects are shown in Figs 1, 2 and 3 for lumpsum, item rate, and percentage rate contracts respectively, where  $T$ =actual completion time in days, and  $P$ =plinth area of project in m<sup>2</sup>. It can be seen from these that the completion time for projects using lumpsum contract is the least compared to those with item rate and percentage rate contracts. The additional time taken for completion of projects being 45 per cent to 75 per cent in case of item rate contracts and 45 per cent to 55 per cent in case of percentage rates contracts depending upon the size of project. Further, between item rate and percentage rate contracts, the variation is of the order of 9 per cent to 16 per cent for minimum and maximum value of plinth areas. From this it can be ascertained that performance of item rate and percentage rate contracts is not much different from each other.

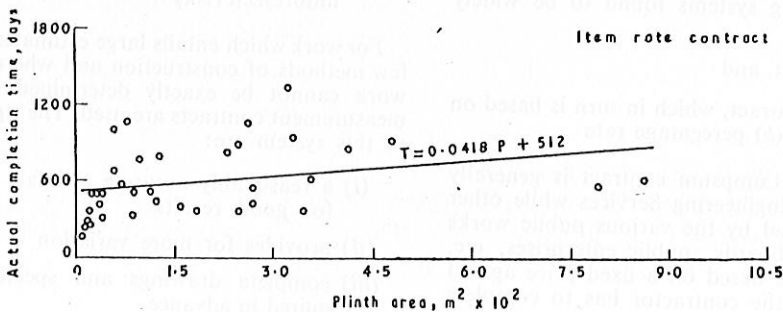


Fig 2 Relation between plinth area and actual completion time for item rate contract

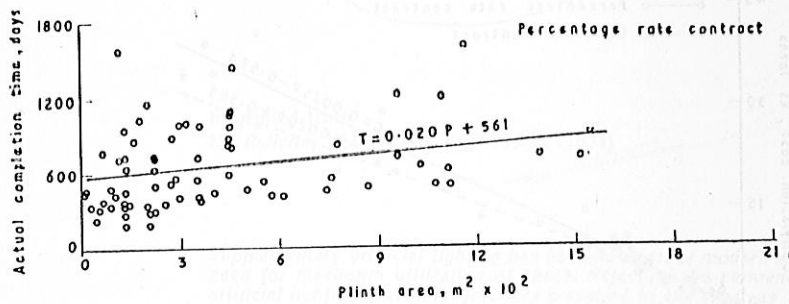


Fig 3 Relation between plinth area and actual completion time for percentage rate contract

**Completion cost:** Before establishing the relations between plinth area and completion cost, it was necessary to adjust the data collected due to variations caused by the following factors:

- (i) specifications
- (ii) number of storeys
- (iii) execution of work at different places
- (iv) design features
- (v) execution of work in different years
- (vi) degree of competition in bidding

**Specifications—**It has been seen that the specifications used by various organisations are same upto type IV tenements; i.e., approximate plinth area of 100m<sup>2</sup>. Hence it was decided to select projects involving tenements from type I to type IV only for establishing the relation between the plinth area and completion cost.

**Number of storeys—**The data collected from various organisations appertained to buildings having different number of storeys varying from single to four storeys. Hence the completion cost was adjusted against the factors mentioned below which were worked out at the Institute.

number of storeys	cost factor
1	1.000
2	0.965
3	1.055
4	1.118

Based on the above factors the cost of a building has been reduced to the equivalent of single-storey structure.

**Execution of work at different places—**The variation in cost due to execution of works at different places is accounted for by applying the relative cost indices for that particular place. However, since the locations of the projects for which the data was collected were spread over a large area, the indices for all of which were not available for various years based on the same weightage factors, it was decided to restrict the study to projects executed in one locality only.

In the case of item rate contract, the data for only a few projects were available for any single locality, hence it was not possible to establish the relationship for this type of contract.

**Design features—**In buildings under consideration, it was found that the variation in quantities of various items in any element was marginal. Moreover these differences were ironed out since a number of types and designs were considered in each contracting system. Hence no adjustment of any type was made due to this factor.

**Execution of work in different years—**The completion cost of all the projects completed in different years was adjusted by bringing all costs to the base year 1972 by utilising the indices of various years.

**Degree of competition in bidding—**The data collected from different organisations invariably pertained to the open bidding system of tendering. Hence it was fair to assume that the degree of competition in all the cases was more or less consistent.

