بسم الله الرحمن الرحيم

CPAS مركز الدراسات التخطيطية والمعمارية

CENTER OF PLANNING AND ARCHITECTURE STUDIES

الدورة التدريبيه الرابعه

" أدارة عمليات التشييد والبناء "

مجموعة محاضرات

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CONSTRUCTION MANAGEMENT FOR ERECTION PROCESS OF PREFABRICATED BUILDINGS

By

Prof. A. Hady Hosny and Dr. Salah B. Nosseir

1 - INTRODUCTION

1.1 - GENERAL

Egypt has recently introduced prefabricated building systems into its construction sector. The level of possible engagement warranted concern regarding many questions that included the impact of sophisticated technology upon decisively manual operations. In fulfillment of its objectives, the Egyptian Academy of Scientific Research and Technology granted finance to Ain Shams University to study the environmental factors affecting such action. The initial phase of this study, Reference 1, included a general surevy and provided a number of recommendations. One of these recommendations constituted the objective of the study reported hereafter.

The level of sophisitication of technology is proportional to its degree of precision which is naturally achieved via quality control. Meanwhile, quality control can be attained only be adopting proper management techniques throughout all project phases. One of the most credible techniques of management science is the Critical Path Method (CPM), References 2 and 3. This technique was utilized for the erection process of prefabricated building construction to identify the environmental factors and to provide the managers with a typical practical example. This practical example involved utilization of data drawn arbitrarily from Reference 4 and the following modifications and amendments.

1.2 - OBJECTIVE

The major objective is to develop a realistic model representing the erection process of prefabricated buildings construction for identification of environmental effects.

1.3 - SCOPE AND APPROACH

The scope of this investigation is limited to the development of CPM network model and to its application to practical problem for the purpose of identifying environmental effects. The model exhibits the following major features:

* Coverage — Inclusion of as many activities as necessary to recognize all of the relevant data of a typical prefabricated buildings project.
* Extensity — Formulation that permits future application to a variety of similar projects.
* Compatibility — Consideration of the interaction with the production process and the transportation process.
* Usefulness — Perform time analysis and present time schedule.
* Readability — Orientation of the format of output towards suitable utilization by managers with no background in the involved techniques.

Proper identification of project characteristics is necessary to identify the appropriate level of detail. Meanshile, levels of detail containing a large number of activities necessitates utilization electronic data processing.

2 - MODEL FORMULATION

2.1 - GENERAL

The network model was formulated in the manner that fulfills the stated objective and scope. After introducing designations and definitions, this chapter provides a list of the model assumptions and presents the mathematical model and identifies the computer facility utilized for its solution.

2.2 - ACTIVITY-TYPE LIST

Table 1 of the Appendix provides a check list of the types of activities together with their designations.

2.3 - DEFINITIONS

The following definitions were introduced for the purpose of concise presentation of the assumptions and the model construction.

Erection process -- is all actions at a construction site.

Erection task -- is the set containing Marking, Leveling, and Joints milestones and joints curing.

Finishing task -- is DW, EL, FL, LA, PL, and PN activities.

Foundation task -- is CR, CS, EX, FC, IN, LA, LL, and PR activities.

Joints milestone -- is JD, JH, JV, and LA activities.

Leveling milestone -- is the physical leveling of a wall unit, LL.

Marking milestone -- is the physical marking of the position of walls on a deck, MM.

Mounting milestone -- is the erection of a truck load.

2.4 - ASSUMPTIONS AND DATA

Listed below are main assumptions made in constructing the network model of this study.

1- Model is concerned only with the construction phase; that is, the preconstruction phase including site selection, detailed engineering design, and tender document preparation are not considered in the model.

2- Model is concerned mainly with the erection process at the construction site; that is, no time delays are assumed due to problems arising from factory production or during transportation from factory to construction site.

3- The erection process includes three major tasks; namely : "Foundation", "Erection", and "Finishing", in that order, see Figure 1.

4- For any block of flats, all Foundation activities precede all Erection activities; whereas, some Erection activities overlaps some Finishing activities, see Figure 2.

5- The Erection task is composed of four milestones; namely : Marking, Leveling, Mounting, and Joints, in that order.

6- For practical application, the model data simulates one of the examples newly introduced in Egypt; namely, that of Misr Concrete Development Company / Larsen and Nielsen Enterprise (MCDC/LN) at Ismailia, Egypt.

7- Only one crane is assumed for utilization at the construction site.

8- All nonzero durations due to crane movements are included in the durations to mount prefabricated elements.

9- Project objective is to complete construction of four blocks of flats located along one line within the same site for which the global network is shown in figure 3.

10- For practical application, the physical characteristics of each of the four blocks represent block type 3 of MCDC/LN which are

- Block dimensions: 7.8 x 50.4 meters
- each Block consists of five floors including ground floor.

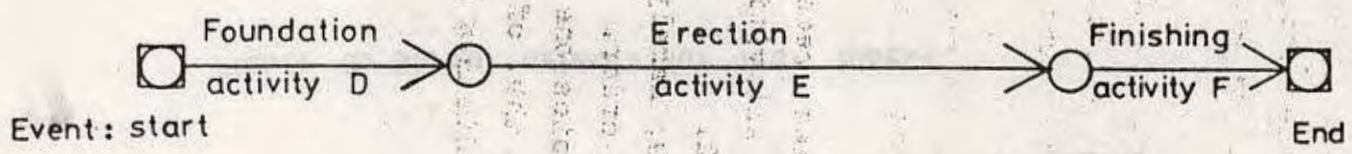


Figure 1. Global network for project.

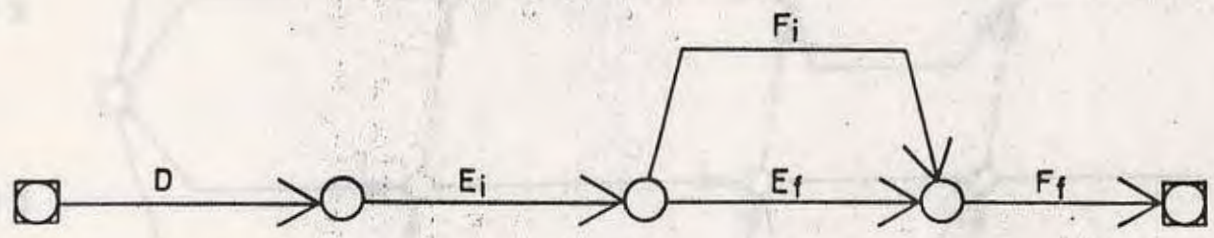


Figure 2. Global network for each block.

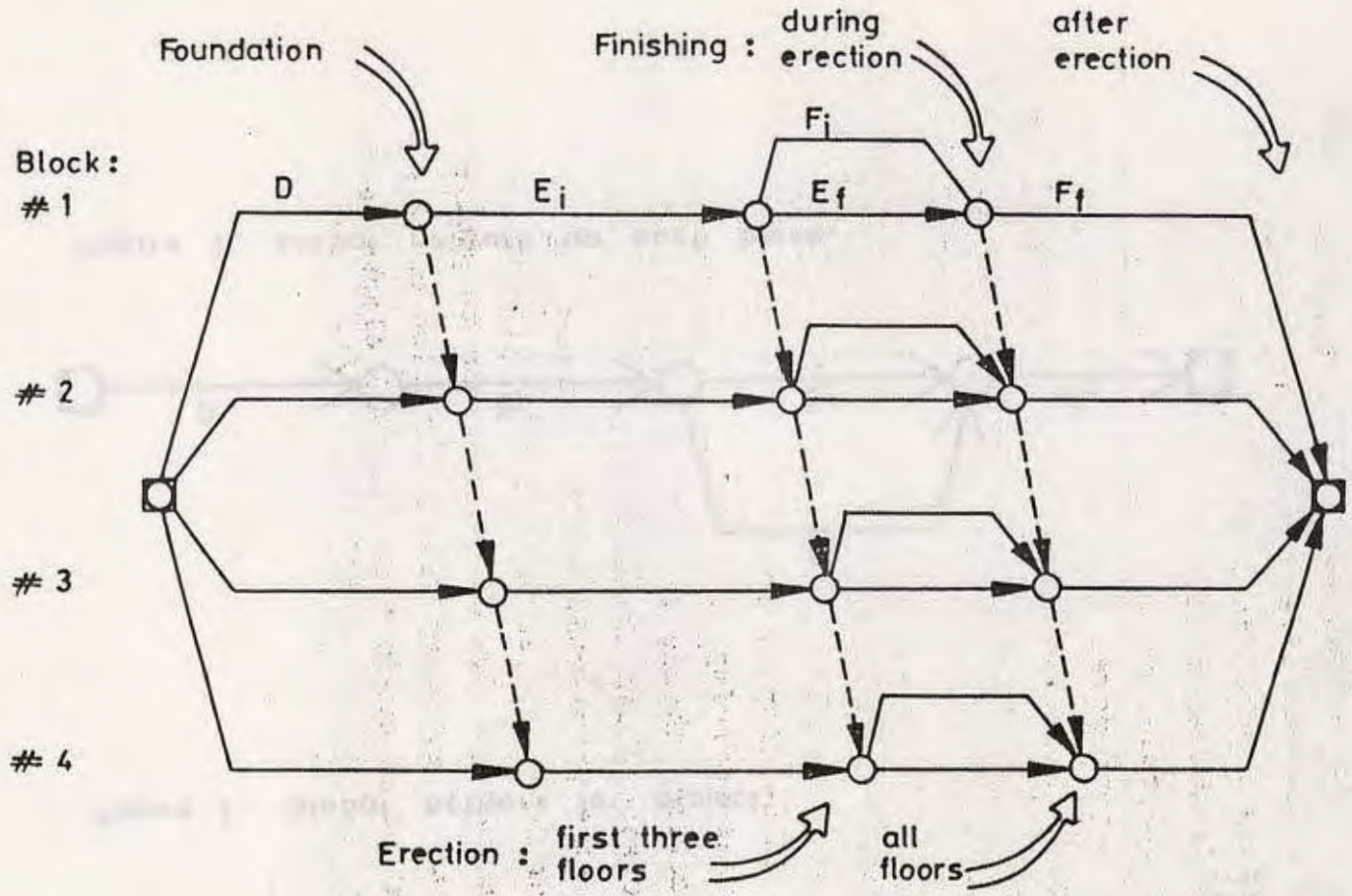


Figure 3. Global network for four blocks.

