International Journal of Innovative Research and Advanced Studies (IJIRAS)
Volume 3 Issue 8, July 2016
ISSN: 2394-4404

# Study Of Resource Levelling By Re-Modified Minimum Moment Method

**Ganesh B. Jadhav**
Student, Master of construction Management,
Imperial College of Engineering & Research,
Wagholi, Pune, India

**Dr. D. M. Ghaitidak**
Associate Professor, Department of Civil Engineering,
Imperial College of Engineering & Research,
Wagholi, Pune, India

***Abstract:** In this paper proposes a modification to the minimum moment method. It is used for resource leveling as presented by Harris and based upon the critical path method. The proposed and the traditional methods were developed with the assumption of no activity splitting and a fixed project duration with unlimited availability of resources. The difference between of these methods is in the criteria of selecting the activity that has to be shifted from its original position to a better position. This is judged by the change in the statical moment of the resource histogram before and after such movement. In the proposed method, and for the activities that lie at the same sequence step, the activity that is to be shifted first is selected based upon both the value of its free float (S) and the value of its resource rate (R). In this way, the calculation of the improvement factor is needed only to determine the extent to which an activity is to be shifted. On the other hand, using the traditional method, the activity with the maximum improvement factor found for each possible day of shifting is selected first. The process is then repeated for all remaining activities using the updated histogram resulting from the shifted activity. The proposed method significantly reduces the calculations so that the number of iterations in each sequence step is equal to the number of its noncritical activities (n) as compared to (n!) in the traditional method. In addition, the calculation process using the proposed method is easier especially for manual computations than the traditional one.*

***Keywords:** resource levelling by re-modified minimum moment method*



## I. INTRODUCTION

Though importance of project planning is recognized in many project based industries, but construction companies depend on scheduling skills. As they are operating under continuously changing environmental conditions and being involved in complex and unique projects, which require multidisciplinary collaboration, they have to develop realistic schedules and update them regularly. Increasing competition within the industry also forces construction companies to provide products of higher quality, in shorter durations, for lower costs and under safer working environments. Obviously, it is not possible to achieve these objectives simultaneously in the absence of an adequate schedule.

Preparation of a schedule for a construction project requires simultaneous consideration of several issues. Scheduling is not a simple matter of determining the sequence and timing of activities within a project, a planner has to cope with a number of constraints and considerations. Precedence relations, lag times, productivity rates, site availability, working calendars and climatic conditions are some of the many issues to be considered during the preparation of a schedule. In addition to these, resource requirements of activities, availability of resources and shapes of the resource requirement curves also need to be considered to ensure economical resource utilization.

## II. OBJECTIVES

- ✓ To involve the study of minimum moment method & its modification for resource leveling.

- ✓ To conduct the study about labour requirement by conventional & Minimum moment method
- ✓ Comparison & Analysis of data of the above study.
- ✓ Discussions & suggestions carried out about economical resource leveling for construction Industry.

## III. PROBLEM STATEMENT

- ✓ Optimizing resource leveling in order to maximize resource utilization efficiency while maintaining the original project duration.
- ✓ Optimizing resource allocation and leveling in order to minimize the negative impacts of resource availability constraints on project time while maximizing resource utilization efficiency.
- ✓ Optimizing resource fluctuation costs in order to provide the most cost effective and efficient resource utilization for construction projects.

## IV. LITERATURE REVIEW

*Abhay Tawalare, Rajesh Lalwani "Resource Leveling in Construction Projects using Re- Modified Minimum Moment Approach"* et. al.(2012) This paper proposes a re-modification to the minimum moment approach of resource leveling which is a modified minimum moment approach to the traditional method by Harris. The method is based on critical path method. The new approach suggests the difference between the methods in the selection criteria of activity which needs to be shifted for leveling resource histogram. In traditional method, the improvement factor found first to select the activity for each possible day of shifting. In modified method maximum value of the product of Resources Rate and Free Float was found first and improvement factor is then calculated for that activity which needs to be shifted.

