Earth Resource Technology

INTEGRATED TECHNOLOGY SOLUTION FOR OPTIMISED AND ENVIRONMENTALLY CONTROLLED BLASTS

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BLASTING: NOT A PRECISE TOOL

- Difficult to control fragmentation sizes
- Damages excavation walls and slopes
- Safety and Social concerns
  - Fly rock
  - Misfires and accidental initiation
- Environmental Concerns
  - Noise & Vibrations
  - Fumes
  - Dust & Fines

ADVANCED TOOLS AND TECHNIQUES

Innovative techniques to design and execution of blasts are needed to carryout large blasts. Several Modern Tools &Techniques are available:

- Face Profiler
- Measurement of Deviation & Rock Properties while Drilling Hole
- GPS Controlled Drill Positioning
- Bulk explosives and delivery system
- Shock Tube/Signal Tube
- Electronic Detonators

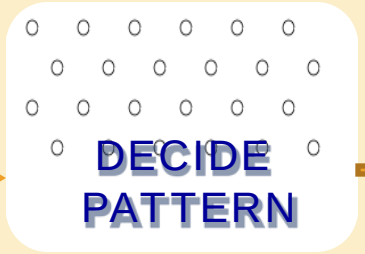
Information Technology Applications

- Design, Charging & Execution
- Data Collection and Analytics
- Impact Predictors and Controls
- Mobile and Web applications

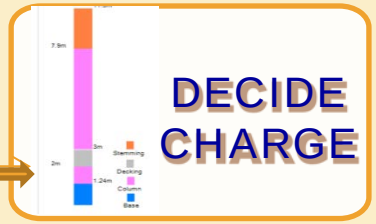
MANAGING BLASTING OPERATIONS NOT ENGINEERING

THERE ARE NO POINTS OF MEASUREMENT OR CONTROL

Geology, Mine Planning
Blast Size, Profile
Quality Info



Fragmentation
Movement



Predictors

Predictors

Monitoring

To Loading
Haulage,
Crushing

- Difference in designed and actual drilled hole pattern in the field, charging and tieup.

- Complete control on results and adverse impacts

- Appropriate data collection after drilling and data analysis and results can be predicted then charging, stemming, delay sequences and delay time can be changed to get optimised fragmentation and to control environmental impacts.

- This is possible with the use of Integrated Information Technology applications which can give real time data monitoring and analysis that can lead to optimisation and control of results.

INTEGRATED INFORMATION TECHNOLOGY APPLICATIONS FOR BLASTING

- An integrated modular software solution developed for blasting operations (design, operational data collection, prediction and reporting subsequent analysis).

- Software has several modules – Blast Designer, Blast Information Data Management, ground and air vibration predictor, wave front reinforcement analyser, fragmentation size predictor, data analysis and advanced reporting.

- Software has integration tools allowing import and export of data/design from other key software packages (mining operational tools, etc), global positioning system (GPS), vibration equipment and has ability to upload photos and videos.

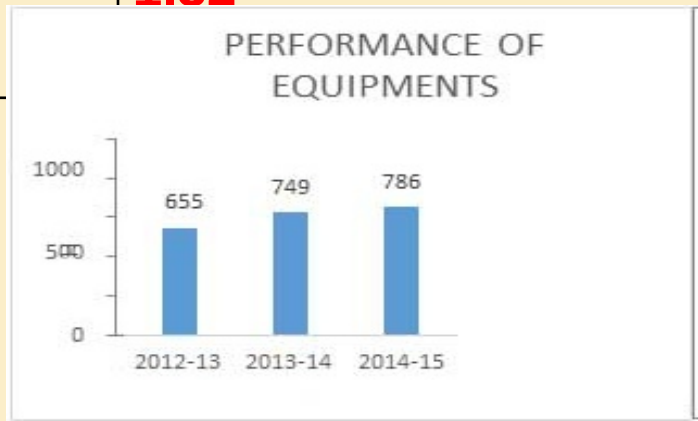
MODULES FOR INTEGRATED BLASTING SOLUTIONS

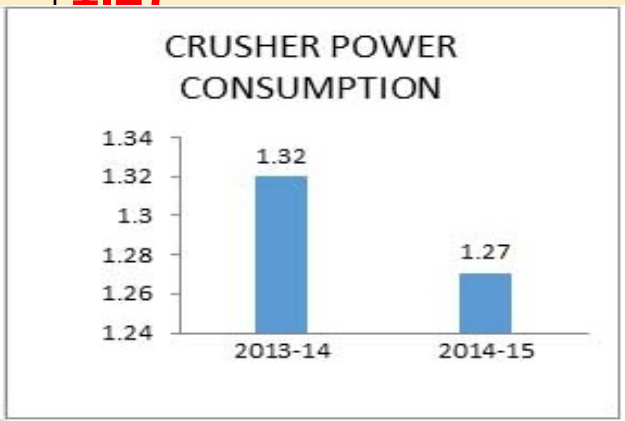
Module No.	Mdule Name	Client server version	Webbased version	Mobile version
A	Surface Blast Design Module	Yes	Yes	Yes
B	Blast Data Management Module	Yes	Yes	Yes
C	Fragmentation Size Predictor	Yes	Yes	Yes
D	Prediction and Control of Environmental Impacts i. Blast vibration prediction and Compliance (Air and Ground) ii. Safety	Yes	Yes	Yes

BLASTING CASE STUDIES

- Two limestone open pit mines (one in north India & other in South India) are using Blast Data Management software.
- Before a blast is carried out, actual drilled hole locations are measured and predictors are used to check fragmentation results, vibration and flyrock distance and if necessary explosive charge loading, delay, initiation sequence are altered for controlling environmental impacts.
- Improved safety, improved environmental impact and reduced drilling and blasting costs.
- In one year there has been improvements in excavator performance, crusher performance and overall cost.

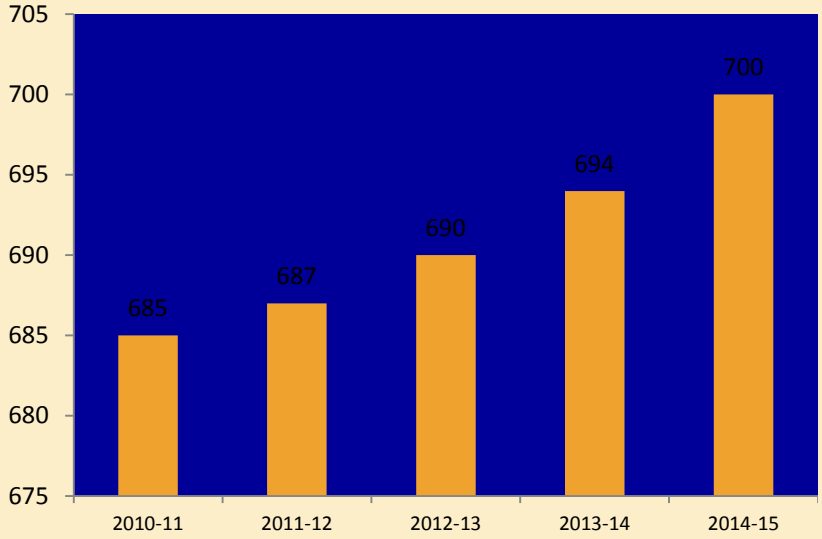
Vasavdatta Cement	Result achieved before implementing Software	Result achieved after implementing
Blast Pattern Parameters	B: 5.5 m, S :10 m H : 10 m	B: 5.25 m S:11 m H: 10 m
Tonnage Mined (t)	4359301	4378717
Blasting Cost in Rs/ t	3	2.8
Powder factor t/kg	11.6	12.29
Total Drilling (155mm, m	40069	39384
Tonnes / m of Drilling	108.79	111.18
Tonnes per hole t	1375	1443
Excavator performance t/h	749	786
Loader Performance(t/h)	318	340
Dumper Performance (t/h)	210	219
Crusher Power Consumption (kwh/t)	1.32	1.27