- each floor contains six flats and three stair wells.
- each floor is composed of 95 load carrying and noncarrying wall elements and 66 slab elements.

11- The rule for the mounting sequence within one block is that all wall elements are mounted first as the crane moves, on its track, in one direction parallel to the longitudinal axis of the block; then the crane makes a similar path to mount all slab elements for the same floor.

12- The general rule for the erection sequence among blocks is that the crane moves, on its track, from the longitudinal edge of one block to that of the neighboring block after completing the Mounting milestone of each floor; then after reaching the last block, the same sequence is repeated for the next floor, see Figure 4.

13- A duration of only one day is assumed for the preparation to connect to public utilities; this greatly underestimates reality in developing countries. Accordingly, one should regard this activity as a part of the check list, meanwhile, proper actions should be taken during the preconstruction phase to accomplish this activity.

14- Initial site preparation before commencing work in the foundation of any block is an activity with one day duration.

15- Physical construction of connections to public utilities is assumed as an activity with a duration of 12 working days.

16- Installation of crane track for all blocks is considered as one activity with a duration of eight working days.

17- Foundation task per block contains 21 activities including dummy, lead, and lag activities. Figure 5 depicts the Foundation activities together with their sequence and durations in a network format.

18- Erection task activities may start immediately after completion of Foundation activities of the same block.

19- Erection task contains 29 activities for each floor of each block; this includes dummy, lead, and lag activities. Figure 6 depicts the Erection activities together with their sequence and durations in a network format.

20- The Mounting milestone of the Erection task contains twenty

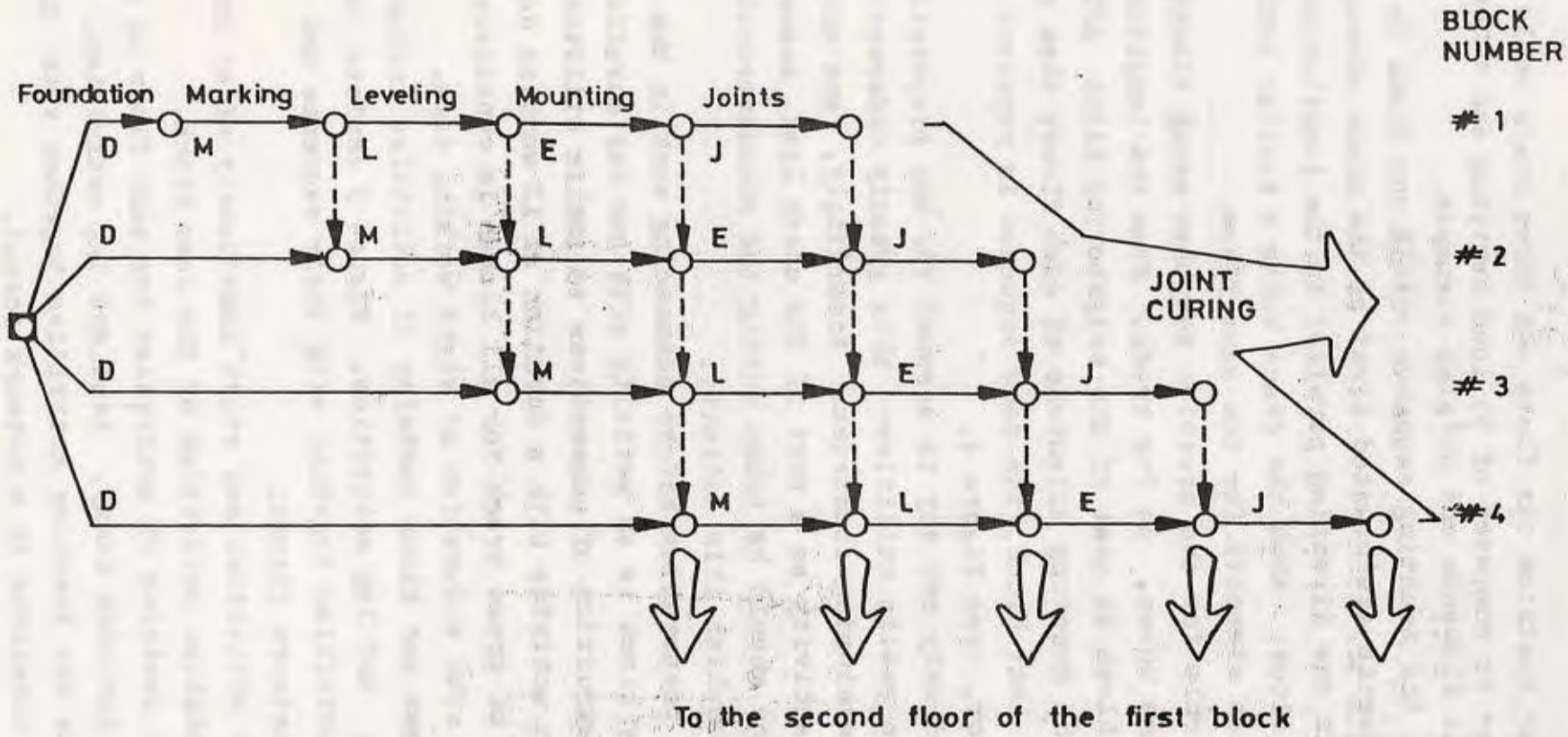


Figure 4. Global network for erection of the first floor of four blocks.

