Planning, Scheduling, Resource Management and Onsite Safety for A Flyover Project: A Case Study At Vmc

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Abstract- *A case study- flyover project has been selected in Kota (Rajasthan), to monitor the planning, scheduling, resource management and onsite safety. Proper planning and scheduling of the project helps to track the project and minimize the chance of delay in project completion thus reducing the cost of project. The Hazard Identification and Risk Assessment (HIRA) and JOB SAFETY ANALYSIS (JSA) for the various activities where made which shows the hazards involved in activities and the control measures for the hazards. This project is done by using primavera p6 software which is widely used for the purpose, software also help to track the project and aids in resource levelling.*

Keywords- Planning, Resource Management, HIRA, JSA, Primavera.

I. INTRODUCTION

Management in the field of construction have achieved a vital importance over a past few decades. The construction management had enabled to achieve the construction more economically in terms of time, money and material. The proper management of the project not only avoids the delay in the work completion but also saves the cost incurred due to delay in project. It also avoids the over usage of the material used for construction and also helps in proper usage of human and machine resource

There must be some cautionary setup, which can alarm the company about its possible success and failures off and on. Project scrutinizing is the process of collecting, logging, and reporting information concerning project performance that project manager and others wish to know. Scrutinizing involves watching the progress of the project against time, assets and performance schedule during execution of the project and detecting lagging areas requiring timely attention and action whereas project controlling uses data from monitor activity to bring actual performance to planned performance.

Site safety is one of the crucial factor which should be kept in the mind before the work starts, during the work and also after the completion of work. Safety in construction are particularly important because the industry is prone to hazardous situations and can be dangerous at times. In recent years, Hazard Identification, Risk Assessment (HIRA) has become fundamental to the practice of planning, management and the operation of a business as a basic of risk management. Job Safety Analysis (JSA) simply means looking at the work task and considering what is the safest way to complete it. It is a way of becoming aware of the hazards involved in doing the job and taking action to prevent an injury. With the advances in the field of information technologies, construction industry has started taking advantages of some of the developed tools. Accelo, Flash desk, Slack, Project Planning Pro, Microsoft Project, Primavera are some of the project planning software. Primavera is an appropriate technology for managing construction projects and can improve the construction planning and efficiency by integrating locational and thematic information in a single environment.

FLYOVER PROJECT DETAILS

- ✓ NAME OF WORK:- Construction of flyover from danbari to keshopura circle on rangbari road kota
- ✓ CLIENT:- URBAN IMPROVEMENT TRUST (UIT) KOTA
- ✓ CONTRACTOR:-VIJAYMISTARY CONSTRUCTION
- ✓ START DATE:- 1/9/17
- ✓ FINISH DATE:- 28/2/19
- ✓ TOTAL COST OF PROJECT: - RS. 1,40,58,28,079
- ✓ OVERALL LENGTH:- 1.6KM (23 span of 40M, 3 spans of 30M, 4 spans of 45M)
- ✓ WIDTH:- 17.200 M (7.5M carriageway and 1.2M divider)
- ✓ TYPE OF SUPERSTRUCTURE:- Segmental box girder

OBJECTIVES

The main objectives of this study are:-

1. The main objective of the project is to plan and schedule fly over project with the given constrains of the resources.
2. To suggest the importance and purpose of monitoring the construction work.
3. To manage the resources in such a way that the given resources are nether under used nor over used.
4. To track the project to compare it with actual work going on and the planed work.
5. To prepare the HIRARC and JSA of every major activity on the site

II. PLANNING AND SCHEDULING

- Planning is the part of the project in which the various events and the activities in the events with their duration are listed down in the order of there of occurrence.
- Scheduling is the part in which the start dates and finish dates are allocated to each activities with their relationship with other activities.