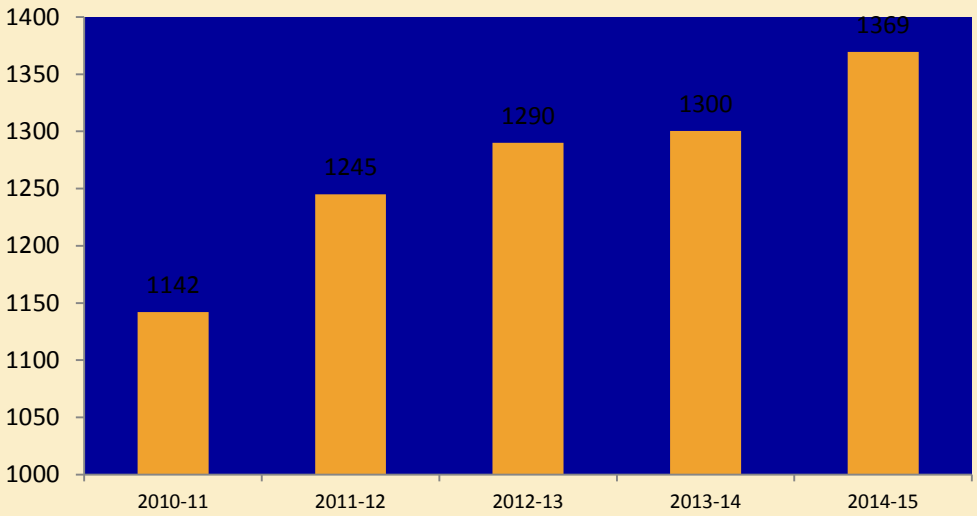


CASE STUDY ADITYA CEMENT

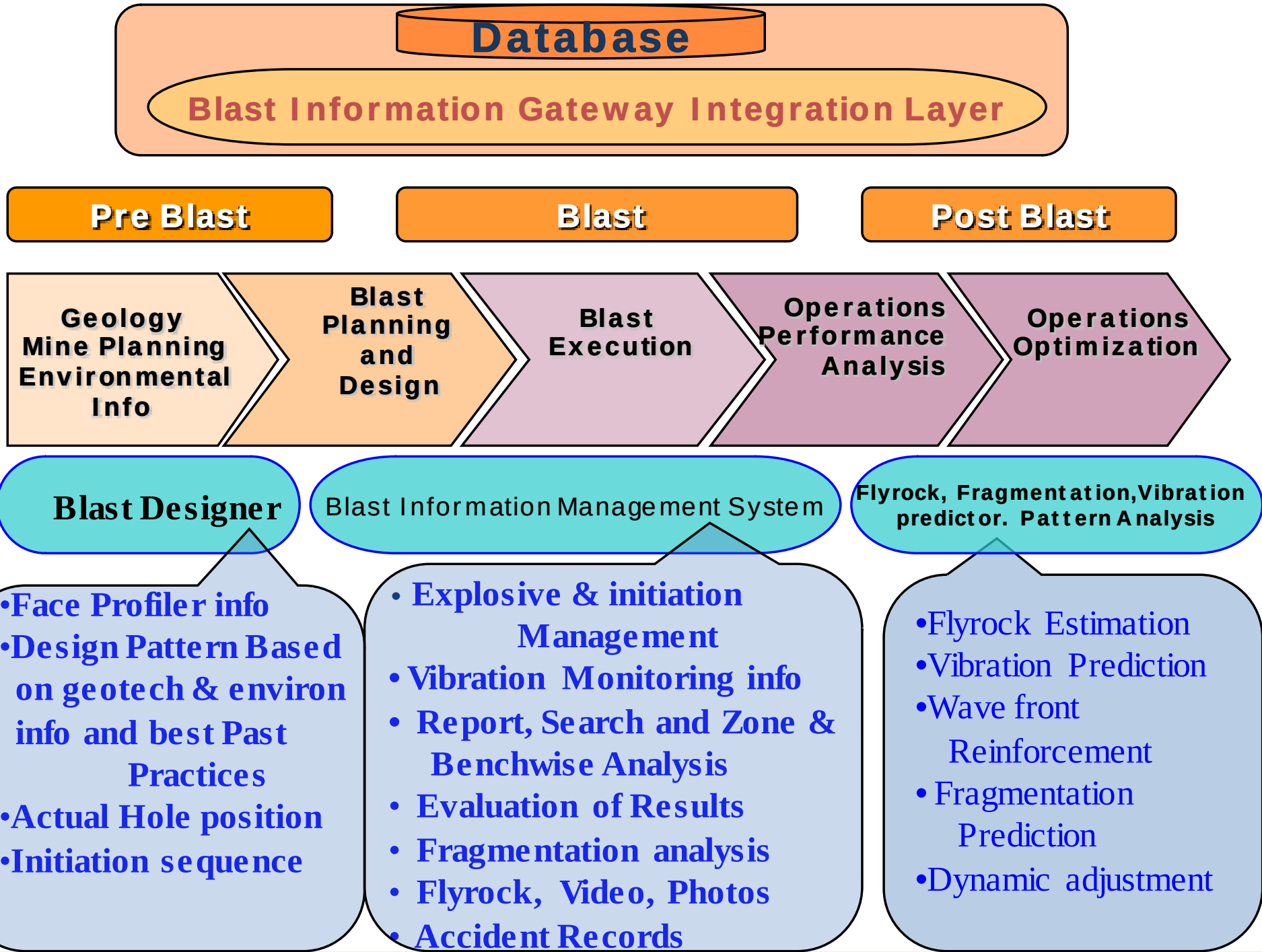
- Drilling diameter 100mm-115mm. A set of about 25 holes is blasted at a time. Bench height varies between 6m and 10.5 m Explosive used is ANFO and initiator used are Excel or Raydet.
- IMPROVEMENTS : Almost for a decade rock breakage of limestone powder factor was improved from 6.5 t/kg to 15 tons/kg. Drill factor was maintained around 75 tons/m. Analysis indicated and powder factor was changed to 13.8 t/kg. Crusher productivity increased from 932 tons/hour to 1369 t/hour. Reduced ground vibration to 4mm/s. Controlling fly rock and dust. Reducing costs by 50%.