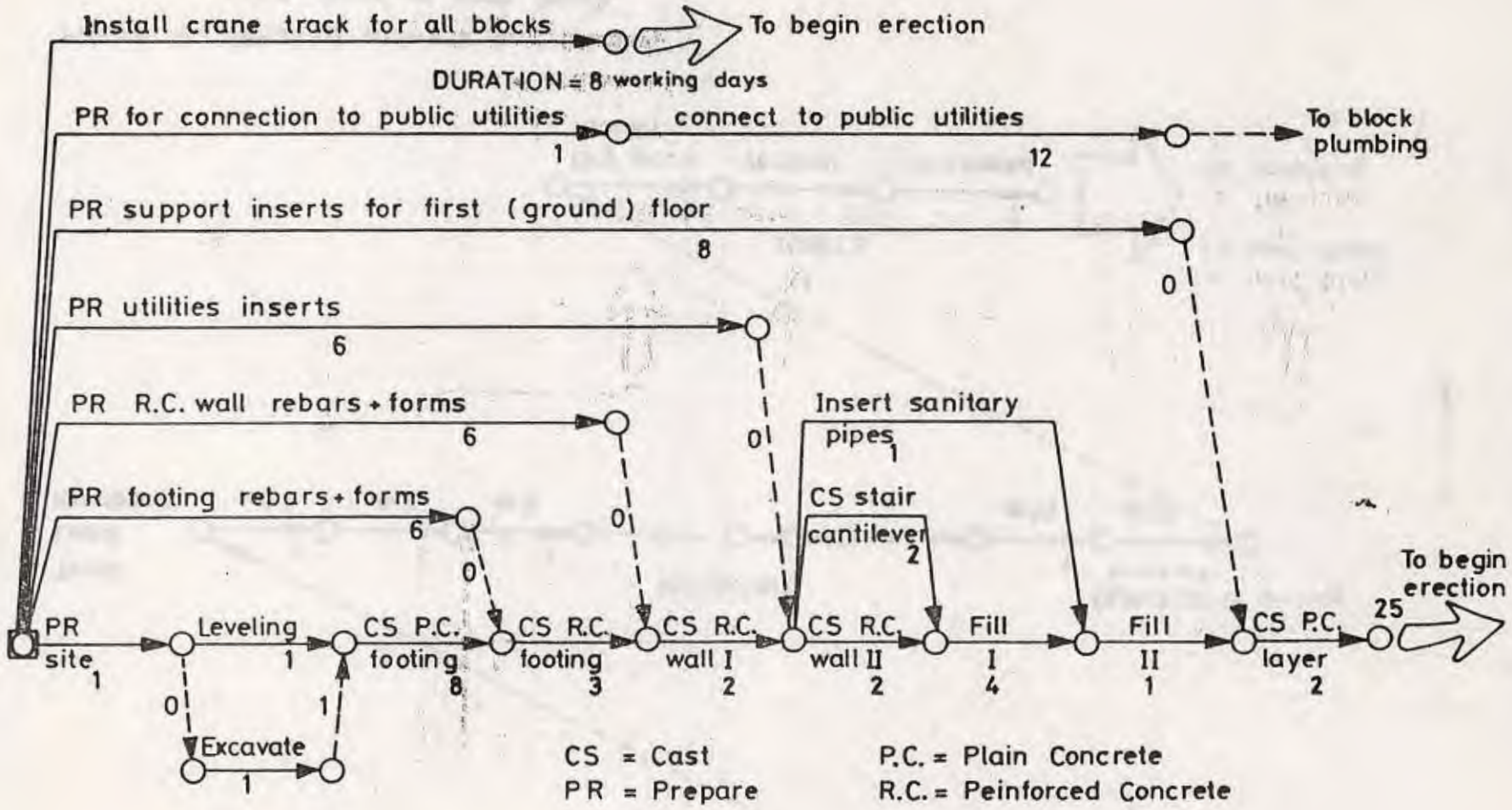


Figure 5. Detailed network for foundation of each block

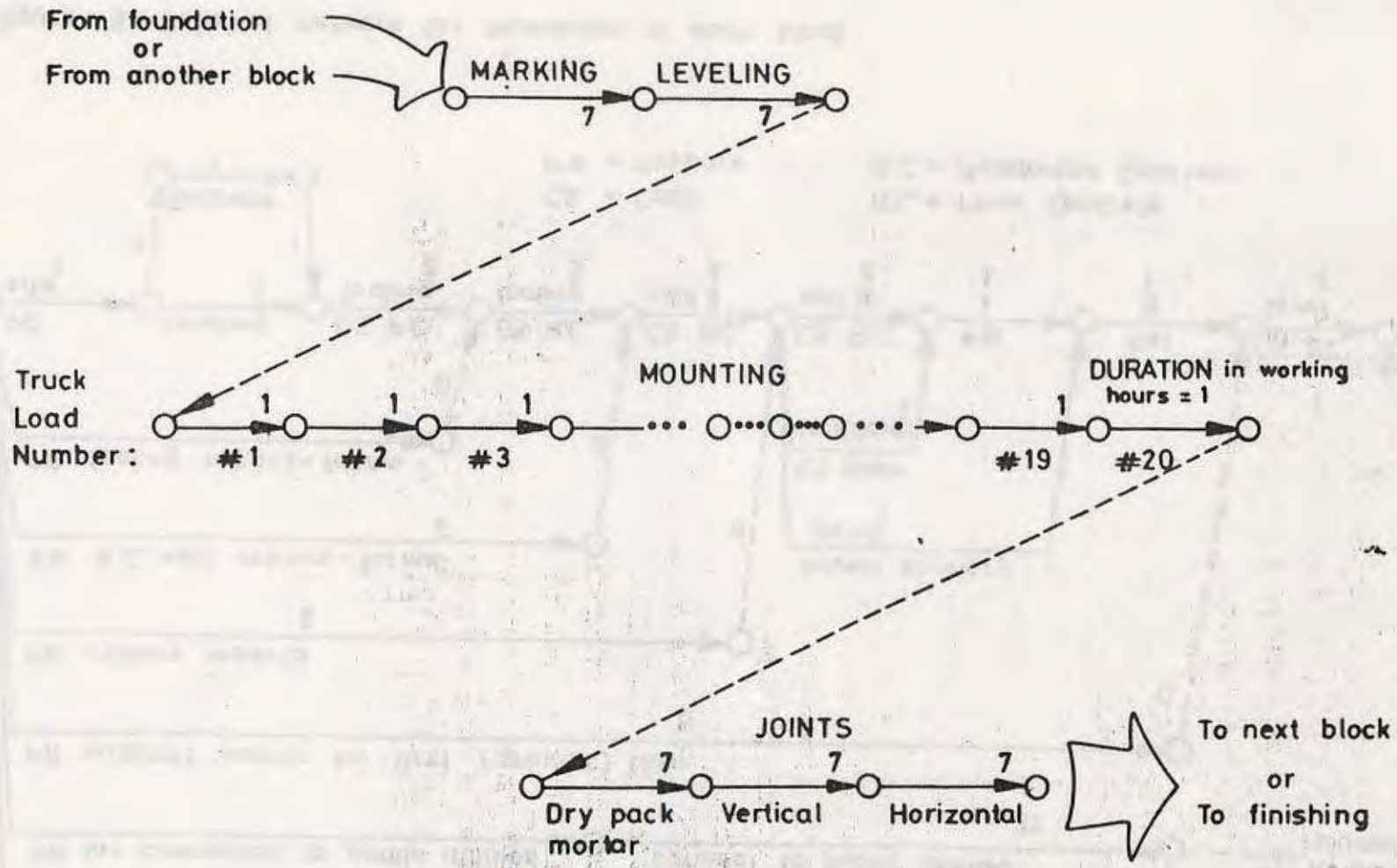


Figure 6. Detailed network for erection of each floor of each block.

activities for each floor of every block, Figure 6; these represent the unloading of prefabricated elements (walls and slabs) carried by truck from the production factory and the proper placing of such elements at their specified locations. The assumed duration for each one of the twenty activities is one hour.

21- The twenty truck loads assumed for the Mounting milestone represent 13 ballets of walls (carrying and noncarrying type) and 7 ballets of slabs.

22- A capacity of 25 tons is assumed for trucks transporting the walls on an A-shaped tailer as well as the ones transporting slabs on a flat-top trailers.

23- All prefabricated elements are assumed to be stacked on each trailer in a specified manner that is optimum for prompt handling at the construction site.

24- Durations for Mounting of the top floor (with special "roof" elements) are assumed the same as for the rest of the floors.

25- The Joints milestone of the Erection task contains three activities for each floor of every block, Figure 6; these represent the construction of dry-pack mortar joints, the vertical joints, and the horizontal joints, in that order. The assumed duration for each one of these three activities is one working day.

26- Three days (real time) are required for curing of the horizontal joints of any floor to begin Marking of the next floor in the same block; this period is assumed to be included in and signals the termination of the Erection task for each floor of every block.

27- The Finishing task of every first (ground) floor may start immediately after completion of the Erection task for the third floor of the same block.

28- The Finishing task for any floor, excluding the first floor, may start immediately after completion of the Erection task for the previous floor in the same block.

29- Finishing task contains 10 activities for each floor of each block; this includes dummy, lead, and lag activities. Figure

7 depicts the Finishing activities together with their sequence and durations in a network format.

30- Finishing task includes activities conducted per block such as exterior painting (3 days per block), exterior plumbing (6 days per block), and roof insulation, leveling, and flooring (6 days per block).

31- Durations are expressed in a working week (six working days), in a working day (seven working hours), or in a working hour.

32- The credibility of the assumed durations depends heavily on the availability of sufficient funding and that the contractors resources are ample. These resources include manpower, tools, furnishings, equipment, handling and transportation means, and raw and prefabricated materials.

33- Effects of force majeure are ignored.

2.5 - The NETWORK MODEL

The model was formulated in the manner that permits a straight forward extension to include or exclude as many activities as necessary to match the required degree of precision. The mathematical basis for this claim is presented in the Appendix hereafter. This feature does not only facilitate minor updating when changes involve durations but also major updating with inclusion of new activities or exclusion of present ones.

2.6 - COMPUTER FACILITIES

The model data was coded in a format compatible with an ICL application package (PERT 1900). This program was excuted through Cairo University Scientific Computation Centre.

3 - RESULTS

3.1 - MODEL FEATURES

The network model that was developed in this study exhibits the

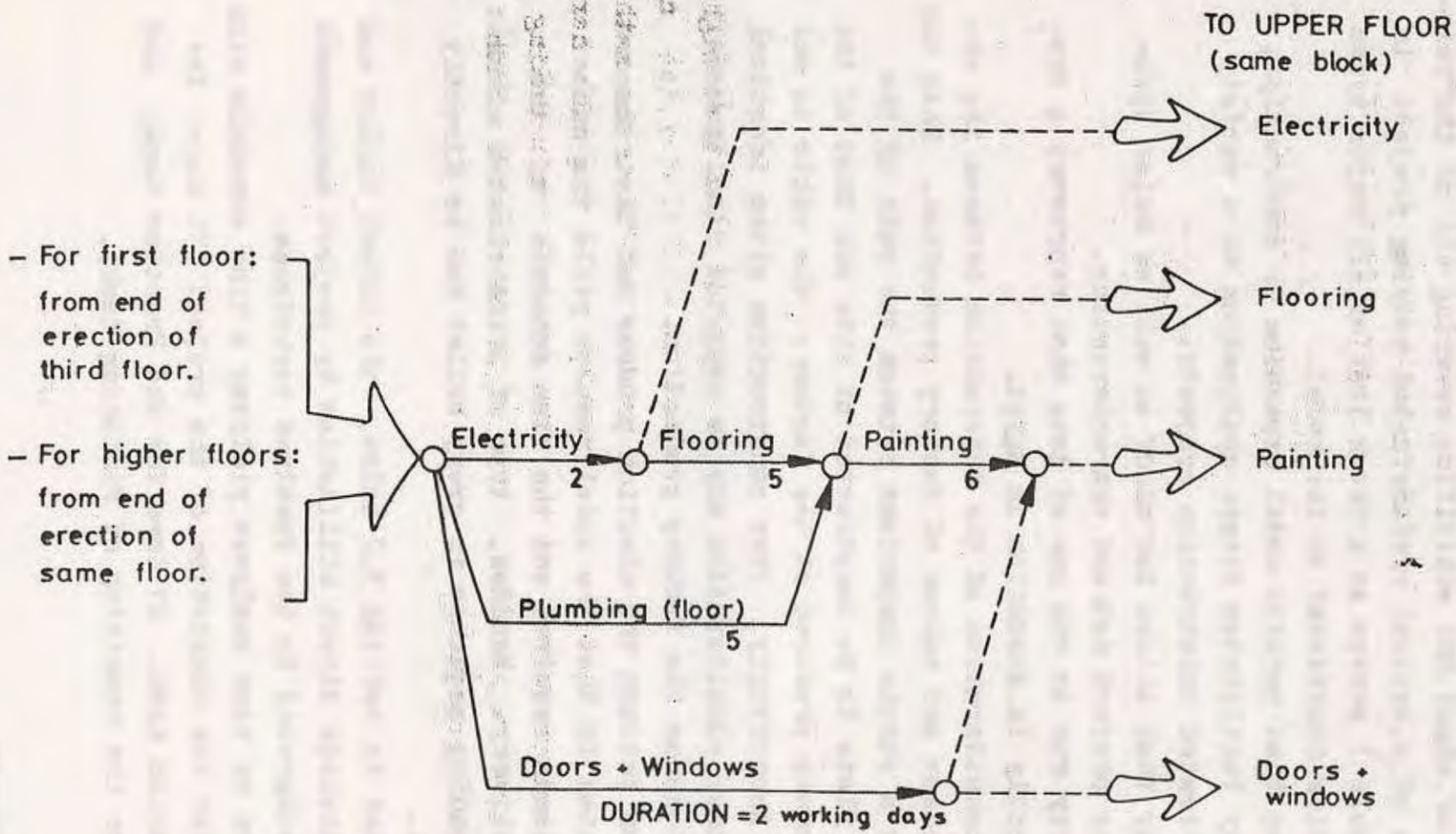


Figure 7. Detailed network for finishing of each floor of each block.