A. Calendar Setup

One of the most important work before starting a planning is to setup the project calendar, which tells about the working hours in a day, working days in a week and holydays if any. In this project the working hours are as follows:-

- 7 days a week of work
- Each day from 8:00 AM to 9:00 PM
- A lunch break at 1:00 PM to 2:00 PM
- Tea breaks from 10:30 AM to 11:00 AM and 4:30 PM to 5:00 PM

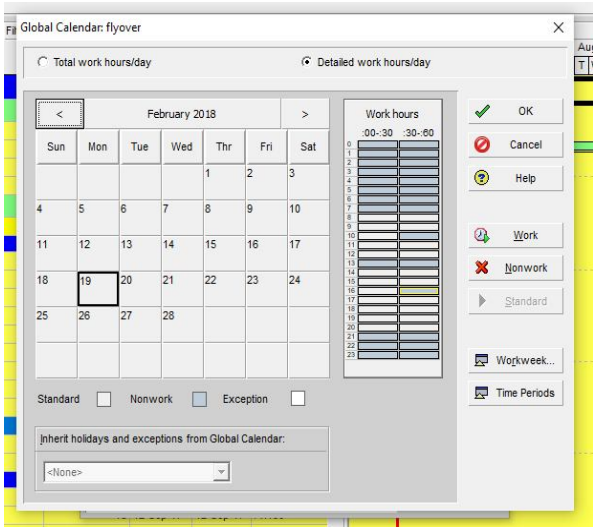


Fig.1 Project Calendar

B. Preconstruction activities

These are some of the activities which are needed to be performed before the actual construction starts

Table 1 preconstruction activities

Activity	Duration
Traffic diversion	2
Camp setup	30
Layout	2
Equipment setup	2

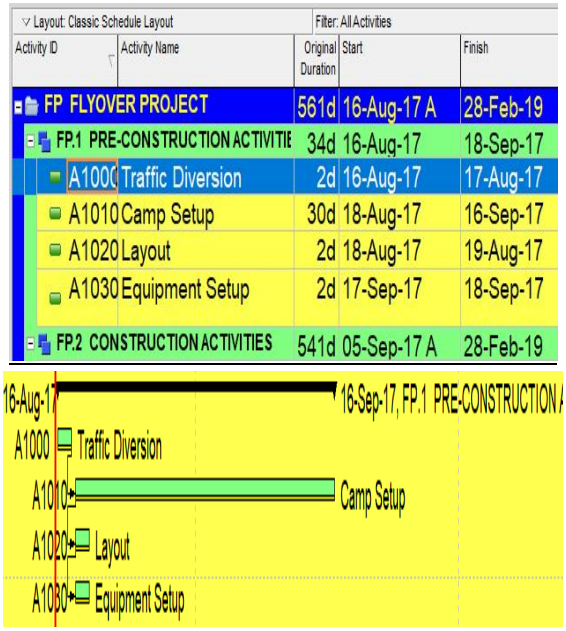


Fig.2 Activities with bar chart

As it can see the preconstruction activities starts on 16th of august and end 16th September 2017. The camp setup takes the maximum of 30days

C. Foundation and Pier work:

Foundation and pier work is the first stage of the construction activity. The following are the foundation and pier activities

Table 2 Foundation and Pier work

Activities	Duration
Excavation	10 days for abutment(A1 and A2) 15 days for 2 piers (P1-P29)
Cleaning	1 day
Anchoring	1 day
PCC	1 day
Steel Binding	3 days
Shuttering	1 day
Concreting	1 day
Deshuttering	1 day
Shuttering of top footing	1 day
Concreting of top footing	1 day
Annular filling	1 day
1st stage work	2 days
2nd stage work	3 days (for P4 - P25)

- ✓ The site has only 2 excavators, so the excavation activity is done 2 at a time
- ✓ The group of workers doing the steel binding work is only one, so the steel binding work is done 1 at a time
- ✓ Keeping the above constrains in mind the event is planned as follows