Excavator Tonnes/Hour



Crusher Output Tonnes /Hour

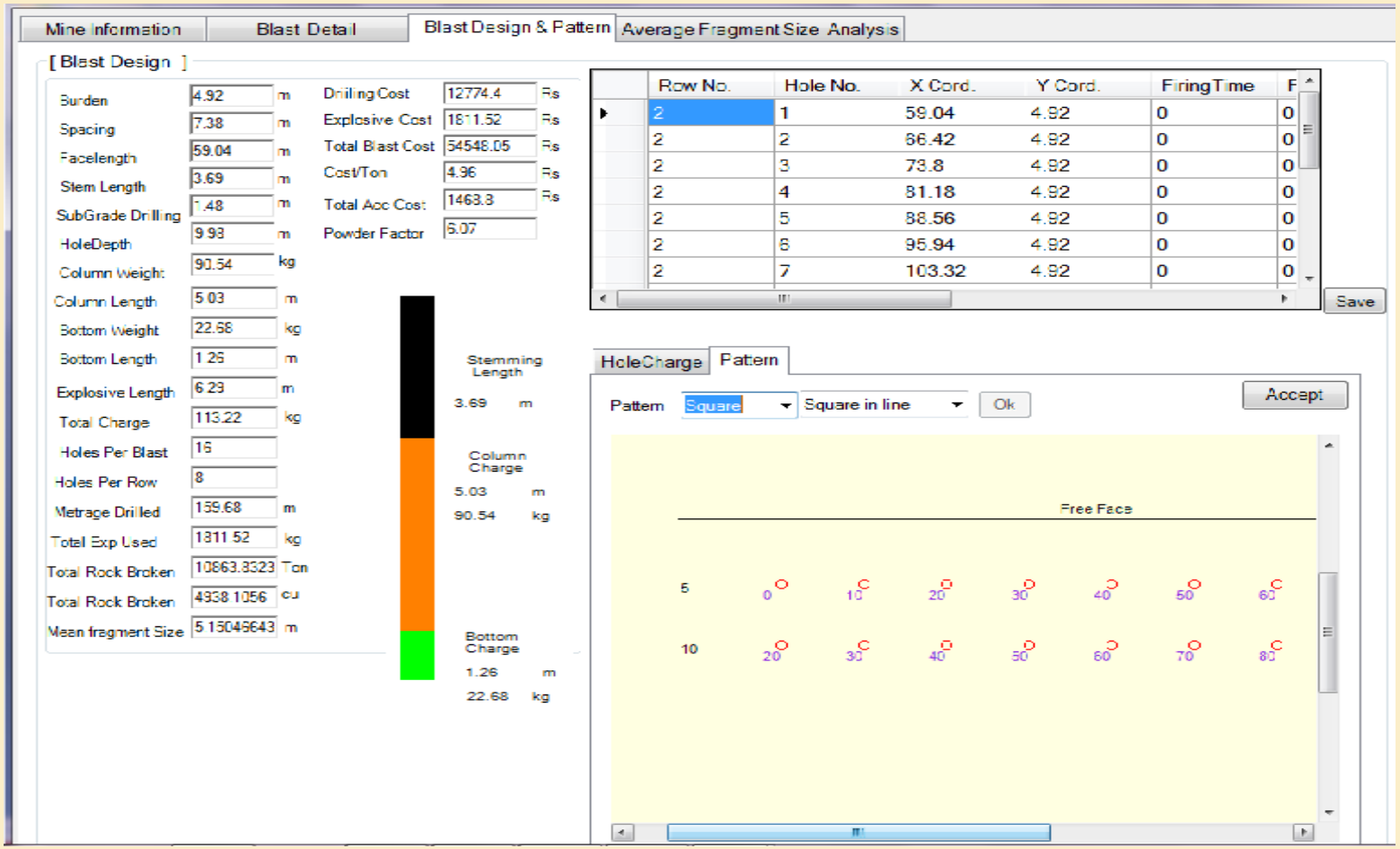

Database
Blast Information Gateway Integration Layer
Pre Blast
Blast
Post Blast
Geology
Mine Planning
Environmental
Info
Blast
Planning
and
Design
Blast
Execution
Operations
Performance
Analysis
Operations
Optimization
Blast Designer
Blast Information Management System
Flyrock, Fragmentation,Vibration
predictor. Pattern Analysis
•Face Profiler info
•Design Pattern Based
on geotech & environ
info and best Past
Practices
•Actual Hole position
•Initiation sequence
• Explosive & initiation
Management
• Vibration Monitoring info
• Report, Search and Zone &
Benchwise Analysis
• Evaluation of Results
• Fragmentation analysis
• Flyrock, Video, Photos
• Accident Records
•Flyrock Estimation
•Vibration Prediction
•Wave front
Reinforcement
• Fragmentation
Prediction
•Dynamic adjustment

INTEGRATED BLASTING SOFTWARE

ERT Earth Resource Technology

BLAST DESIGNER (BLADES)	BLAST DATA MANAGEMENT SYSTEM (BIMS)	GROUND VIBRATION PREDICTION
AIR VIBRATION PREDICTION	SIMULATION & WAVE FRONT REIFORCEMENT ANALYSIS	FLYROCK ESTIMATION
VIDEO, PHOTOS IMPORT/EXPORT	FRAGMENTATION PREDICTION	COST ANALYSIS

Blast Designer Software

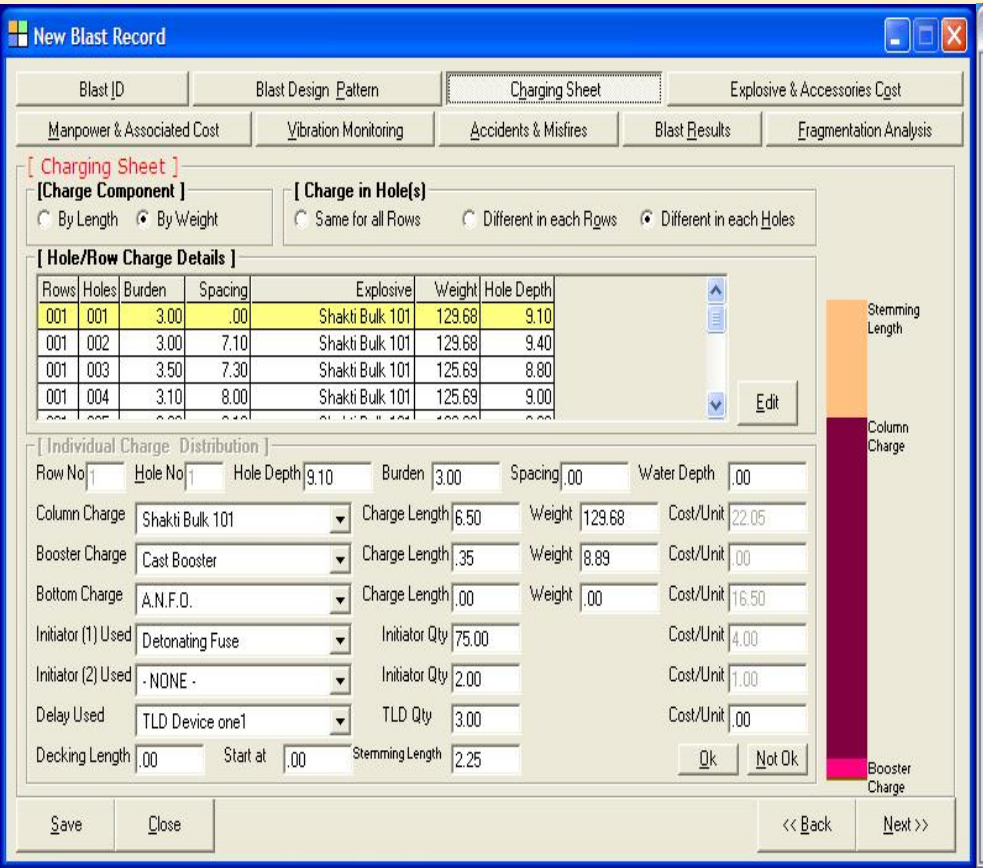


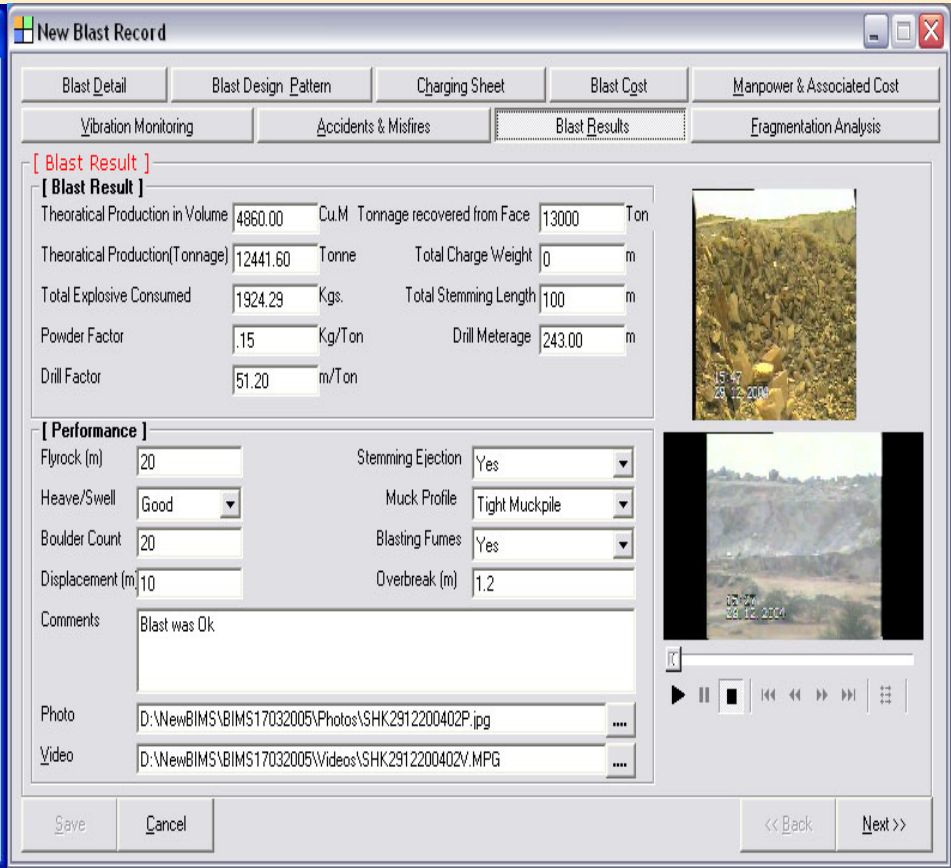
Several software are available and are regularly used. However, Software are needed which have been tailored according to mine blasting practices. Further, they need to be calibrated over a period of time in a mine for given bench/face.