following major features:

1 - Inclusion of about 900 activities covering all of the "relevant" data of a typical prefabricated housing project in Egypt. Table 1 serves as a check list of all major types of activities considered in the model.

2 - Formulation that permits model expansion or contraction, and thereby facilitates future application to a variety of prefabricated construction projects.

3 - Flexibility that allows for minor as well as major updating of the project data and characteristics.

4 - Practicality due to the use of data that represent a project currently in execution in Egypt.

5 - Implicit consideration of the interaction between the erection process and volume of factory production. This can be seen by a simple comparison between the rate of the number of flats to be constructed at site and that of the flats elements produced at the factory; the ratio is one to four. Accordingly, four construction sites identical to that under consideration may be operated simultaneously to fully consume the factory production.

6 - Correlation between the erection process and thetransportation system in that the model results yield the number of truck loads required and the time schedule of the ballets delivery. Besides, type of prefabricated element and the loading sequence in every ballet can be directly identified.

7 - As presented in section 3.2 below, the output format was oriented towards direct utilization by project management with no background in the involved techniques.

8 - Performance of time analyses yielding a time schedule with 122 days for the completion of the project (31 days for the Foundation task, 67 days for the Erection task, and 24 days for the remaining of Finishing task).

3.2 - TIME SCHEDULE

Results of time analysis called for modification of the number

of blocks in order to locate the Mounting activities on a critical path: this was done to admit the fact that the crane and its crew represent the most valuable resources. Relevant results are summarized in a bar chart format compatible with the networks presented earlier. Figure 8 shows the bar chart for the global activities of four blocks with durations shown as real time. The total project duration is 122 days which indicates that the average construction time is approximately one flat per day: this average includes foundation and finishing time subject to the assumptions of section 2.4. This average varies with the number of blocks at the construction site. For example, considering the limit of constructing one block, the crane should wait, for every floor, a duration that is sufficient to construct all the floor joints as the curing time. This may double the mounting durations; and thereby, the average duration to construct one flat increases considerably.

Figure 8 also implies that the real time duration of the Erection task is 67 days which represents about 55 percent of the total duration. This percent, or similar ones, may be regarded as the basis for economic evaluation of introducing prefabricated construction into a decisively manual system. The value of this percent may also suggests introduction of mechanization to Foundation and Finishing tasks in order to be in harmony with the Erection task. The float indicated for some of the Foundation tasks, Figure 8, may suggest redistribution of resources to reduce the duration of the Foundation task for the first block since it is a critical one. The same reasoning may be applied to the Finishing tasks in order to reduce the duration for the Finishing task of the last block.

Figure 9 presents a bar chart for the global Erection activities of a typical floor. Upon deciding on the start date of the project, a real-time duration axis may then be defined for any specified floor. Accordingly, the specific dates for the Mounting activities may be utilized in planning for the number and contents of each ballet to be transported to the construction

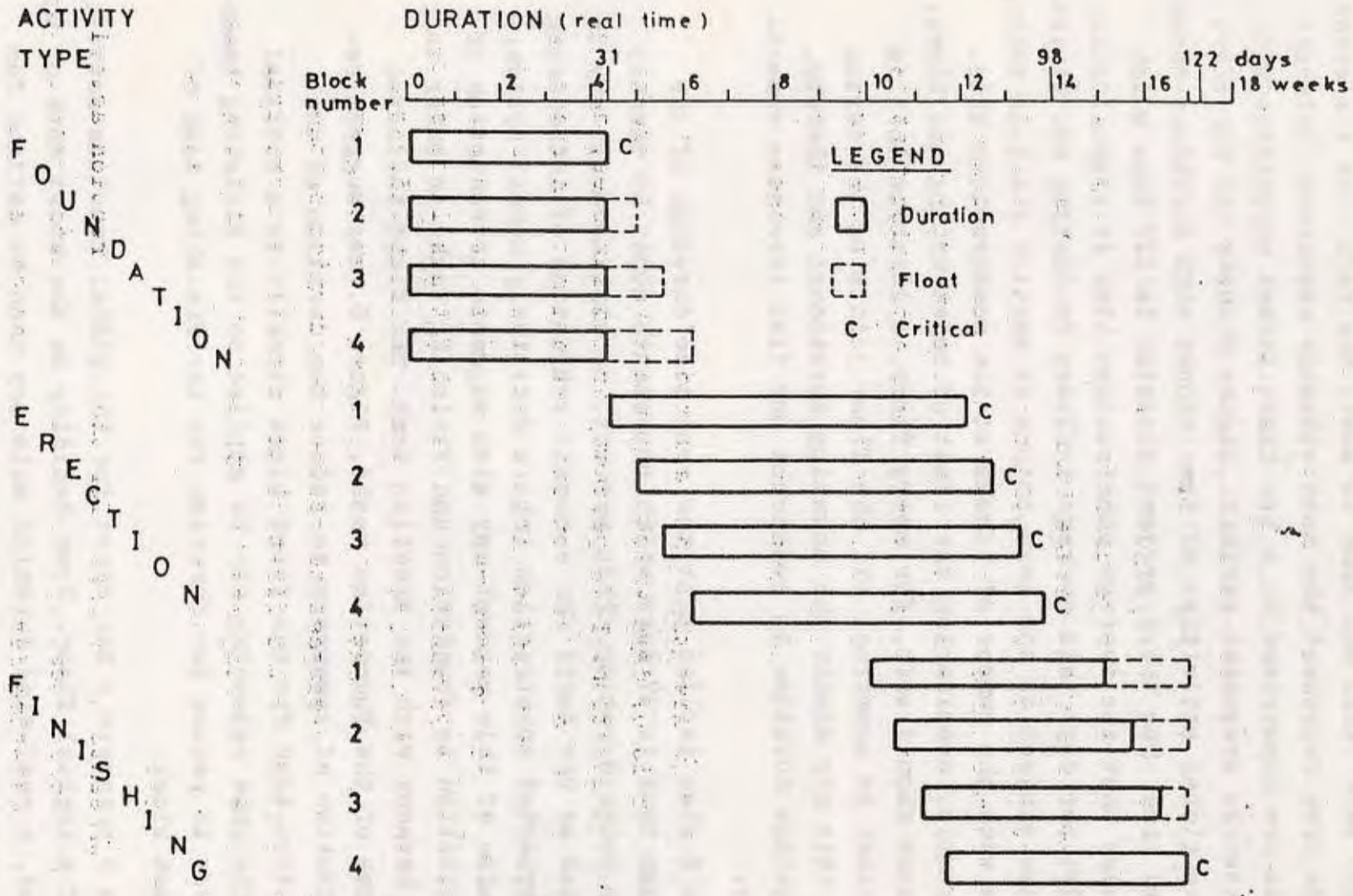
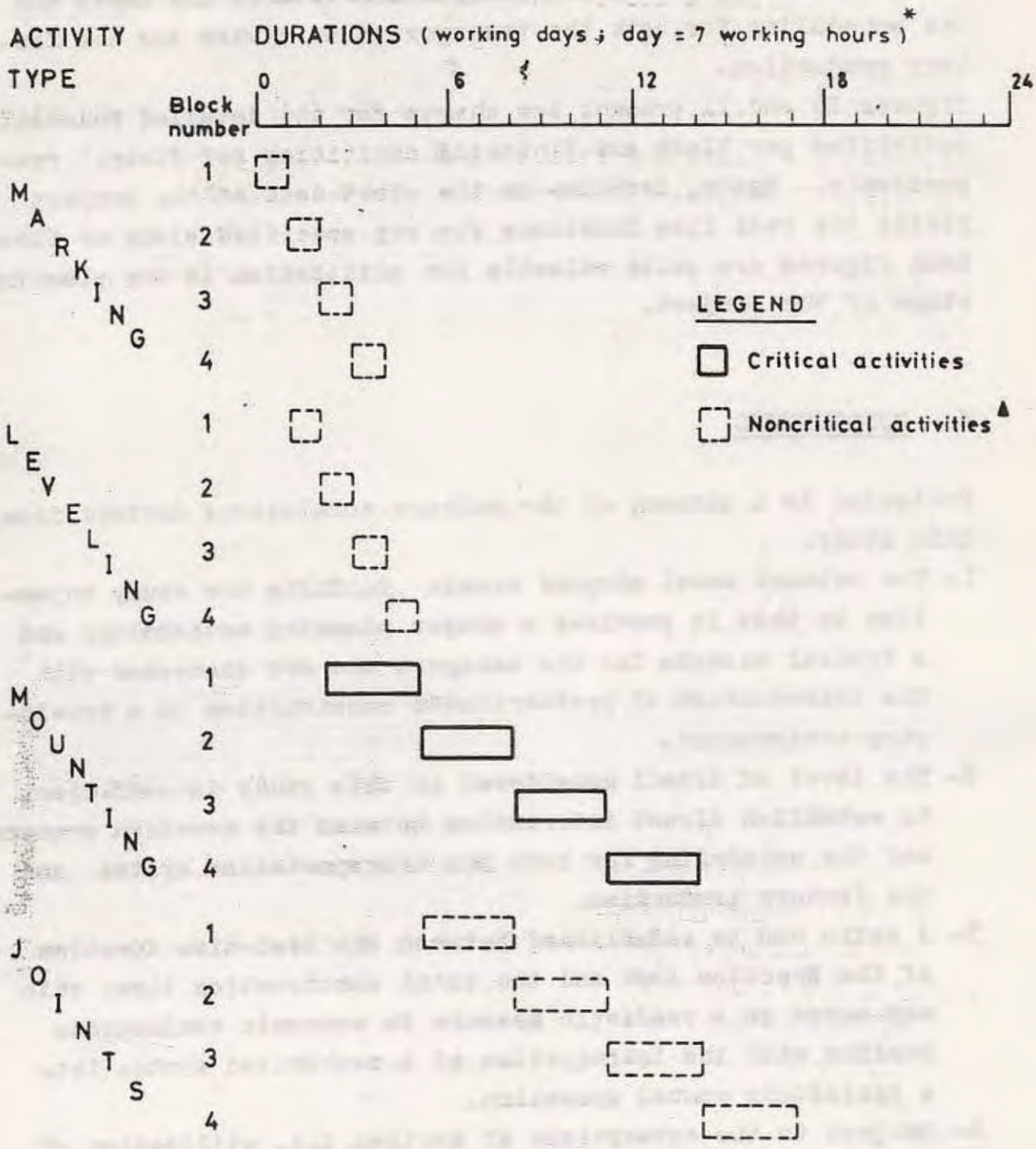