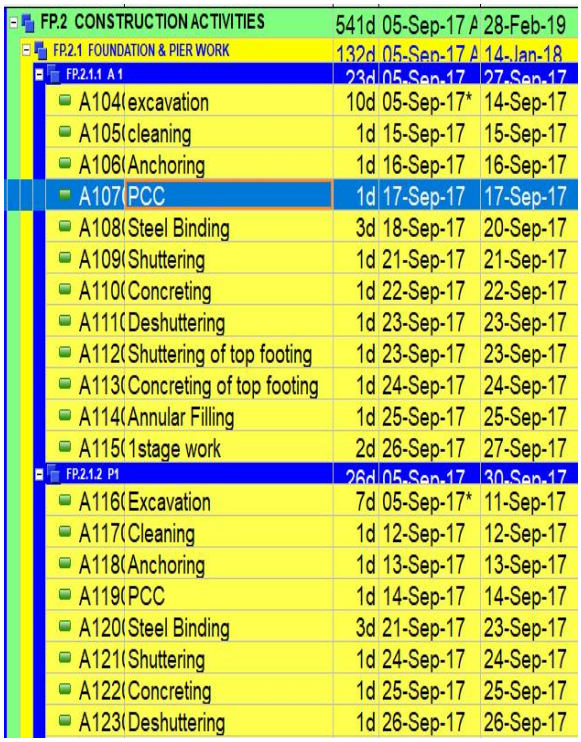


FIG.3 A1 and P1

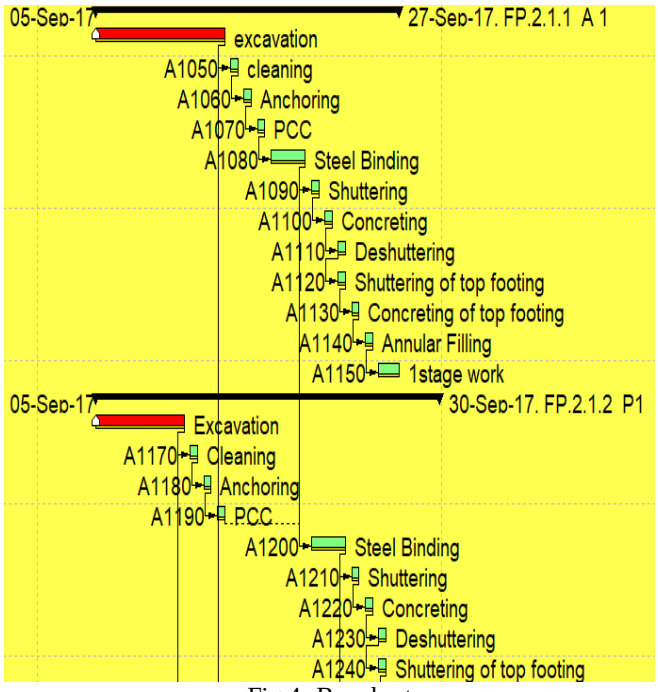


Fig 4- Bar chart

- Foundation and pier work which starts on 5th September 2017 (Fig.3).
- Foundation and pier work is planned to be completed on 22nd January 2018 (Fig.5)

FP.2.1.31 A 2	23d	23-Dec-17	14-Jan-18
A486 Excavation	10d	23-Dec-17	01-Jan-18
A487 Cleaning	1d	02-Jan-18	02-Jan-18
A488 Anchoring	1d	03-Jan-18	03-Jan-18
A489 PCC	1d	04-Jan-18	04-Jan-18
A490 Steel Binding	3d	05-Jan-18	07-Jan-18
A491 Shuttering	1d	08-Jan-18	08-Jan-18
A492 Concreting	1d	09-Jan-18	09-Jan-18
A493 Deshuttering	1d	10-Jan-18	10-Jan-18
A494 Shuttering of top footing	1d	10-Jan-18	10-Jan-18
A495 Concreting of top footing	1d	11-Jan-18	11-Jan-18
A496 Annular Filling	1d	12-Jan-18	12-Jan-18
A497 1st stage work	2d	13-Jan-18	14-Jan-18
FP.2.2 PIER CAP WORK (PCW)	1d 6h	10-Nov-17	24-Apr-18