*Ming Lu, M.ASCE; and Hoi-Ching Lam "Critical Path Scheduling under Resource Calendar Constraints"* et.al (2008) Resource calendars specify nonworking days of driving resources involved in construction projects. As part of the resource availability constraints in critical path method CPM scheduling, resource calendars may postpone activity start time, extend activity duration, and hence prolong the total project duration. Ultimately, resource calendars bring about changes to the critical path identification. Research has yet to address how to incorporate the effects of multiple resource calendars on the total float determination. In this research, the popular *P3* software is used as a tool for investigating the current practice of CPM scheduling under resource limit and calendar constraints.

*Mohammed A. Salem Hiyassat "Applying Modified Minimum Method to Multiple Resource Leveling"* el.at. (2001) The purpose of this paper is to extend the modification of the minimum moment approach applied to networks with single resource leveling to networks with multiple resources. Specifically, the contribution of this paper is to outline a procedure to level multiple resources using the modified minimum moment approach. The heuristic procedure is applied to both methods of leveling multiple resources: leveling multiple resources in series and combined resource leveling. For comparison purposes, the proposed procedure is demonstrated through the same examples that were used to illustrate the use of the traditional minimum moment to both methods of multiple resource leveling

*Jaeho Son and Miroslaw J. Skibniewski "Multiheristic Approaches for Resource Leveling in Construction Project"* et. al. (2013) The fluctuation of required resources causes problems in construction scheduling. Thus, researchers developed resource leveling techniques to minimize the deviation between the resource requirements and the desired resource profile. However, the resource leveling problem, except for small size scheduling problems, cannot be solved with exact optimization methods, because it is defined as a discrete combinatorial problem. Thus, researchers used heuristic approaches to get an acceptable solution that may not necessarily be optimal.

## V. MODIFIED MINIMUM MOMENT METHOD

This method is suggested by Mohammad Hiyassat. This is the modification over traditional minimum moment approach in terms of the criteria of selecting the activity that has to be shifted from its original position to a better position. According to this method, the activities that lie at the same sequence step, the activity that is to be shifted first is selected based upon both the value of its free float(S) and the value of its resource rate (R). The criteria used for selecting an activity for possible shifting is the value in terms of multiplication of activity resource rate (R) and the free float(S) of that corresponding activity. In a sequence step of network, the values of (RxS) are calculated for all the activities and the activity having maximum value of (R x S) is considered for first possible shifting. At this stage the same improvement factor introduced by the traditional method is calculated. If the improvement factor for a given activity is either positive or zero, then only activity can be shifted; otherwise, activity cannot be shifted. To calculate the improvement factor (IF) the value of R is dropped and its value is constant for the same activity. Thus, the mathematical form of the Improvement factor is as follows,

$$IF(\text{activity } J,S) = \sum x - \sum w - mR$$

The chosen activity is shifted to get maximum moment improvement within its limit of free float. The network and resource histogram is updated for selection of the next activity with the largest value of the term (R x S). The process continues up to first sequence step of the same network where forward cycle ends.

To compare between two resource histograms (e.g., before and after leveling) or even between two histograms with different resources. when resources are arranged in a histogram over a fixed interval, the minimum moment of the element exists when the histogram is shaped as a rectangle over this interval. This moment is the minimum possible for any resource histogram regardless of the total amount of the resource.