Figure 8. Bar chart for global activities of four blocks.



* Real-time durations depend on corresponding week ends and holidays.

▲ Float depends on number of marking and leveling teams and on block location.

Figure 9. Bar chart for global erection activities of one floor in four blocks.

site; this implies a direct interaction between the model and the scheduling for both the transportation system and the factory production.

Figures 10 and 11 present bar charts for the detailed Foundation activities per block and Finishing activities per floor, respectively. Again, decision on the start date of the project yields the real time durations for any specified block or floor. Such figures are quite valuable for utilization in the planning stage of the project.

4 - CONCLUSIONS

Following is a summary of the authors conclusions derived from this study:

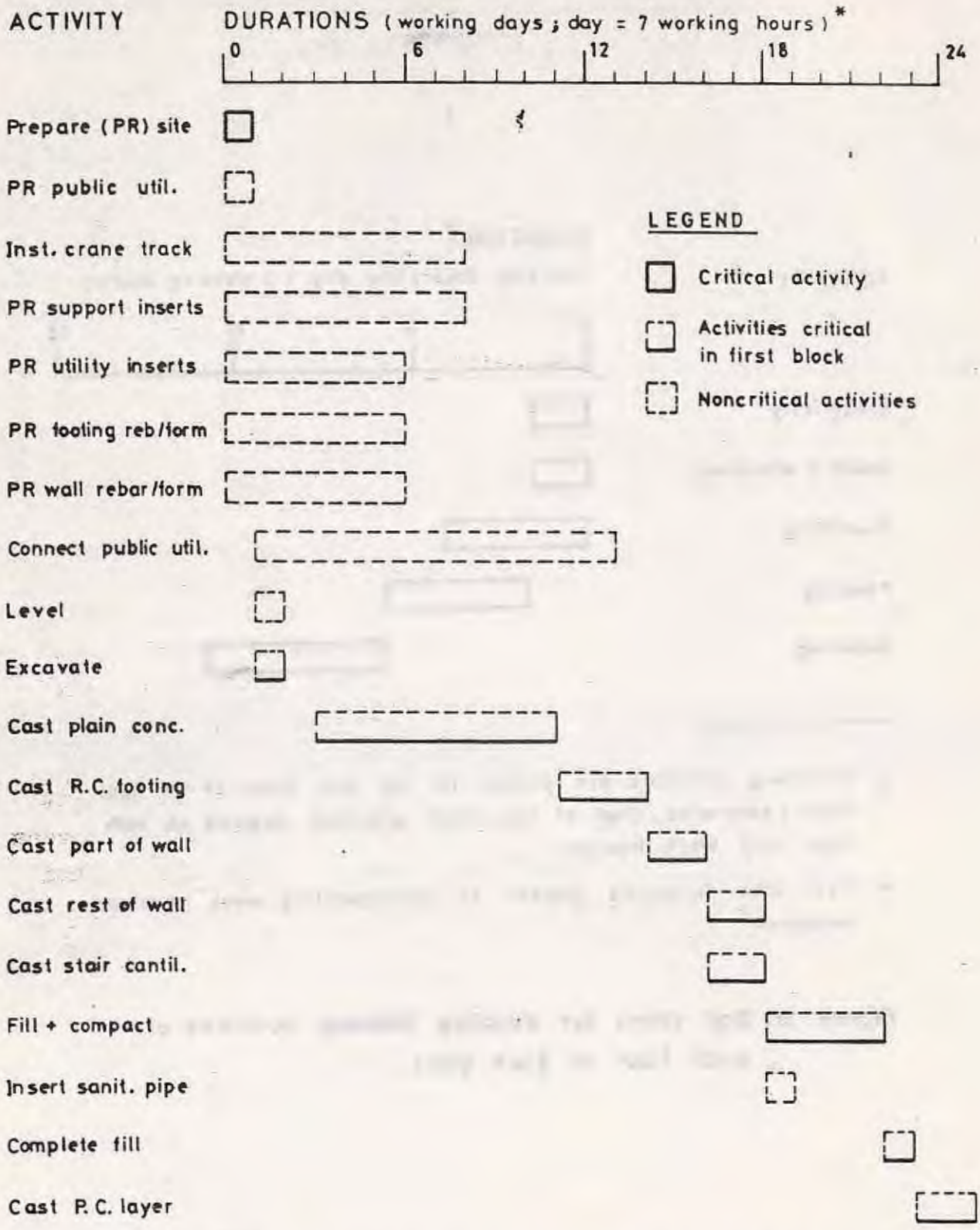
1- The network model adopted herein fulfills the study objective in that it provides a proper planning methodology and a typical example for the managers who are concerned with the introduction of prefabricated construction in a developing environment.

2- The level of detail considered in this study is sufficient to establish direct interaction between the erection process and the scheduling for both the transportation system and the factory production.

3- A ratio can be established between the real-time duration of the Erection task and the total construction time; this may serve as a realistic measure in economic evaluations dealing with the introduction of a mechanized system into a decisively manual operation.

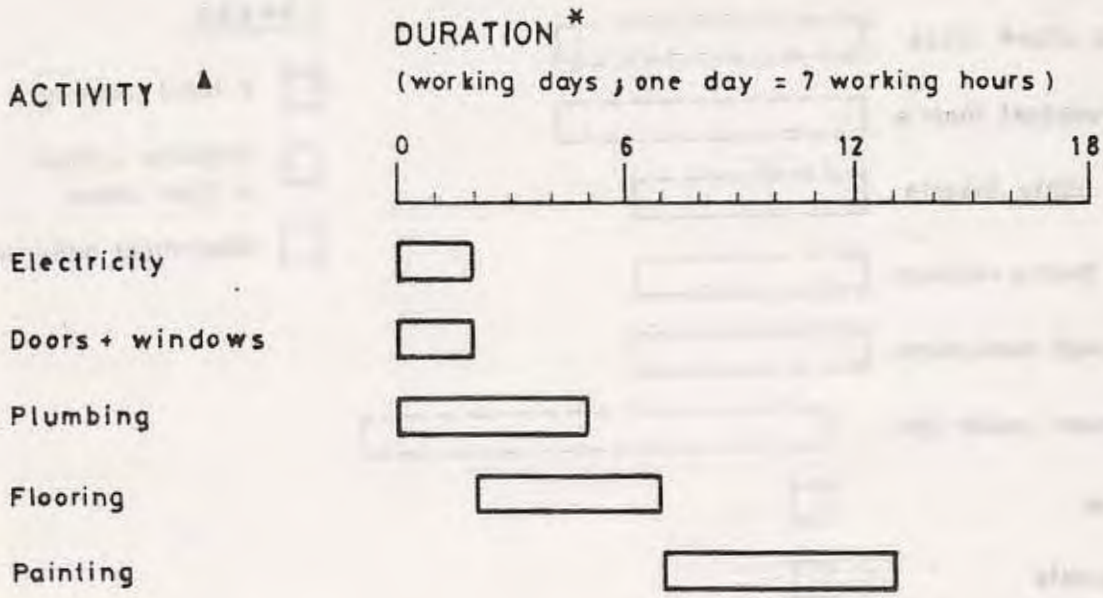
4- Subject to the assumptions of section 2.4, utilization of the model produced a real-time schedule with a total project duration of 122 days. This implies an average construction time of one flat per day including foundation and finishing time.