Fig.5 A2

D. PIER CAP WORK

Table 3. Pier Cap Work

Activities	Duration
Staging	A1-P3 and P27-A2 2 days P4-P26 3days
Bottom Shuttering	2 days
Steel Binding	5 days
Side Shuttering	1 day
Concreting	1 day
Deshuttering	6 hours

- ✓ The pier cap activities where planned to be starting 2 months after the start of pier work (fig.6)
- ✓ The pier cap work starts on 10th of November 2017.
- ✓ For this event there was 3 sets of staging material so, staging work of 3 piers can be done at a time
- ✓ There is only 1 labour group doing the steel binding work
- ✓ There is a lag of 1 day to be given after concreting for the deshuttering
- ✓ Keeping the above things in mind the event is planned as follows

Activity ID	Activity Name	Original Duration	Start	Finish
FP.2.2 PIER CAP WORK (PCW)		164d 6h	10-Nov-17	24-Apr-18
FP.2.2.1 PCW-A1		14d 6h	10-Nov-17	24-Nov-17
A506	staging	2d	10-Nov-17*	11-Nov-17
A507	Bottom shuttering	1d	12-Nov-17	12-Nov-17
A508	Steel Binding	8d	13-Nov-17	20-Nov-17
A509	Side Shuttering	1d	21-Nov-17	21-Nov-17
A510	Concreting	1d	22-Nov-17	22-Nov-17
A511	Deshuttering	0d 6h	24-Nov-17	24-Nov-17
FP.2.2.2 PCW-P1		19d 6h	10-Nov-17	29-Nov-17
A512	staging	2d	10-Nov-17*	11-Nov-17
A513	Bottom shuttering	2d	12-Nov-17	13-Nov-17
A514	Steel Binding	5d	21-Nov-17	25-Nov-17
A515	Side Shuttering	1d	26-Nov-17	26-Nov-17
A516	Concreting	1d	27-Nov-17	27-Nov-17
A517	Deshuttering	0d 6h	29-Nov-17	29-Nov-17
FP.2.2.3 PCW-P2		24d 6h	10-Nov-17	04-Dec-17
A518	staging	2d	10-Nov-17*	11-Nov-17
A519	Bottom shuttering	2d	12-Nov-17	13-Nov-17
A520	Steel Binding	5d	26-Nov-17	30-Nov-17
A521	Side Shuttering	1d	01-Dec-17	01-Dec-17
A522	Concreting	1d	02-Dec-17	02-Dec-17
A523	Deshuttering	0d 6h	04-Dec-17	04-Dec-17

Fig.6 PCW A1-P2

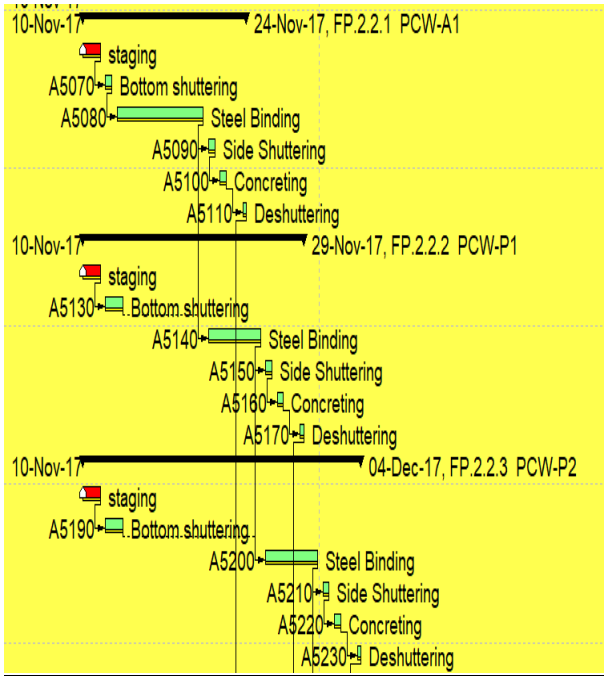


Fig.7 Bar chart

- Pier cap work starts on 10th November 2017(Fig.6)
- As per the plan the pier cap work should end on 24nd January 201(Fig.8)