**Performance:** Considering all the above factors, the data collected was reduced to a uniform base and relations were established between the completion cost and total plinth area of the project for lump sum and percentage rate contracts, Fig 4, where C=completion cost in lakhs of rupees, and P=plinth area of the project in m<sup>2</sup>. It can be seen that upto a plinth area of 1870m<sup>2</sup>, the percentage rate contract performs comparatively better as far as completion cost is concerned, while for plinth areas above 1870m<sup>2</sup> the observation is reversed. However, since the total plinth area of projects is generally in the range of more than 1870m<sup>2</sup>, it can be said that overall performance of lumpsum contract is better than the percentage rate contract.

**Variation in time:** As is often the case, building contracts are rarely completed within the scheduled period. The performance of a contract can thus be also compared by studying the extent of time variation between stipulated and actual completion time. The extent of this variation was computed as a percentage of stipulated time for each project and the results are represented in different ranges of percentage variation, and are shown in Table 1. The table indicates that in the case of lumpsum contracts the higher percentage of projects, namely 79 per cent lies in the lower range of variation as compared to 36 per cent and 30 per cent for percentage rate and item rate contracts respectively. It can be concluded that the performance of lumpsum contracts is comparatively better. Further, the incidence and the percentage variation in the percentage rate and item rate contract are more or less the same.

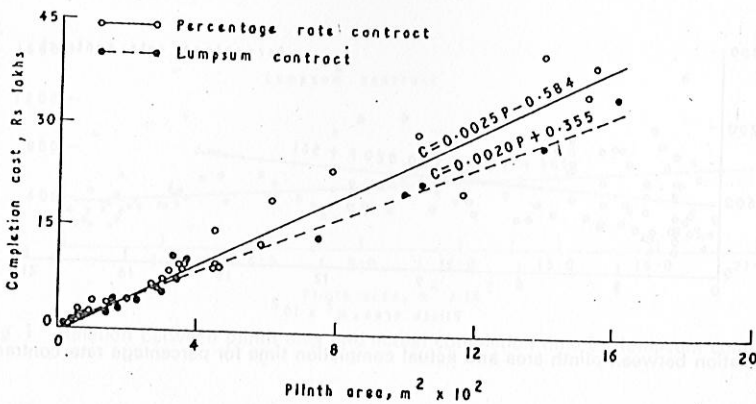


Fig 4 Relation between plinth area and completion cost.

TABLE 1 Extent of variation in time for different types of contracts

Percentage variation in time	Number of contracts, per cent		
	lumpsum	percentage rate	item rate
0	16	8	11
1—20	36	11	8
21—50	27	17	11
51—100	18	24	25
101—200	3	29	28
201 and above	0	11	17

**Variation in cost:** Building projects are seldom completed within the estimated cost. The extent of variation between the tendered and completion cost was used to measure the performance of a contract. The magnitude of this variation was computed as a percentage of tendered cost for the individual project and the results are represented in different ranges of variation separately for each type of contract, Table 2. This table indicates that in the case of lumpsum contracts, 87 per cent of the projects are completed within 5 per cent variation in cost. The corresponding figures for percentage rate and item rate contracts are 46 and 50 per cent respectively. Thus it is concluded that variation in cost is least in the case of lumpsum contracts while the trend is more or less the same in percentage rate and item rate contracts.

**Disputes:** Disputes are a very common phenomenon and can broadly be classified into two categories: those which are mutually resolved by the contractor and owner/engineer; those which are not resolved by the contractor and owner leading to litigation or arbitration.

TABLE 2 Extent of variation in completion cost for different types of contracts

Percentage variation in cost	Number of contracts, per cent		
	lumpsum	percentage rate	item rate
0	2	0	5
1—5	85	46	45
6—10	6	22	20
11—20	7	32	30

The records of the disputes of the first category are not properly kept in the departments and at the same time there is a difficulty in getting access to records of such disputes. Keeping the above limitations in view, the incidence of disputes of only the second category were studied. The percentage of the contracts referred to arbitration was computed and the results are presented in Table 3. It can be seen from the table that the incidence of disputes in lumpsum contract is minimum, namely 10 per cent as compared to the corresponding figures of 47 and 19 for the percentage rate and item rate contracts respectively.

TABLE 3 Incidence of arbitration for different types of contracts

Serial no	Type of contract	Total number of projects	Contracts taken to arbitration	
			nos	per cent
1	Percentage rate contract	40	19	47.5
2	Lumpsum contract	50	5	10.0
3	Item rate contract	47	9	19.0

### Conclusions

The quantitative analysis of the problem indicates that the performance of lumpsum contract is better than percentage rate and item rate contracts for projects like housing. The lumpsum contract should, therefore, be used for buildings using repetitive and traditional construction.

The comparative performance of item rates and percentage rate contracts show them to be not much different from each other. Further, a large variation in stipulated and actual completion time in almost all the contracts indicates that the stipulation of completion time should be specified more rationally.

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