BLAST DATA COLLECTION AND ANALYSIS

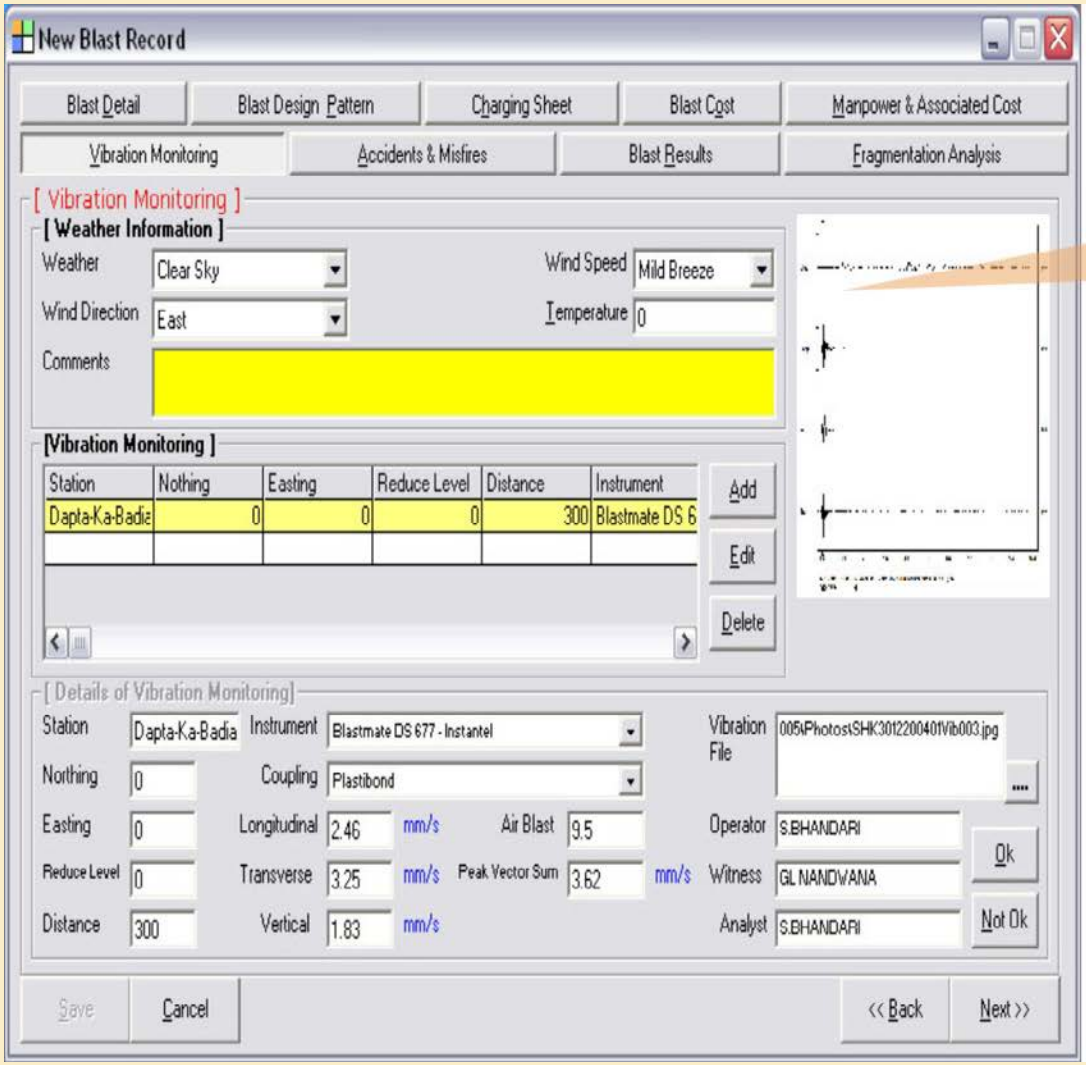
Systematic recording of data regarding a blast face, drill and blast pattern, explosive charge distribution, initiators.

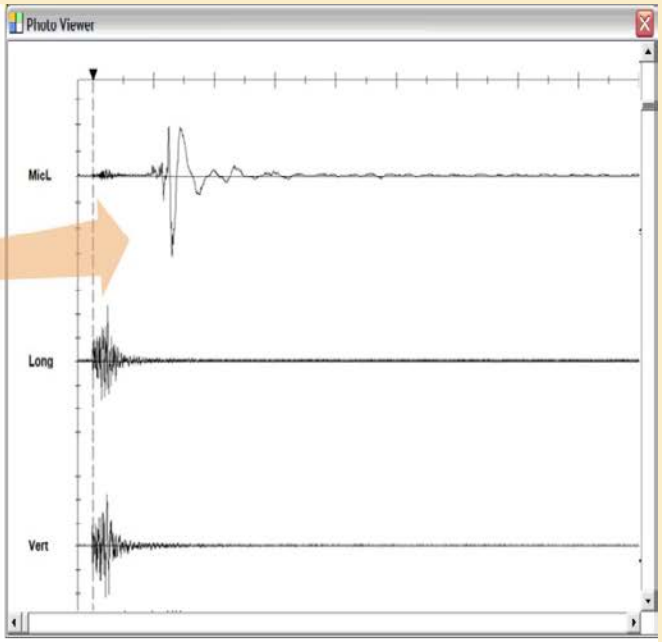
Recorded by personnel & vibration monitors, videos, photo & equipment performance & data analysis ability.





GROUND & AIR VIBRATION MONITORING INFORMATION





REPORTS/SEARCHING

ADITYA BIRLA
UltraTech

ERTC

Blast Detail

Blast No.	AC1008201301	**Blast Date**	10/08/2013	**Blast Time**	11:44:48

Mine Name:	Aditya Limestone Mines	**Operation:**	Production Blasting
Pit Name:	Pit1	**Rock Type:**	LIME STONE
Bench Name:	Bench 3	**Material Blasted:**	High Grade
Zone Name:	Zone 2002		

FACE DETAILS

Hole Diameter	115	mm
Face Length	21	m
Hole Angle	0	Degree
Sub Grade	0	m
HoleDepth	10	m

BLAST PATTERN

Pattern	Staggered	
Rows No.	2	
Total Holes	8	
Burden	4.5	m
Spacing	7	m

BLAST RESULT

Volume Broken	0.00	Cu.m
Tonnage Recovered	0.00	Ton
Explosive	0.00	Kgs.
Powder Factor	0.00	Ton/Kg
Drill Factor	0.00	Ton/m
Blast Fumes	Yes	

POST BLAST EVALUATION

Flyrock	0.00	m
Boulder Count	0.00	Nos
Over Break	0.00	m
Heave / Swell	Good	
Muck Profile	Scattered Muckpile	
Stemming Ejection	Yes	
Fragmentation	Good	

Ground Vibration Prediction & Control

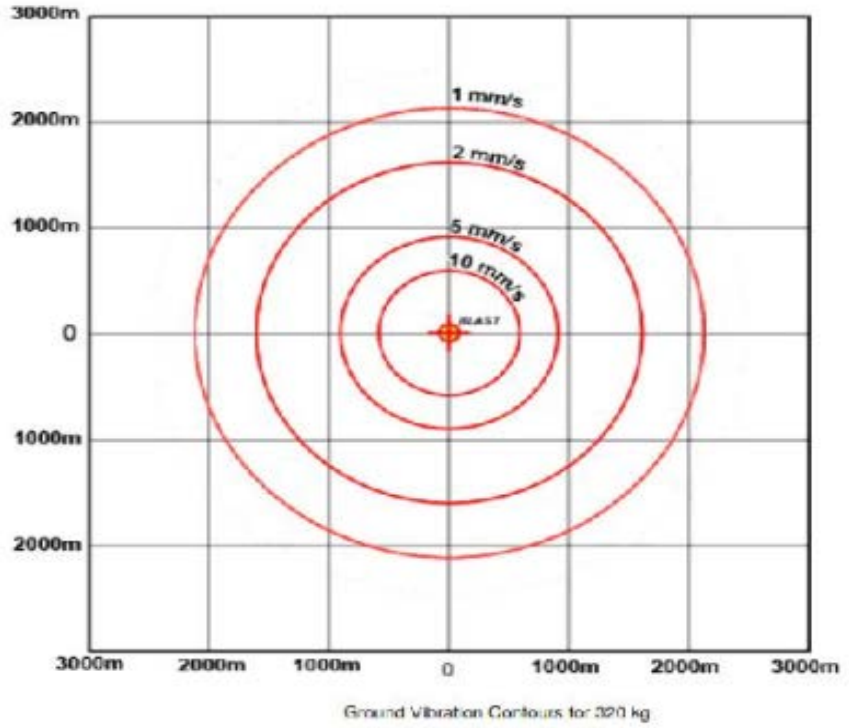
- Determination of site constant and exponent from ground vibration readings
- Determining minimum charge per delay

Determination of PPV (mm/s) based on Charge and Distance

Distance(m) →

Charge (kg) ↓	5	10	20	50	100	200	500	1000	2000	5000	10000
0.25	38.72	14.67	5.56	1.54	0.58	0.22	0.06	0.02	0.01	0	0
0.5	62.9	23.84	9.03	2.5	0.95	0.36	0.1	0.04	0.01	0	0
0.75	83.55	31.66	12	3.33	1.26	0.48	0.13	0.05	0.02	0.01	0
1	102.19	38.72	14.67	4.07	1.54	0.58	0.16	0.06	0.02	0.01	0
1.5	135.72	51.43	19.49	5.4	2.05	0.78	0.22	0.08	0.03	0.01	0
2.5	194.07	73.54	27.87	7.73	2.93	1.11	0.31	0.12	0.04	0.01	0
5	315.26	119.46	45.27	12.55	4.76	1.8	0.5	0.19	0.07	0.02	0.01
7.5	418.73	158.67	60.12	16.67	6.32	2.39	0.66	0.25	0.1	0.03	0.01
10	512.14	194.07	73.54	20.39	7.73	2.93	0.81	0.31	0.12	0.03	0.01
15	680.23	257.76	97.67	27.08	10.26	3.89	1.08	0.41	0.15	0.04	0.02