FP.2.2.29	PCW-P28	15d	30-Mar-18	14-Apr-18
A674	staging	2d	30-Mar-18	01-Apr-18
A675	Bottom shuttering	2d	01-Apr-18	03-Apr-18
A676	Steel Binding	5d	06-Apr-18	10-Apr-18
A677	Side Shuttering	1d	11-Apr-18	11-Apr-18
A678	Concreting	1d	12-Apr-18	12-Apr-18
A679	Deshuttering	0d 6h	14-Apr-18	14-Apr-18
FP.2.2.30	PCW-P29	15d	04-Apr-18	19-Apr-18
A680	staging	2d	04-Apr-18	06-Apr-18
A681	Bottom shuttering	2d	06-Apr-18	08-Apr-18
A682	Steel Binding	5d	11-Apr-18	15-Apr-18
A683	Side Shuttering	1d	16-Apr-18	16-Apr-18
A684	Concreting	1d	17-Apr-18	17-Apr-18
A685	Deshuttering	0d 6h	19-Apr-18	19-Apr-18
FP.2.2.31	PCW-A2	15d	09-Apr-18	24-Apr-18
A686	staging	2d	09-Apr-18	11-Apr-18
A687	Bottom shuttering	2d	11-Apr-18	13-Apr-18
A688	Steel Binding	5d	16-Apr-18	20-Apr-18
A689	Side Shuttering	1d	21-Apr-18	21-Apr-18
A690	Concreting	1d	22-Apr-18	22-Apr-18
A691	Deshuttering	0d 6h	24-Apr-18	24-Apr-18

Fig.8 PCW P28-A2

E. SEGMENT CONSTRUCTION

The construction of the segment is planned to be started from 1st of March 2018. There are 540 segments to be constructed for the total 30 spans, below are the activities of the segment construction (table 4)

Table 4. Activities of segment construction

Activity	Duration
ISMB Frames 8 no.	120 days(15 for one)
Outer Shuttering	1 hour
Steel Binding	1 day
Profiling	6 hours
Inner Touch-up	4 hours
Concreting	3 hours

- ✓ In the above table (Table 4) we can see the duration of outer shuttering to concreating is approximately of 3 days so, there are 540 to be constructed.
- ✓ Which gives us the duration of 1620 days (540x3=1620)
- ✓ But segment casting can be done 6 at a time which gives us 270 days (1620/6=270)
- ✓ 270 days means 9 months approx. (270/30=9)
- ✓ We see it takes 9 months to cast 540 segment, which also shows that 60 segments can be casted in a month (540/9=60)

FP.2.32.7	SEGMENT CONSTRUCTION	407d	15-Oct-17	26-Nov-18
A8060	ISMB FRAMES 8 NO.	120d	15-Oct-17*	11-Feb-18
A8070	Outer Shuttering	0d 1h	01-Mar-18*	01-Mar-18
A8080	steel binding	1d	01-Mar-18	03-Mar-18
A8090	Profiling	0d 6h	03-Mar-18	03-Mar-18
A8100	Inner Touch-up	0d 4h	03-Mar-18	03-Mar-18
A8110	Concreting	0d 3h	04-Mar-18	04-Mar-18
A8120	segment 1-60	30d	01-Mar-18*	31-Mar-18
A8130	segment 61-120	30d	01-Apr-18	30-Apr-18
A8140	segment 121-180	30d	01-May-18	30-May-18
A8150	segment 181-240	30d	31-May-18	29-Jun-18
A8160	segment 241-300	30d	30-Jun-18	29-Jul-18
A8170	segment 301-360	30d	30-Jul-18	28-Aug-18
A8180	segment 361-420	30d	29-Aug-18	27-Sep-18
A8190	segment 421-480	30d	28-Sep-18	27-Oct-18
A8200	segment 481-540	30d	28-Oct-18	26-Nov-18

Fig.9 Segment 1-540

- ✓ Segment construction starts on 15th October 2017 and end on 26th November 2018 (Fig. 3.8)
- ✓ Launching work starts on 11th June 2017 and end on 2nd January 2019
- ✓ Now 2 months can be given to finishing work.
- ✓ Thus the project end on 28th February 2019.