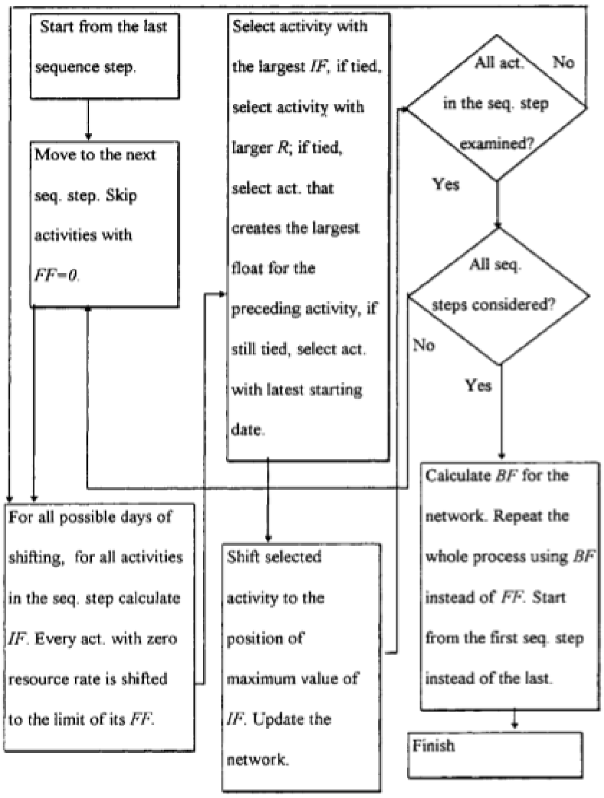
$$RIC = n^*\sum Y_i^2/(\sum Y_i)^2$$

Where $\sum Y_i$= Sum of daily resource sum at $i^{th}$ day

Ideally, the value of this coefficient would be one; hence, the nearer the value of the RIC is to one, the more closely the resource histogram is to a rectangle.

## VI. PROPOSED METHOD

The methodology adopted to achieve the above objectives comprises of the following steps:




Flowchart—Traditional Minimum Moment Approach

*Figure 1*

## VII. DATA COLLECTION

| Sr No. | Task Name | Quantity | R new | D new |
|---|---|---|---|---|
| 1 | Excavation | 470 | 0 | 14 |
| 2 | Foundation for PCC | 28.2 | 1 | 6 |
| 3 | RCC footing | 218.55 | 2 | 37 |
| 4 | Columns up to Plinth | 8.46 | 1 | 3 |
| 5 | Plinth and GroundBeams | 21 | 2 | 4 |
| 6 | Murum filling | 765 | 0 | 11 |
| 7 | Soling | 55.6 | 0 | 1 |
| 8 | PCC below flooring | 204.206 | 4 | 11 |
| 9 | Columns up to first floor slab | 20 | 1 | 7 |
| 10 | First floor slab | 82 | 3 | 10 |
| 11 | Ground floor brickwork | 82.133 | 5 | 14 |
| 12 | Ground floor Neeru plaster | 1078.74 | 7 | 16 |
| 13 | Columns up to second slab | 20 | 1 | 7 |
| 14 | Second floor slab | 82 | 6 | 5 |
| 15 | First floor brickwork | 82.133 | 5 | 14 |
| 16 | Ground floor flooring | 204.206 | 6 | 7 |
| 17 | Doors & Windows | 10.702 | 0 | 16 |
| 18 | Columns up to second slab | 20 | 1 | 7 |
| 19 | First floor flooring | 204.206 | 6 | 7 |
| 20 | External sand faced plaster | 252.698 | 3 | 9 |
| 21 | Painting | 1331.412 | 7 | 12 |
| 22 | Site cleaning | L.S. | 0 | 14 |