5- The durations introduced into the model to determine the time schedule are based on sertain assumptions concerning cost and resources (manpower, equipment, and materials) .



* Real-time durations depend on corresponding week ends and holidays.

Figure 10. Bar chart for detailed foundation activities of one block.



▲ Finishing activities are critical for the last floor of the last block; otherwise, float of noncritical activities depend on both floor and block location.

* Real-time durations depend on corresponding week ends and holidays.

Figure 11. Bar chart for detailed finishing activities of each floor of each block.

The validity of the schedule is heavily dependent on the availability of finance and resources at the appropriate time.

5 - RECOMMENDATIONS

Following are the recommendations believed to be of major significance for the implementation of a prefabricated construction project in the manner prescribed in the time schedule.

1- A careful plan for follow-up is to be devised to include decisions concerning:
   a) The level of detail for follow-up as it may not necessarily be the same as that adopted in the planning phase.
   b) The reporting formats, authority, and schedule. That is, in which format, to whom, and every how long should a follow-up report be submitted.
   c) The development of a Project Management Information System (PMIS). This provides control over collection, flow, and filing of data. PMIS provides the seed for a more comprehensive Management Information System (MIS).
   d) The manpower and training required to accomplish the follow-up task systematically and promptly.
2- A nation-wide resources (manpower, equipment, and materials) planning study seems essential to validate the durations assumed for the time schedule if prefabricated construction is to be utilized at a wide scale.
3- A cost analysis study is required to guide managers to secure finance of the various tasks with ample time for utilization.
4- Statistical studies are recommended for identification of work measures that should test for variations between well trained and newly trained crews and personnel.
5- Detailed scheduling studies are recommended for the pro-

duction process and the transportation process with emphasis on the factors imposed by the environmental conditions and on factors of interfacing with erection process.

6 - AKNOWLEDGMENTS

The Egyptian Academy of Scientific Research and Technology granted finance of this study to the Faculty of Engineering, Ain Shams University. Misr Concrete Development Company provided model data. Eng. Aref Salama contributed in model construction, data processing, and analysis of results. Dr.Mohamed Ismail reviewed the model and provided modifications. Mrs. Amira Badawi contributed in data processing and typing.

7 - REFERENCES

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APPENDIX

Table I– KEY FOR ACTIVITY DESIGNATION

Designation		Activity
CM	—	Move crane between blocks.
CR	—	Install crane track.
CS	—	Cast concrete.
DW	—	Finish doors and windows.
EL	—	Finish electricity.
ET	—	Erect a truck load.
EX	—	Excavate.
FC	—	Fill and compact.
FL	—	Finish flooring.
IN	—	Insert.
JD	—	Construct dry mortar joints.
JH	—	Construct horizontal joints.
JV	—	Construct vertical joints.
LA	—	Lead or lag.
LL	—	Perform leveling operation.
MM	—	Perform marking operation.
PL	—	Finish plumbing.
PN	—	Finish painting.
PR	—	Prepare for a specified operation.

بسم الله الرحمن الرحيم

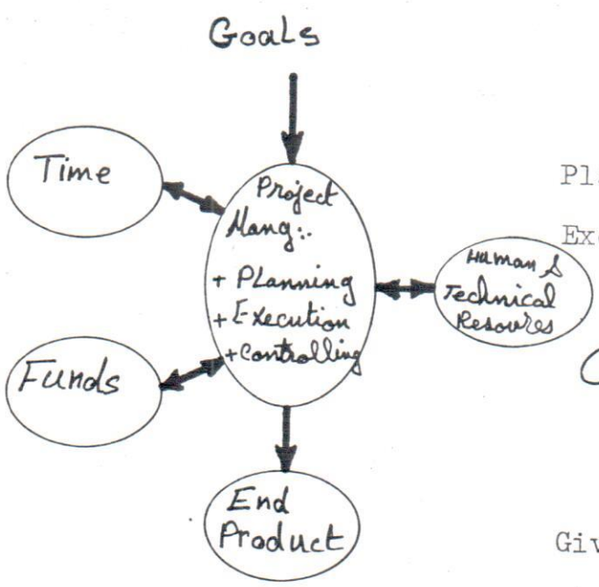
تصور عـــام لبرنامـــج التنفيـــذ :

لاى مشروع هناك هدف رئيسى هو انهاء المشروع بصورة مرضية فى فترة زمنية وبقيمة محدده

Practical Completion Within the agreed cost , time & Quality target

لتحقيق اهداف اى مشروع يلزم لتنظيم وادارة المشروع مايلـــى :
Organization a Mangment Function

* تخطيط برنامج العمل Planning
* تحديد الحصول على مصادر التنفيذ (تمويل ـمواد ومعدات وعمالـــــة) Procurment
* مراقبة عامة للتنفيذ control
* تنظيم تقارير واتصالات لتنفيذ تعليمات Communication& Reporting



ادارة المشـــروع وتشمـــل علميـــات:
Constriction ProjectManagement

* التخطيط Planning
* التنفيذ Executin
* مراقبة المشروع من البداية الى النهاية
Controlling from ispection to Completion

وذلـــك فـــى :

* فترة محدده Giventime
* تكلفة معينة at a given cost

باستعمـــال الامكانيات البشـــرية والفنيـــة المتاحـــة

In accordance With available Technical& Human Resources

However ,this definition dose not exclinde possible alterations that result when

مع ضرورة استبعاد اى تغييرات محتملة نتيجـــــة

_ Basic Clssimption Changes

* متغيرات فى القروض الاولية

- Original estimates are no longer volid

* اى تغيرات متوقعة للتكلفة التقديرية الاوليـــة •

- - New facts ,changes and restrictions owner which could not be anticepated

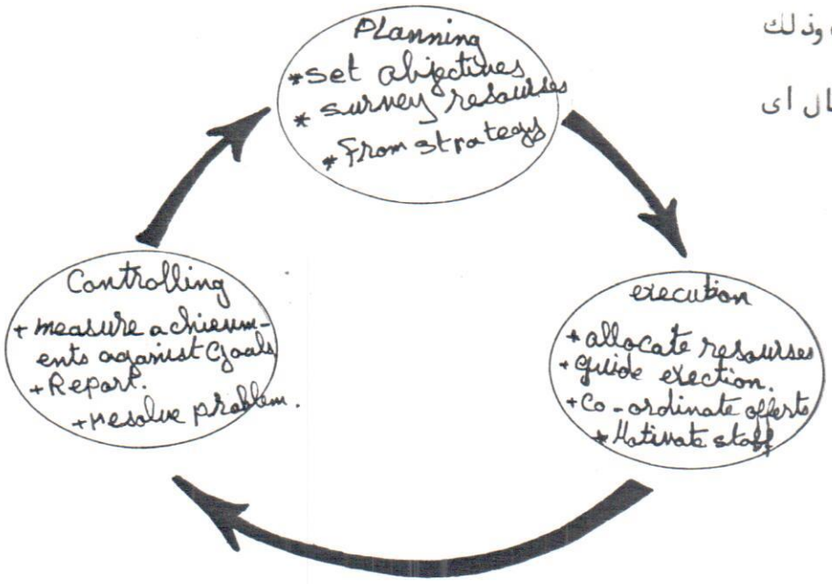
* ظهور حقائق مستجدة او تغييرات او موانع لم تكـــن متوقعة •

بالنسبة للبند الاخيرفانة عند تقدير تكلفة اى مشروع فانه يجب عمل حساب بند اضافى للمتنوعات والاشياء الغير متوقعة وهذا البند تقديرى بالكامل ويعتمد على سابقة الخبرة •

Contingencies

The main Objectives of P.M. is to have the activities from a dynamic cyele, Iplaming

من اهم اهداف ادارة المشروع ان تكون انشطة ديناميكية بحيث تقبل التغيسرات وذلك عن طريق دائرى لاحتمال اى تغيير باستمرار .



حصـــر نوعيـــات الاعمـــال :

ـ مراجعة جداول الكميات للتأكد من مطابقتها للواقع .

Mitestones Events

ـ تحديد الاحداث الهامة

وهى تمثل الانتهاء من اعمال معينة مثل

اساســـات

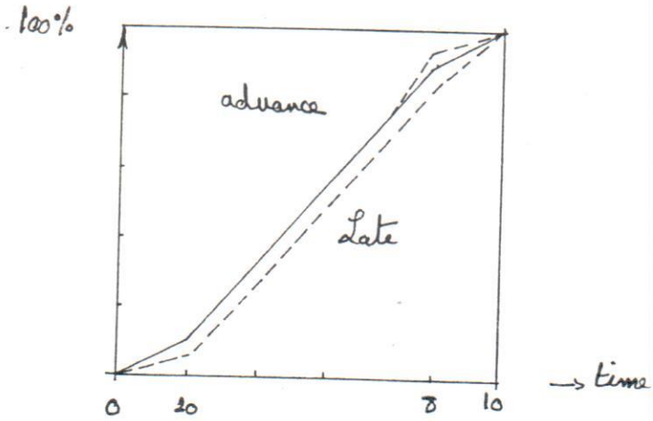
هيكل خرسانى

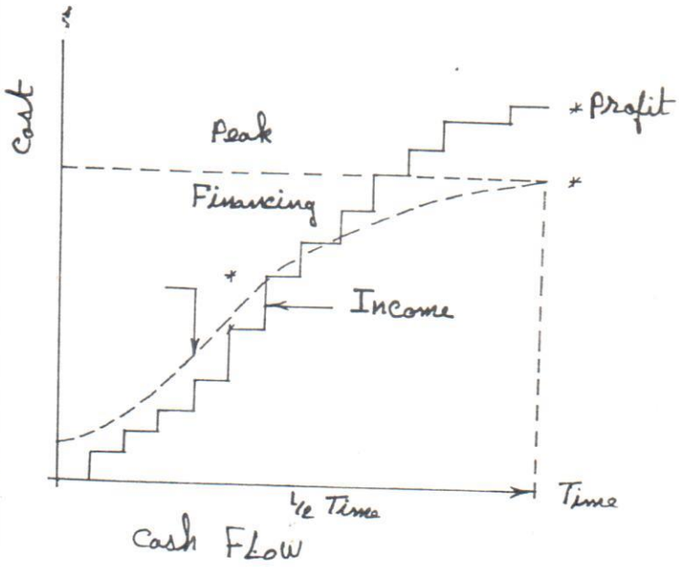
مبانى ـ نجارة وكريتال ـ ارضيات

اعمال صحية ـ دهانات

اعمال كهربائية ـ تسليم المشروع

تطور معدلات التنفيذ مع الوقت :-





1/1/81

Time → months / Activities ↓	1	2	3	4	5	6	7	8
تجهيز الموقع								
اساسات								
هيكل خرسانى								
أو معدنى								
مبانى أو حوائط								
نجارة وكريتال								
أعمال صحية								
أرضيات								
دهانات								
أعمال كهربائية								
نظافة وتسليم								