III. RESOURCE INPUT AND ALLOCATION

A. RESOURCE INPUT

- The resource input includes the collecting the list of labour.
- After getting the labour list the next thing is to put the number of labour in the software.
- The method of putting the labour in the software is based on working hour of a single labour in a day and the total number of labour present
- for example, there are 7 welder in company's list (and the working hours of each labour is 11 hours (from 8 AM to 9 PM with 2hours of break in between), so when we put the labour quantity for welder we put it as

number of labour/machine present x working hour in a day—(equation 1)

- ➢ welder present would be: - 7x11= 77 hours/ day
- ➢ carpenter present would be: - 8x11= 88 hours/ day

- pile labour present would be: - 39x11= 429 hours/ day
- shuttering helper present would be:- 52x11= 572 hours/ day

Apart from labour another group of persons present at site are project manager, senior engineer, site engineers, safety engineer and supervisors.

- Project manager-1
- Senior engineer- 1
- Site engineer- 4
- Safety engineer- 1
- Supervisors- 4

Display: Current Project's Resources

Resource ID	Max Units/Time	Resource Name	Resource Type	Default Units / Time
weld	77/d	welder	Labor	11/d
weld.h	44/d	welder helper	Labor	11/d
shut.h	605/d	shuttering helper	Labor	11/d
p labour	429/d	pile labour	Labor	11/d
survy	11/d	surveyor	Labor	11/d
survey-h	11/d	serveyor helper	Labor	11/d
mson	11/d	messon	Labor	11/d
male-l	132/d	male labour	Labor	11/d
fema;e-l	121/d	female labour	Labor	11/d
exvtr	22/d	excavator	Nonlabor	11/d
drill-mach	22/d	drill machine	Nonlabor	11/d
air com	11/d	air compressor	Nonlabor	11/d
crn	22/d	crane	Nonlabor	11/d
vib.	33/d	vibrator	Nonlabor	11/d
skld-1	110/d	skilled	Labor	11/d
unskld-1	220/d	unskilled	Labor	11/d
skld-3	66/d	skilled	Labor	11/d
unskld-3	154/d	unskilled	Labor	11/d
skld-4	22/d	skilled	Labor	11/d
unskid-4	55/d	unskilled	Labor	11/d
PM-1	11/d	Project Manager	Labor	11/d
Sn. engg	11/d	Senior Engineer	Labor	11/d

Fig.10 Labour list as in software

B. RESOURCE ALLOCATION

Now at the time of assigning the above listed resources (Fig.10) to the planned activities the method changes, it goes as shown below:-

Number of labour/machine used in that activity x Actual working hours labour/machine x -----(equation2) Days of work the labour/machine is to be used

For example, for any activity X the completion period is 3 days and their labour/Machine used are:-

- 1 crane for 3 hours
- 8 helpers for 11 hours
- 3 welders for 7 hours
- 1 site engineer for 10 hours

Now when we put the above date in the software, we put it as shown below

- Crane- 1 x 3 x 3 = 9 hours
- Helper- 8 x 11 x 3 = 264 hours
- Welders- 3 x 7 x 3 = 63 hours
- Site engineer- 1 x 10 x 3 = 30 hours

The above explained method is applied while assigning the resource for each and every activity. Below figures shows the date input in software