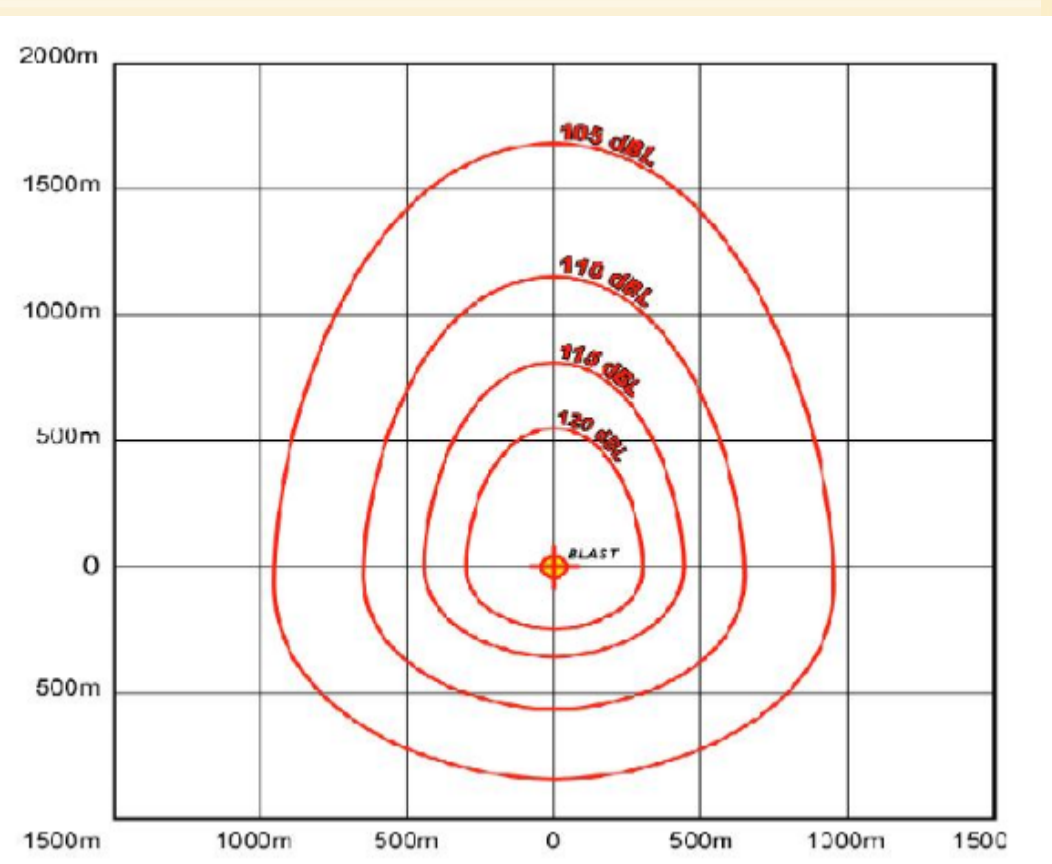
1 2 3



Ground Vibration Contours for 320 kg

AIR BLAST PREDICTIONS

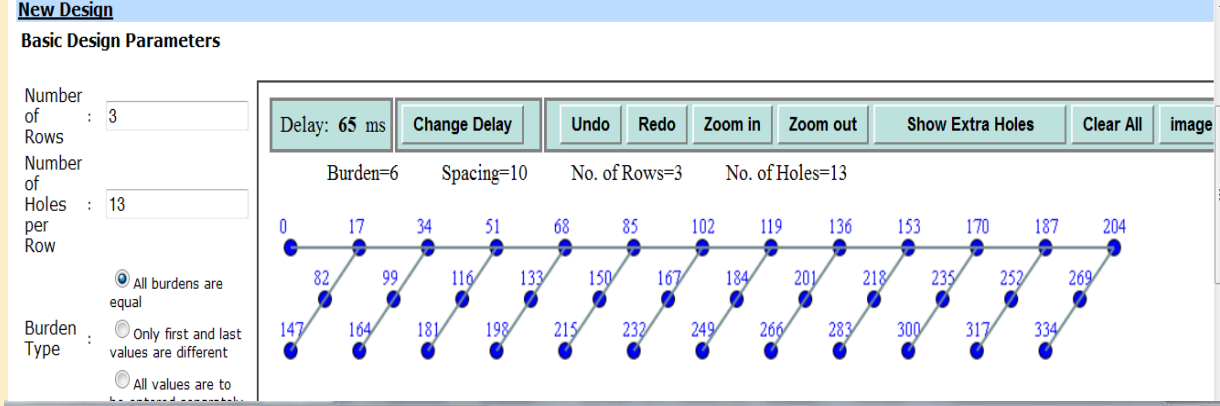
VIBRATION TABLE
VIBRATION PLOT
VIBRATION LIMIT TABLE

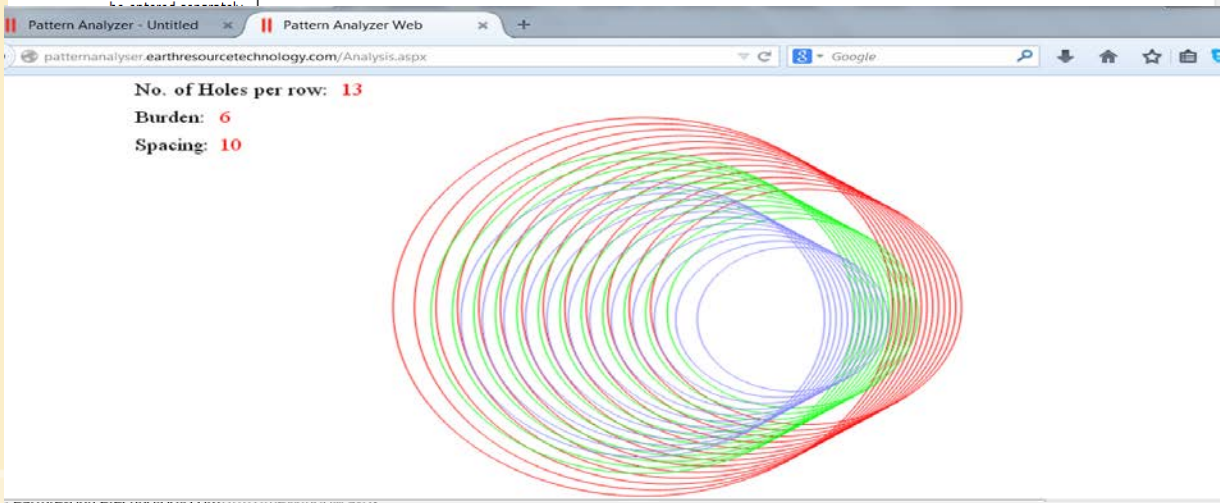


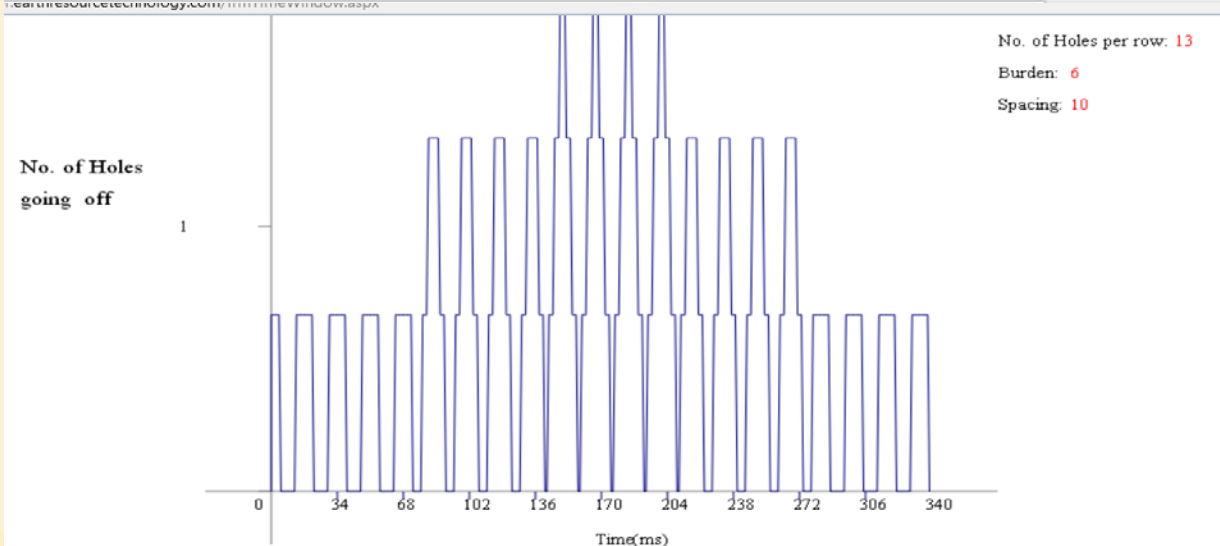
Similation

Airblast & Ground Vibration Reinforcement

Time window Analysis

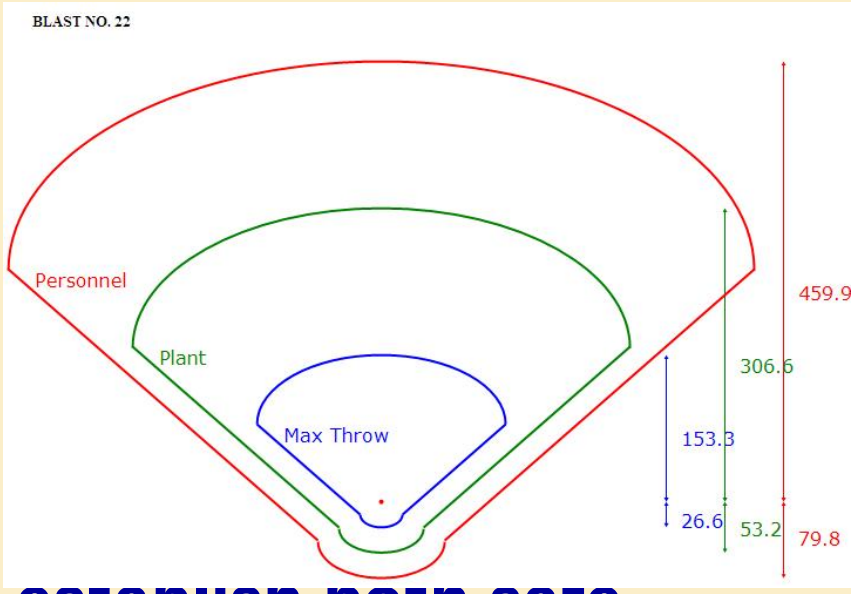






FLYROCK PREDICTION SOFTWARE

- **Inputs are:**
  - **Charge mass**
  - **Burden or stemming height**
  - **Site calibration**



- **Output is the distance that rock will be thrown & this quantification can be used to establish both safe clearance distances**

- **Zone of flyrock travel is indicated by this tool. Using safety factors danger zones for machinery and persons respectively. If it is not possible to remove any structure or person then one can change charging of holes.**

Earth Resource Technology

www.earthresourcetechnology.com

Home | Mine Details | Prediction | MINE NAME - M1 | BLAST NAME - P1 | Welcome admin

Blasting Predictors & Control Tools

- Wavefront Reinforcement
- Fragmentation Prediction