*Table 1*

## VIII. PROPOSED NETWORK AND BAR CHART

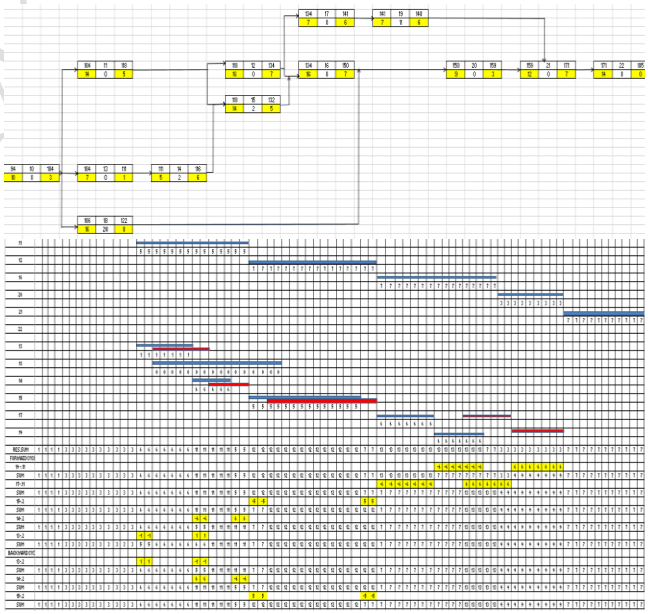


*Figure 2*

## IX. RESULTS AND DISCUSSION

| | Max. Y | EFR (%) | SFR (%) | Moment | RIC |
|---|---|---|---|---|---|
| **EST solution** | 13 | 23.27 | 76.73 | 3300 | 2.07 |
| **Remodified Minimum Moment method** | 13 | 24.90 | 75.10 | 3084 | 1.93 |

*Table 2*

- ✓ From the above table, it is clear that Maximum daily sum is same 13 by Re modified Minimum Moment method and EST solution.
- ✓ As maximum daily sum is same by all the two methods and EFR & SFR calculated by Re modified Minimum Moment method solution is different as that of with calculated by EST solution.
- ✓ Moment of histogram is reduced to 3084 by Re modified Minimum Moment method than EST.
- ✓ RIC is reduced to 1.93 by Re modified Minimum Moment method from 2.07.

## X. CONCLUSION

This study aimed to determine whether Re modified Minimum Moment method is applicable for resource leveling of Construction project. Data was collected from residential construction projects. Data was analyzed by arranging the activities according to their EST, Re modified Minimum Moment method & LFT. Histograms are drawn for all these solutions & various factors like Maximum daily resource sum, Moment of histogram, Effective force ratio (EFR), Stand by force ratio (SFR) & Resource Improvement Coefficient (RIC) are calculated & compared. On the basis of this study the conclusion was elaborated as below:-

- ✓ Maximum daily resource sum, stand by force ratio of a construction project is reduced or remains same by application of Re modified Minimum Moment Method.
- ✓ Effective force ratio is increased or remains same by application of Re modified Minimum Moment Method.
- ✓ Though all the above three mentioned factors are remain same but moment & RIC of histogram drawn by Re modified Minimum Moment method is reduced & hence Re modified Minimum Moment method used for resource leveling is applicable to construction project.

## APPENDIX

*NOTATIONS*

*The following symbols are used in this paper:*

M0 = statical before-shifting-moment of daily resource about axis 0-0;

M1 = statical after-shifting-moment of daily resource about axis 0-0;

m = minimum of either the days that activity is to be shifted

(S) or the activity duration (t);

R = resource rate; S = number of days up to which the activity can be shifted;

Wi = daily resource to which m daily resource rates (R) are to be added;

Xi = daily resource to which m daily resource rates (R) are to be deduced; and Yi = daily resources.

## REFERENCES

[1] Ahuja HN (1976) Construction Performance Control by Networks. John Wiley & Sons, Inc, New York

[2] Akpan EOP (2000) Resource smoothing: a cost minimization approach. Journal of Production Planning & Control 11(8):775-780

[3] Gomar JE, Haas CT, Morton DP (2002) Assignment and Allocation Optimization of Partially Multi-skilled Workforce. Journal of Construction Engineering and Management 128(2):103-109

[4] Tawalare A, Lalwani R (2013) Resource Leveling in Construction Projects using Re- Modified Minimum Moment Approach. World Academy of Science, Engineering and Technology 62 (2012):33-35

[5] Zaffalon M, Rizzoli AE, Gambardella LM (1998) Resource Allocation and Scheduling Of Operations in an Intermodal Terminal 113(4):520-528

[6] Zhang H, Li H, Tam CM (2006b) Particle Swarm Optimization for Preemptive Scheduling under Break and Resource-Constraints. Journal of Construction Engineering & Management 132(3):259-267

[7] Son J, Skibniewski MJ (1999) Multi heuristic Approach for Resource Leveling Problem in Construction Engineering: Hybrid Approach. Journal of Construction Engineering and Management 125(1):23-31

[8] Rayes KE, Jun DH (2009) Optimizing Resource Leveling in Construction Projects. Journal of Construction Engineering and Management 135(11):1172-1180