ـ لكل من هذه الاحداث يلزم القيام بانشطة معين activities فى زمن يتوقف على حجم الاعمال والامكانيات. ولهذا يلزم تحديد الاتـــى لكل نشـــاط:

* المواد المطلوبة وتوقيت الحصول عليها بالموقع.
* المعدات اللازمة لتنفيذ النشاط.
* العمالة المطلوبة لتنفيذ النشاط.

وهنا يجب دراسة اساليب التنفيذ المختلفة للوصول الى انسب طرق التنفيذ (الاكثر اقتصادا ويمكن تنفيذها فى الزمن المحدد).

* اساليب التنفيذ يمكن تقسيمها الى:

١ـ ميكنة متطورة حديثة — Use of advanced Machinery

٢ـ نصف ميكنة — Semi - Mechanietion

٣ـ طرق عادية — Manual labour

مميـــزات وعيـــوب الطـرق المختلفـــة:

الميكنـــة الحديثـــة المتطورة:

مميزاتهـــا:

* امكانية تنفيذ اعمال كبيرة واعمال لاتتوفر لعمال العاديين.
* يمكن الاعتماد عليها اذا احسن استعمالها ولاتتأثر بالحالة الاجتماعية والاقتصادية بالمنطقة حيث انها لاتعتمد علـــى العمالة المحليـــة.
* اذا احسن استعمالها تكون ادق فى الالتزام ببرنامج التنفيذ.
* فى الدول النامية يمكن الاستفادة منها فى تدريب عمالـــة فنية ترفع من مستوى العمالة.

عيوبهـــا :

* تحتاج الى راس مال وغالبا ماتكون ماكينات مستوردة فى الدول النامية .
* فى حالة عدم توفر قطع الغيار او الصيانة قد تسبب عبئا على المشروع .
* اى انخفاض فى معدل الانتاج لعدم دارية كافية قد يؤدى الى زيادة التكلفة ومدة التنفيذ .

الطـرق العادية :

مميزاتهـــا :

* تشغيل عمالة عادية بنسبة اكبر (اذا كانت متوفرة) . فى بعض الحالات قد تكون .

عيوبهـــا :

* توقيت العمالة العادية المطلوبة قد لايكون مناسبا وتاثيرها الاكبر بالاحوال الجوية . فى المناطق النائية تحتاج الى ايواء وتغذيـة .

اتخـــاذ قرار استعمـال الماكينـــات :

- حجم الاعمال وهل يمكن عملها يدويا فى الوقت المحدد .
- توافر العمالة وتكلفتها .
- الخبرة المتاحة للماكينات المطلوبة (خبرة محلية) .
- توفير قطع الغيار واعمال الصيانة .
- بالنسبة للدول النامية - نصف الميكنة ربما تكون مناسبة .

اختبـــار ماكينـــات الانشـاء : Construction Equipment Selection

ـ اختبار الميكنة المناسبة له تاثير على اقتصاديات المشروع وامكانية انهاء المشروع فى الزمن المحدد .

ـ ونظرا لوجود قطاع عريض لمختلف المعدات فى الاسواق التجارية فاختيار المعدات المعدات المناسبة ربما تحتاج الى عناية وذقة .

ـ بعض الاعتبارات التى يجب مراعاتها عند اختبار الميكنة المناسبة :

* استعمال معدات متوفرة لدى المقاول ،حيث ان شراء معدات جديدة لايحتمل استهلاكها بالكامل اثناء المشروع تشكل عبئا على اقتصاديات المشروع.

* مناسبة المعدة للعمل المطلوب منها مع مراعاة ظروف البيئة ـ الطرق الجوفى المنطقـــة .

* تناسب انواع المعدات ـ عدم تعدد النوعيات بقدر الامكان ـ اذا امكن اختبار موتور موحد للمعدات Common Type of E nginer For different Machines Such as Excavators, dump tyuks, tractors ; scropres

* حجم المعدة ـ مع دراسة استعمل معدة كبيرة ذات انتاج ضخم او استعمال اكثر من معدة صغيرة بانتاج اقل وخصوصا فى حالة استدعاء وجود معدة احتياطية للطوارئ .

* استعمال معدات شائعة ونمطية Standard Equpment لسهولة الحصول عليها وتوافر قطع الغيار لها .وسهولة بيعها بعد انتهاء المشروع او استعمالها فى مشروع آخر .

* تكلفة المعدة واثر ذلك على اقتصاديات المشروع Country of Origin

مكان التصنيع واستيراد بمعملة صعبة •

* قطع الغيار اللازمة والاساسية والمفروض توافرها •

* امكانية الاستفادة من المعدة فى اعمال مختلفة •

Versatility The machine selected should be if possible , be capable of performing more than one function and should have the feature of interconver tililty as for as posible.

مثـــال :

* يستحسن استخدام معدات من اقل عدد من المنتجيين

Equpment frim same manifecture as for as possible

* مناسبة المعدة للاستعمال بمعرفة العمالة المحلية المتوفرة •

* امكانية استعمال المعدة فى مشروعات اخرى •

مثـال لحسـاب تكلفـة المعـدة :

عناصـر التكلفـة :

الثمن الاساسى	Taitial cost
ثمن المعدة كخردة	Scrape Valuđ
العمر الافتراضى •	Estimated life period
الاستهـلاك •	De preciation
رخص وتأمينـات •	Licence insurance

Repairs & Maintance	اصلاح وصيانة .
General overheads	مصروفات ادارية .
Profit	ربـــــــح .
Mobil crane	مثـــال لتكلفة و ونش صغـــير على عجـــل :

الثمـــن الاساسى	٠٠٠ ٢٨	جنيهـا
الثمـــن كخـردة	٠٠٠ ٣	"

الاستهلاك على خمس سنوات بمعدل ٢٠٪ سنويا .

فوائد البنك بواقع ١٥٪ فى حالة التمويل عن طريق بنك .

مصاريف اصلاح وتجديد $\frac{١}{٣}$ ٣٣٪ +

(أ) الثمن الاساسى	٠٠٠ ٢٨	جنيهـا .
الثمـــن كخـردة	٠٠٠ ٣	
صافـــى الثمـن	٠٠٠ ٢٥	

(ب) فوائـد التمويـل بواقـع ١٥٪

السنة الاولى ٠٠٠ ٢٥×١٥٪ = ٣٧٥٠

السنة الثانية ٢١٢٥٠×١٥٪ = ٣١٨٧ر٥

السنة الثالثة ١٨٠٦٢ر٥×١٥٪ = ٢٧٠٩ر٣٧٥

السنة الرابعة ١٥٣٥٣ر١٢٥×١٥٪ = ٢٣٠٢ر٩٧٠

السنة الخامسة ١٣٠٥٠ر١٥٥×١٥٪ = ١٩٥٧ر٥٢٣

١٣٩٠٧ر٣٦٨

		مليم جنيه
صافى الضمن + فوائد التمويل = ...	٢٥٪ + ١٣٩٠٧,٣٦٨ =	٣٨٩٠٧,٣٦٨
اصلاح وتجديد بواقع ١/٣ ٣٣٪	=	١٣٩٦٩,١٢٢
		٥٢٨٧٦,٤٩٠

اجمالى التكلفة

التكلفة السنوية (٥ سنوات)	١٠٥٧٥,٢٩٨
مصاريف رخص وتأمينات	ر ٨٠٠
	١١٣٧٥,٢٩٨

(ج) تكلفة الساعة :

عدد الاسابيع السنوية		٥٢
اجازات	٣	
صيانة	٢	
انتقال للموقع	١	
اعطال وبطالة	٦	
	١٢	١٢
عدد اسابيع العمل		٤٠ اسبوع

ساعات العمل فى الاسبوع = ٤٤ ساعة

ساعات العمل السنوية = ٤٠ × ٤٤ = ١٧٦٠ ساعة

تكلفة الساعة من الثمن الاساس = ١١٣٧٥,٢٩٨ / ١٧٦٠ = ٦,٤٦٣ مليم جنيه

مصاريف التشغيل :

	مليم جنيه
اجر السواق فى اليوم شامل التامينات =	ر ١٢
وقود وتشحيم	ر ٤
	ر ١٦

تكلفة الساعة لمصاريف التشغيل = ١٦ ج ٨ = ٢ر مليم جنية

اجمالى التكاليف للساعة = من اليمين الاساسى + من مصاريف التشغيل

= ٦٫٤٦٣ + ٢ = ٨٫٤٦٣

مصاريف ادارية بواقع ١٠٪ ٨٤٦ر

٩٫٣٠٩

ارباح " ١٠٪ ٦٣١ر

اجمالى ثمن ساعة تشغيل ١٠٫٢٤٠ جنيها

انتاجية المعدة: Output

من المهم اختيار المعدة التى تعطى الانتاجية المطلوب فى الزمن المحدد مثال لحساب الانتاجية

- مطلوب صب ١٥٤م٣ خرسانة فى ٦ ايام (٨ساعات عمل يوميا) .