- Blast Clearance Zone Estimator
- Ground Vibration
- Air Vibration
- Blast Information System (BIMS)

FRAGMENTATION ANALYSIS & PREDICTION

Design Parameters

Blast Design Info | Rock Property Info | Explosive Info

Bench Height (m)	15
Hole Diameter (mm)	235
Hole Depth (m)	15
Subgrade (m)	0
Burden (m)	3.7
Spacing (m)	12.3
Stemming (m)	2.02
Drilling Accuracy (m)	0.1
Spacing to Burden Ratio	3.32
Drill Pattern	Staggered

Design Parameters

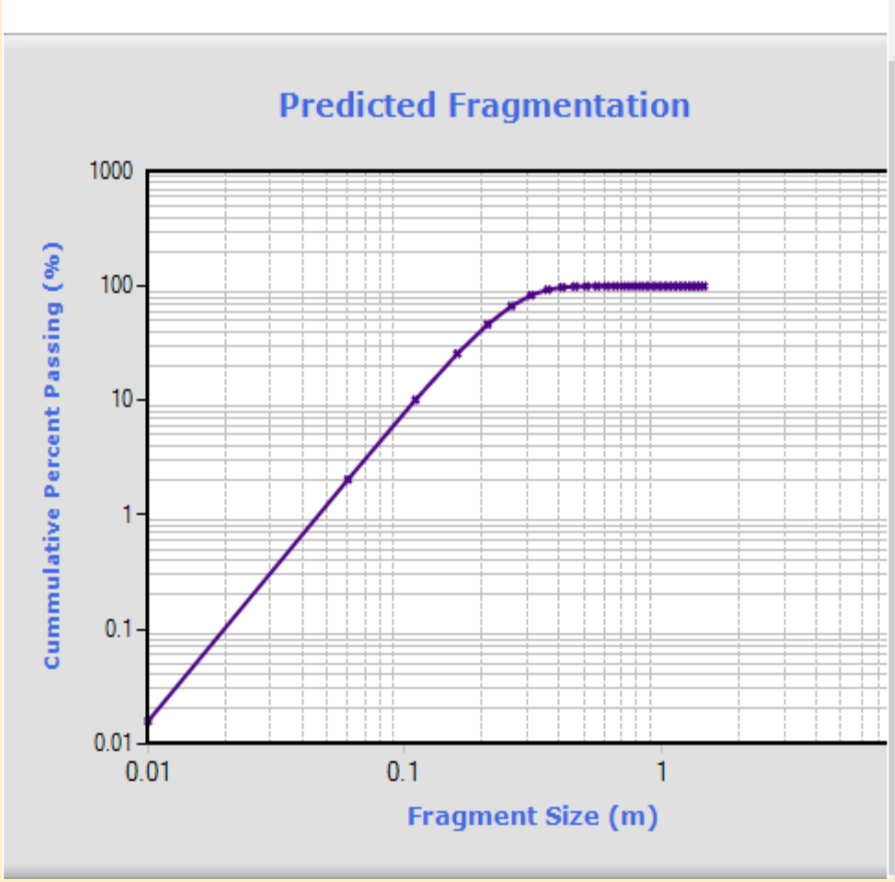
Blast Design Info | Rock Property Info | Explosive Info

Specific Gravity (SG)	2.8
Young's Modulus (GPa)	60
UCS - Compressive Strength (MPa)	100
Rock Mass Description	13
Vertical Joint Spacing (JPS)	20
Joint Plan Orientation (JPO)	20
Sonic Velocity (Vp)	100

Blast Design Info | Rock Property Info | Explosive Info

Explosive Diameter (mm)	100
Explosive Density (ton/m3)	0.9
REE (RWS to ANFO)	1

FRAGMENTATION PREDICTOR RESULTS



Tabular Format

Size (m)	Percentage Passing (%)
0	0%
0.05	1.2%
0.1	7.9%
0.15	22.1%
0.2	42%
0.25	63.2%
0.3	80.6%
0.35	91.8%
0.4	97.2%
0.45	99.3%

1 2 3 4

Fragmentation Predictor allows user to design blasts for desired fragmentation size