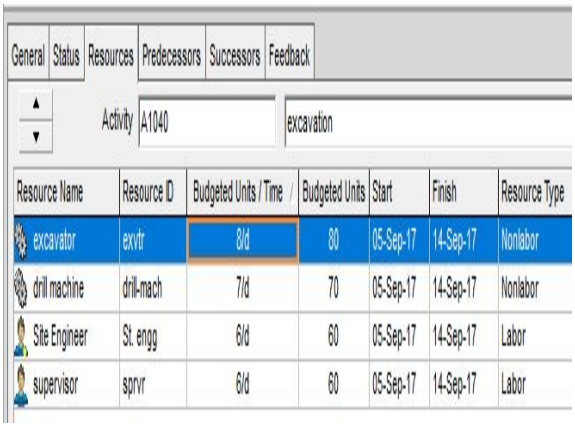


Fig.11 Resources for excavation

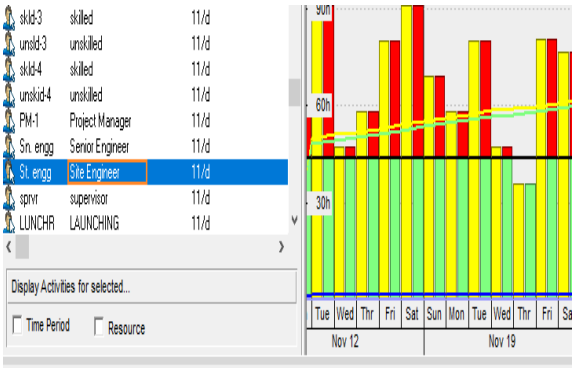
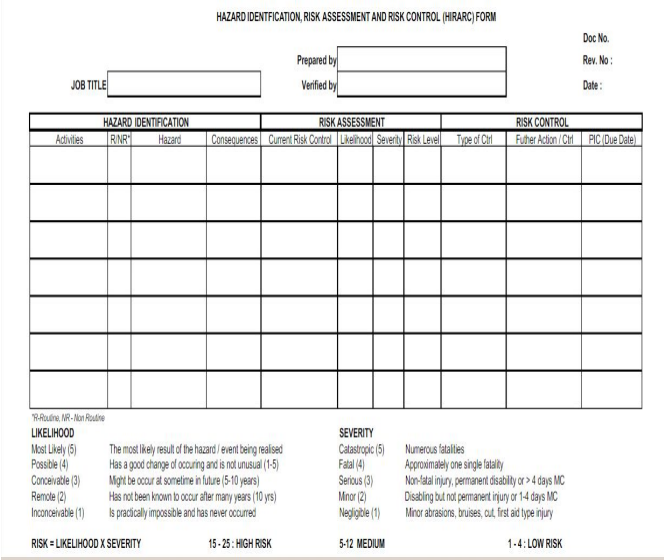


Fig.12 Resource usage graph for Site Engineer

IV. ONSITE SAFETY



HAZARD IDENTFICATION, RISK ASSESSMENT AND RISK CONTROL (HIRARC) FORM

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Rev. No :
JOB TITLE
Verified by
Date :

HAZARD IDENTIFICATION				RISK ASSESSMENT				RISK CONTROL		
Activities	R/NR*	Hazard	Consequences	Current Risk Control	Likelihood	Severity	Risk Level	Type of Ctrl	Futher Action / Ctrl	PIC (Due Date)

*R-Routine, NR - Non Routine

LIKELIHOOD

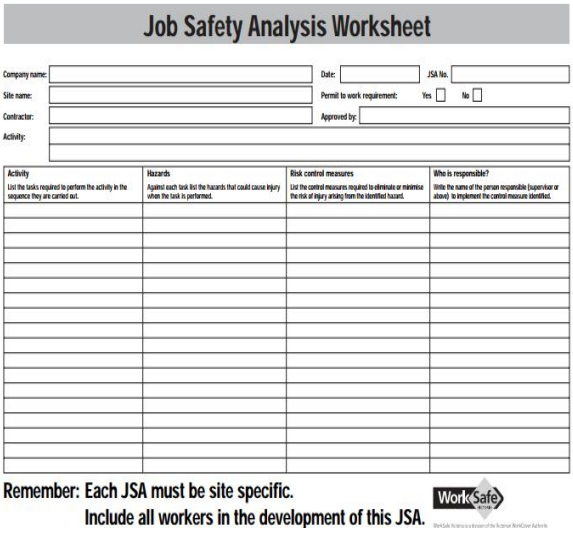
Most Likely (5)	The most likely result of the hazard / event being realised
Possible (4)	Has a good change of occuring and is not unusual (1-5)
Conceivable (3)	Might be occur at sometime in future (5-10 years)
Remote (2)	Has not been known to occur after many years (10 yrs)
Inconceivable (1)	Is practically impossible and has never occurred