ساعات العمل المنتجة = ٦×٨×$\frac{٤}{٥}$ = ٣٨٫٤ ساعة

بافتراض ان $\frac{١}{٥}$ يوم يضيع بين راحة وصيانة وعطل (يحدد من خبرة سابقة) .

انتاجية خلاط الخرسانة المطلوب = $\frac{١٥٤}{٣٨٫٤}$ = ٤م٣/ساعة

دورة الخلاط:

تحميل ١ر دقيقة

زمن الخلط ٣ر

تفريغ ١

اجمالى الدورة ٥ دقائق

عدد الخلطات فى الساعة = $\frac{٦٠}{٥}$ = ١٢ خلطة/ساعة

∴ حجم الخلاط المطلوب = $\frac{٤}{١٢}$ = $\frac{١}{٣}$م٣

∴ خلاطة سعة ١/٣ م٣ يكفى لتحقيق هذا المعدل .

التنسيق بين المعدات: Plant Matching

التنسيق بين انتاجية المعدات المختلفة مطلوب واساسى للحصول على اقصى كفاءة فى التنفيذ .

مثال: حساب معدة نقل خرسانة Dumper من موقع الخلاط الى مكان الصب

عدد معدات النقل = $\frac{\text{انتاجية الخلاط فى الساعة}}{\text{انتاجية المعدة النقل فى الساعة}}$ + ١ معدة اضافية .

No of Dumpers

وذلك لضمان عدم انتظار الخلاط لاى معدة نقل .

مثال: مطلوب معرفة عدد معدات نقل خرسانة Dumpers سعة ٣٫٠م٥ لنقل خرسانة لمسافة ٢٠٠م ، والخلاط المستعمل سعة ٣٫٠م٥ ، ويعطى ٦م٣/ساعة

∴ عدد الخلطات فى الساعة = $\frac{٦}{٠٫٥}$ = ١٢ خلطة/ساعة

فترة تحميل المعدة = $\frac{٦٠ \text{ دقيقة}}{١٢ \text{ خلطة}}$ = ٥ دقائق

فترة تفريغ المعدة = ٠٫٥ دقيقة .

فترة انتقال المعدة لمسافة ٢٠٠م بمعدل ١٥كجم/ساعة بالاضافة الى حوالى ٠٫٥ دقيقة مغادرة حوالى ١٫٥ دقيقة اجمالى ٧٫٠ دقائق

عدد رحلات المعدة فى الساعة = $\frac{٦٠}{٧}$ = ٨٫٥ رحلة

حجم الخرسانة التى يمكن للمعدة الواحدة نقلها فى الساعة = ٨٫٥ × ٠٫٥ = ٤٫٢٥م٣/ساعة

عدد معدات النقل Dumpers = $\frac{٦}{٤٫٢٥}$ = ١ = ٣ معدات نقل .

3 Dumpers are required

بسم الله الرحمن الرحيم

استخـــدام الوسائل الحديثـة لتخطيط برنامج التنفيـــذ :

الطرق الحديثة الاساسية هى باستعمال C.P.M او Pert

Critical Path Method

ـ طريقة المسار الحرج

Performance Evaluation

ـ برانج وتقييم الاعمال port

(Programme & Revoew Techniques

وجميع هذه الطرق تعتمد على تحديد الاحداث الهامة Events للمشروع والانشطة المختلفة Activities

كمايلزم عمل شبكة منطقية لتسلسل الاحداث Net work

وهناك عدة طرق لتمثيل هذه الشبكات المنطقية وهناك طريقتان اساسيتان .

طريقةتمثل i,j No tation I,J

وفيها يمثل النشاط بسهم يبدأ من i وينتهى عند j ويبدأ من حدث وينتهى عند حدث هو نهاية النشاط

ولكل نشاط بجانب توصيفه يلزم تحديد الاتـــى :

ـ مدة التنفيذ D Duration

ـ بداية مبكرة E.S. Early start

ـ بداية متأخرة L.S Late Start

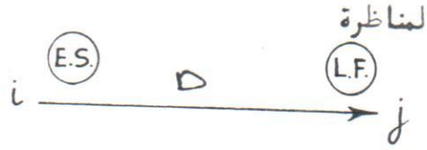
ـ نهاية مبكرة E.F. Early Finish

ـ نهاية متاخرة L.F Late Finish

وكذلك يمكن اضافة الى برنامج التنفيذ

الامكانيات Resourses

معدات وعمالة وانتاجيتها وتكلفتها والمدة المناظرة



وكذلك يحدد مقدار التارجح لكل الانشطة

Floor= F=(L.F.-E.S.) -D

OR = L.F.-E.F.

OR = L.S.-E.S.

وعندما يكون مقدار التأرجح صفر يصبح هذا النشاط حرج

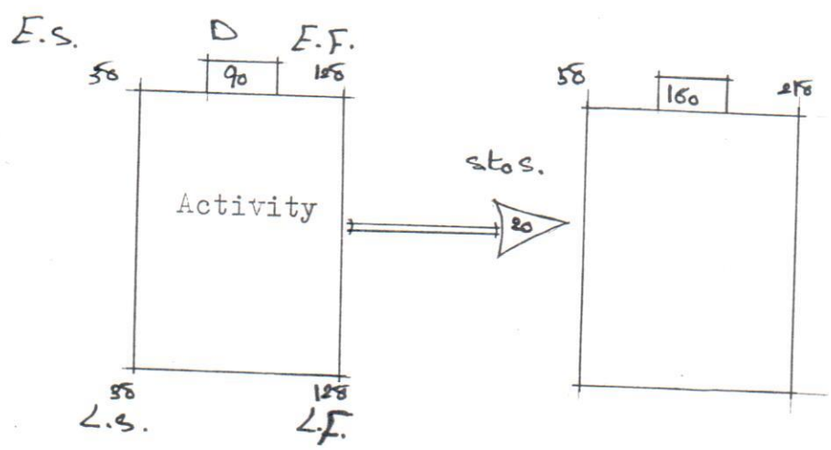
ـ وعند عمل شبكة البرنامج تحدد الانشطة (الاحداث) السابقة والانشطة (الاحداث) اللاحقة Preceeding & Following

ـ كمايمكن عمل شبكات فرعية لكل نشاط وامكانية تداخل بعض الاعمال بغرض اختصار الوقت

والامثلة التالية توضح هذه الطرق:

طريقة تمثيل الشبكة Precedence Notation

وهذه الطريقة تميل بها النشاط داخل مربع ويبين علية البيانات المطلوبة



اقامـــة مبـــنى اداري اوسكـــنى :

الاحداث الرئيسية ومدة التنفيذ لكل منهـــا :

ـ تجهيز الموقع	٤	يوم
ـ الاساسات	٢٠	"
ـ الهيكل الخرسانى	٦٠	"
ـ اعمال المبانى	٢٠	"
ـ اعمال النجارة والكريتال	١٠	"
ـ الاعمال الصحية	١٢	"
ـ اعمال الكهرباء	٥	"
ـ الارضيات	٣٠	"
ـ دهانات	٤٠	"
ـ تنظيف الموقع وتسليمة	٤	"
	٢٠٥	يوم

فى حالة عمل ترتيب تسلسلى لجميع الاحداث يكون المجموع

مثـــال لتفاصيـــل اعمـال الاساسات:

ـ المدد المطلوبة للاعمال المختلفة

ـ تخطيط الموقع	١ يوم	
ـ حفر القواعـــد	٤ "	
ـ صب خرسانة عادية	٤ "	
ـ صب خرسانة عادية	٤ "	
ـ خرسانة مسلحة	٨ "	
ـ ردم	٣ "	(مدة لاتقل عن ٢ يوم من صب الخرسانة المسلحـــة)
اجمالـــــــى	٢٠ يوم	

ويمكن اختصار زمن التنفيذ بتداخل بعض الاعمال

السيد / الدكتور عبد الهادى حسنى

الاسم :	السيد الدكتور / عبد الهادى حسنى .
تاريخ الميلاد :	١٩٢٩/٣/١٨ .
الشهادات الحاصل عليها :	* دكتوراه الفلسفة ـ انجلترا ١٩٥٧ . * دبلوم ميكانيكا تربة واساسات ١٩٥١ . * ماجيستير هندسة مدنية ـ خرسانة ١٩٥٤ . * بكالوريوس هندسة مدنية القاهرة ١٩٥٠ .
الوظيفة الحالية :	استاذ المنشئات الخرسانية ـ كلية الهندسة جامعة عين شمس .
الخبرة السابقة :	* مهندس استشارى منذ عام ١٩٧٢ . * مكتب هندسى ١٩٥٨ .
السكن :	٤٩ شارع الشهيد عبد المنعم حافظ ـ الماظة م . ج
تليفون :	العمل : ٩١٤٧٨٤ منزل : ٦٦٠٣١٢