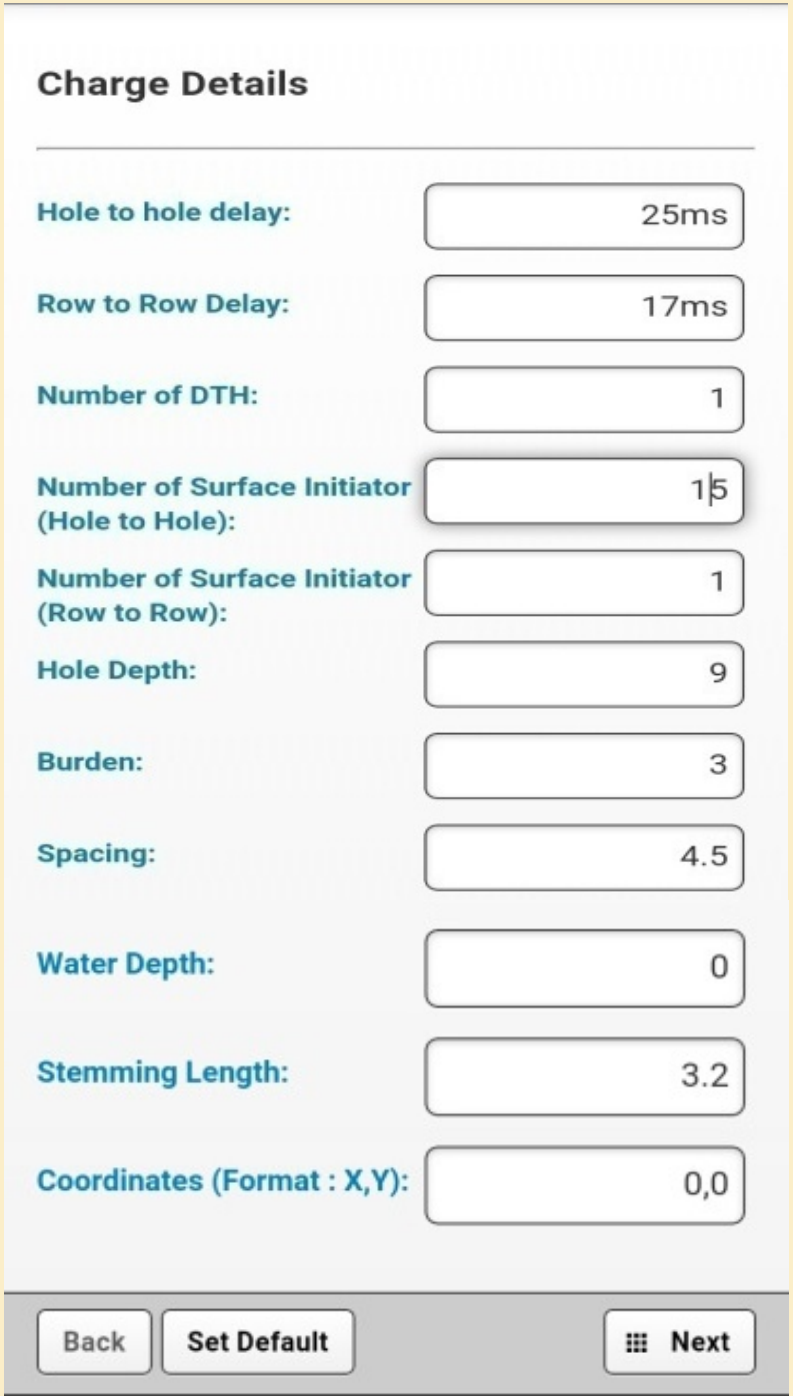
MOBILITY SOLUTION

- There is growing convergence of “consumer“ technologies such as iOS and Android phones, devices such as camera, motion sensors, and GPS systems.
- Use of Mobile devices makes it easier for mining personnel to collect On-Site blasting data. As part of the technology solution a Mobile App has been developed.
- Mobile technology is being used to streamline blasting project management, operations, safety eliminate delays, and reduce overall project costs.

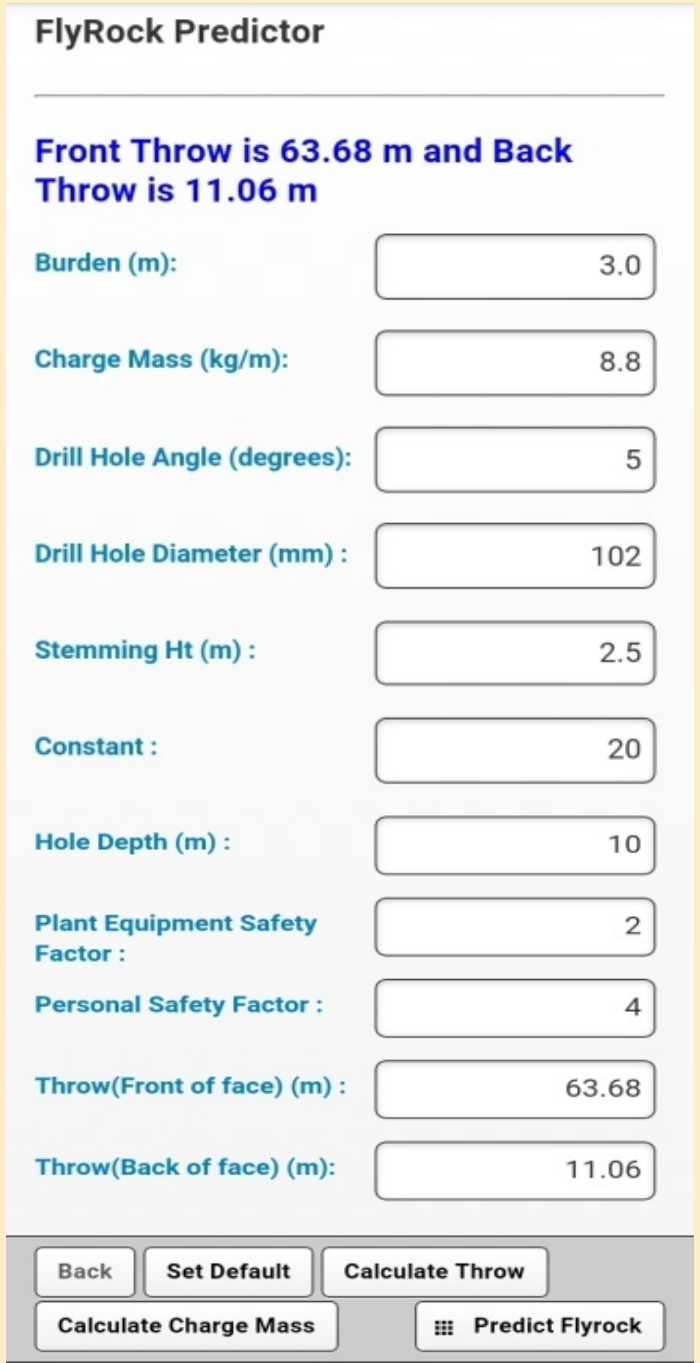
On Site Blasting Tools an Integrated Blast Mobility Application