SEVERITY

Catastropic (5)	Numerous fatalities
Fatal (4)	Approximately one single fatality
Serious (3)	Non-fatal injury, permanent disability or > 4 days MC
Minor (2)	Disabling but not permanent injury or 1-4 days MC
Negligible (1)	Minor abrasions, bruises, cut, first aid type injury

RISK = LIKELIHOOD X SEVERITY 15 - 25 : HIGH RISK 5-12 MEDIUM 1 - 4 : LOW RISK

Fig.13 HIRA Worksheet



Job Safety Analysis Worksheet

Company name: Date: JSA No.
Site name: Permit to work requirement: Yes No
Contractor: Approved by:
Activity:

Activity	Hazards	Risk control measures	Who is responsible?
List the tasks required to perform the activity in the sequence they are carried out.	Against each task list the hazards that could cause injury when the task is performed.	List the control measures required to eliminate or minimise the risk of injury arising from the identified hazard.	Write the name of the person responsible (supervisor or above) to implement the control measure identified.

Remember: Each JSA must be site specific.
Include all workers in the development of this JSA.

Fig.14 JSA Worksheet

Table5. HIRA Worksheet

HAZARD IDENTIFICATION				RISK ASSESSMENT			
ACTIVITY	**R/NR**	**HAZARD**	**CONSEQUENCES**	**CURRENT RISK CONTROL**	**LIKELI-HOOD**	**SEVERITY**	**RISK LEVEL**
Excavation	R	Slipping, falling, noise pollution	First aid injuries, fracture, effect on ears	Barrications, earplugs, safety shoes	3	2	6 (medium)
Cleaning	R	Harmful for body parts like eyes, ears, nose	Skin problems, and effect on eyes, ears and nose	Use of mask, hand gloves, safety goggles, safety garments	3	3	9 (medium)
Steel binding	R	Injuries from steel	Harmful for body	Use of hand gloves, use of shoulder pack.	1	1	2 (low risk)
Shuttering	R	Cut injuries, falling of shuttering, lifting of heavy weights	Bleeding, injuries to body, shoulder pain.	Use of proper PPE'S, good housekeeping, use of proper lifting methods	2	3	6 (medium)

TABLE6. JSA WORKSHEET

SL. NO.	ACTIVITY	HAZARDS	RISK CONTROL MEASURES	WHO IS RESPONSIBLE
1.	Welding	Effect on eyes, shocks, burns, fire hazards	Use of proper welding shield with black glasses, presence fire extinguisher or sand, first-aid kit.	Supervisors and site engineers, safety engineer
2.	Gas cutting	Gas leakage, burns, fire, untrained person.	Use of flash back arrester, skilled labour, presence of fire extinguisher.	Supervisors and site engineers, safety engineer.
3.	Grinding	Improper equipment's, untrained users, shock, cuts	Skilled persons, proper equipment's used, checking for proper wiring.	Supervisors and site engineers, safety engineer.
4.	Height works	Falling material or person working, improper platforms, improper hand rails, untrained persons	Use of proper safety harness, proper platform and hand rails, trained persons	Supervisors and site engineers, safety engineer.

V. DISCUSSION

- Use of software in planning and scheduling makes the job much easier, error free and time saving
- Software also aids to manage the resources present on the site, very effectively and saves the amount incurred due to over or under allocation of resources
- The making of HIRA and JSA facilitate to understand various hazards involved in the activities
- Regular site visits benefits in understanding the construction processes more meritoriously

VI. ACKNOWLEDGEMENT

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The project would have been impossible without the help of the project manager, senior engineer, site engineers, foremen's and the labour on the site, so I extend my thanks to people who directly and indirectly helped me in the project work

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