Limitation

Integrated Blast Mobile App



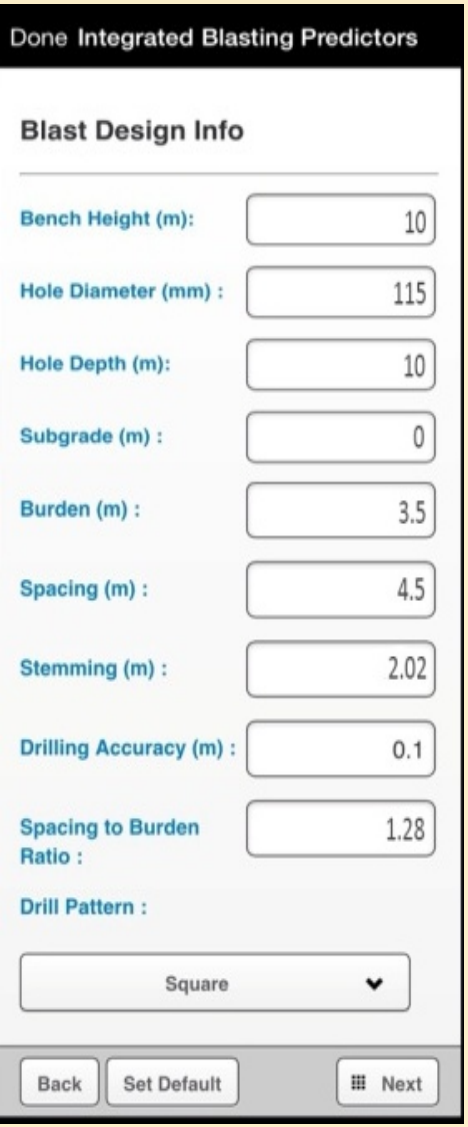
Flyrock Predictor

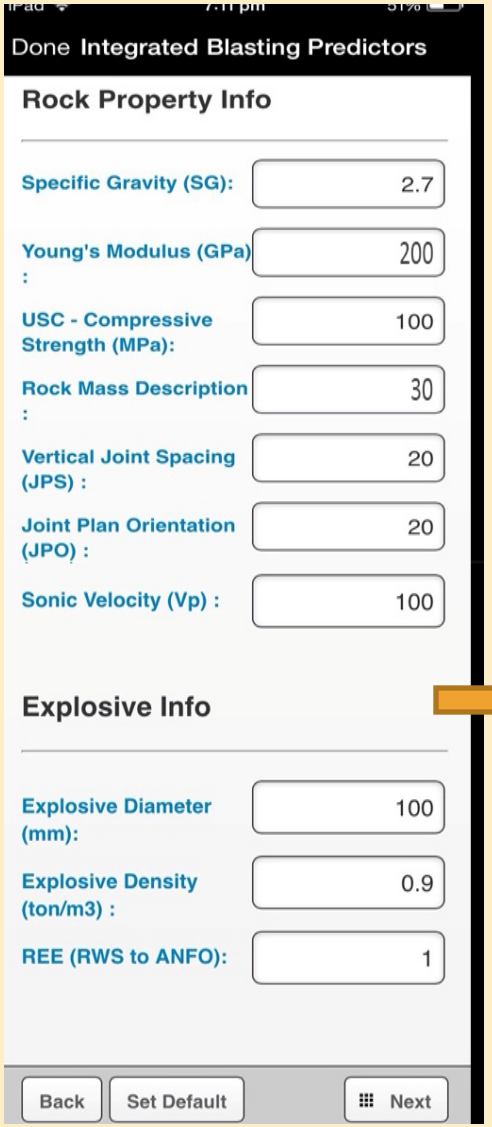


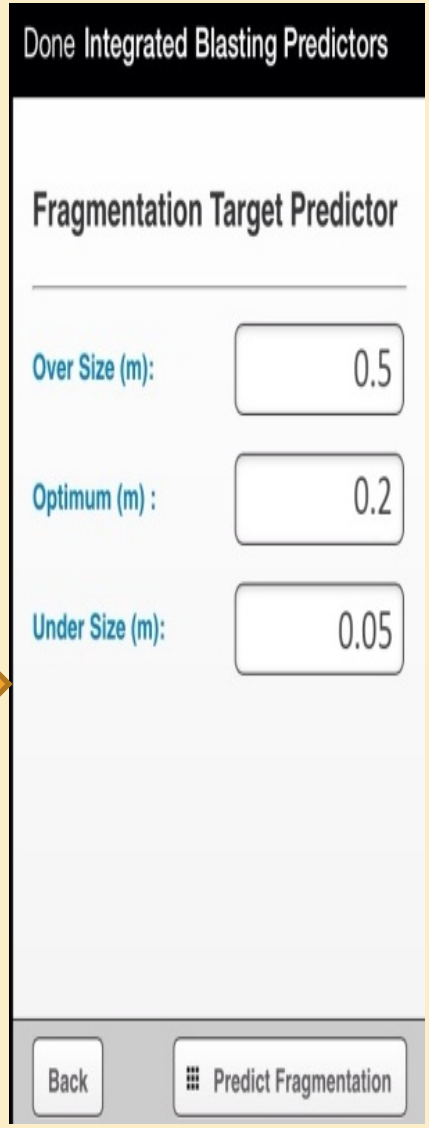
Fragment Size Distribution Predictor

INPUT PARAMETERS

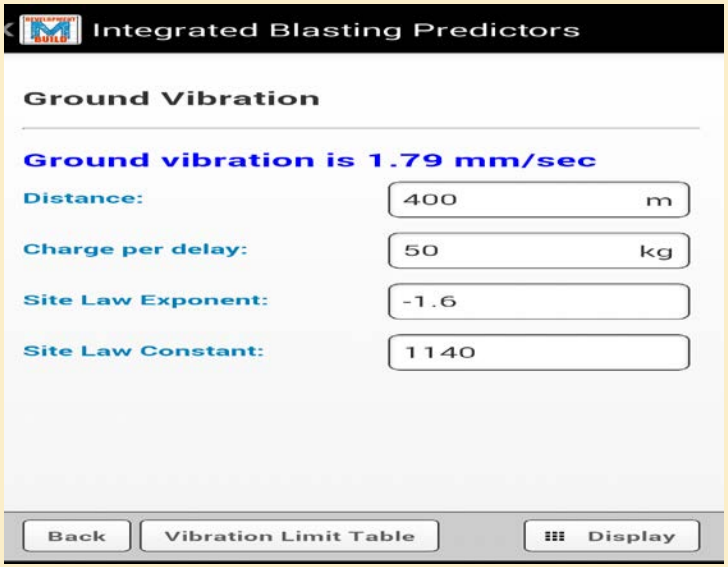
FRAGMENTATION RESULT

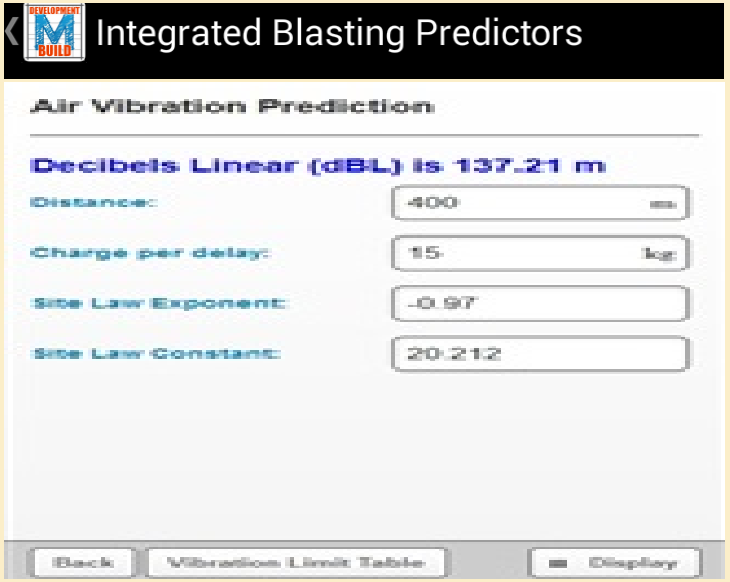


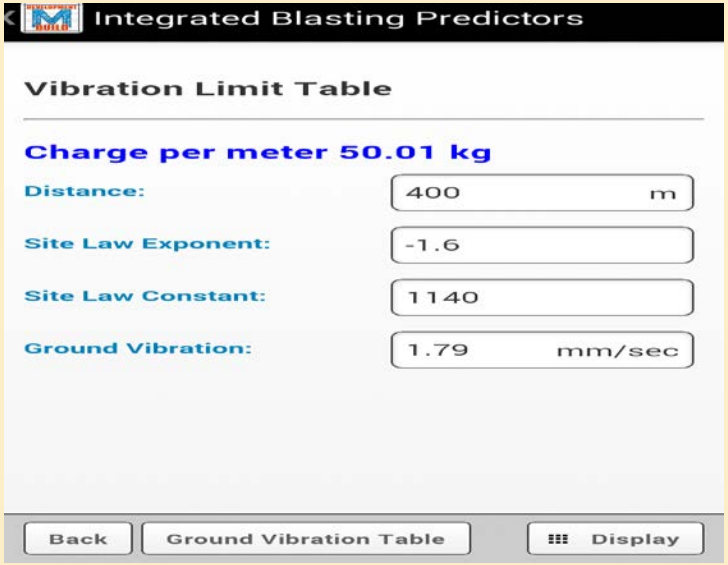


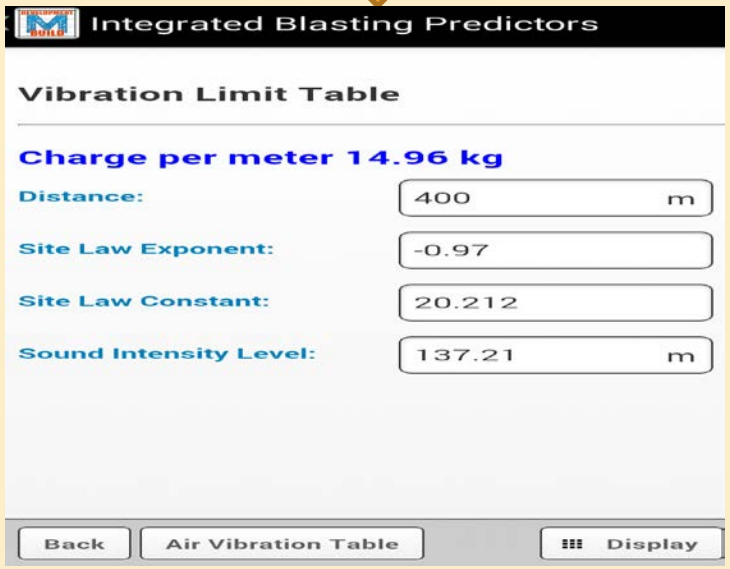


Ground and Air Vibration Prediction









CONCLUSIONS

- Blasting operations needs to use innovative technology. Several technologies are being adopted to make blasting operations efficient and reduce environmental impact.
- Data storage and analysis helps to quickly respond to information and remain successful in today's competitive market place.
- An integrated blasting software solution used in a couple mines , though some individual modules have been in use in many mines in Australia as Terrock tools. This is convenient since it can be used by medium range and smaller operations to improve results and control adverse impacts.
- Integrated Mobility solution provides an important "ON-SITE BLASTING TOOL".