COMPLETE SOLUTIONS FOR THE
MINING AND MINERALS INDUSTRY

# DESIGN CONSIDERATIONS FOR IMPROVING SAFETY IN MINES

ANDREW BANNERMAN – TWP CONSULTING

AMRE SHAFT SAFETY SEMINAR

6 MARCH 2008

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# WHO WE ARE

- Engineering
- Procurement
- Construction
- Management

- Current projects

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# SYNOPSIS

Certain key safety considerations encountered in 2 recent shaft sinking projects, namely:

- Impala No. 20 Shaft
- Konkola No. 4 Shaft (Zambia)

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# IMPALA 20 SHAFT

- Shaft depth 1 060 metres
- Double drum rock winder - 2 x 18 t skips
- Double drum man winder – 14 t man and material cage and c/weight
- Service winder – max 5 persons
- Hoisting capacity 185 ktm

COMPLETE SOLUTIONS FOR THE
MINING AND MINERALS INDUSTRY

# IMPALA 20 SHAFT

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# IMPALA 20 SHAFT

## DESIGN INNOVATIONS ON IMPALA 20 SHAFT:

- Technogrid arresting devices
- Technopost rolling stock arresters
- Winder ESPD system

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# KONKOLA NO. 4 SHAFT

- Shaft depth of 1 470m
- Rock hoisted from mid shaft and bottom shaft
- Koepe rock winder - 2 x 37 t skips
- BMR rock winder - 2 x 26 t skips
- Koepe man winder - 8 t man and material cage and c/weight
- Hoisting capacity 688 ktm

COMPLETE SOLUTIONS FOR THE
MINING AND MINERALS INDUSTRY

# KONKOLA NO. 4 SHAFT

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# KONKOLA NO. 4 SHAFT

## DESIGN INNOVATIONS ON KONKOLA NO. 4 SHAFT

- Technogrid arresting devices
- Design of a mid-shaft rock hoisting level

# CONVEYANCE ARRESTING

- Means safely bringing an over-running conveyance to rest in a manner which reduces the chance of injury (or death) to personnel and reduces the damage to equipment and the shaft.

- Last chance to prevent catastrophe prior to crash beams
- Misunderstood science

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# CONVEYANCE ARRESTING

The risk of injury or death to personnel in a conveyance should a overwind event occur is a major concern

So where to start?

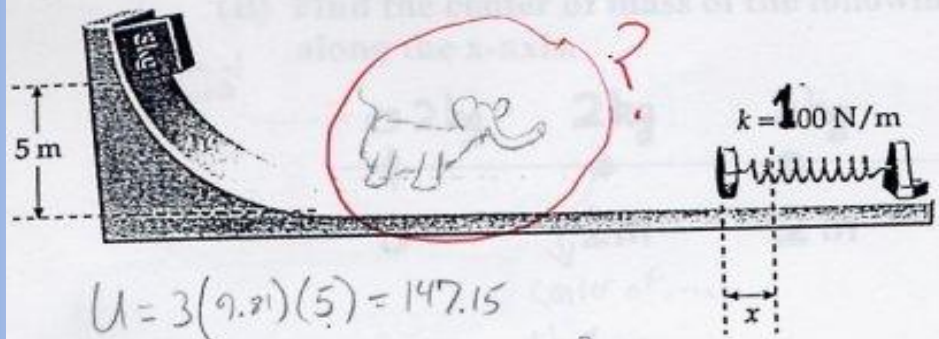
# CONVEYANCE ARRESTING

## Where to start....

**2. A 3-kg object is released from rest at a height of 5m on a curved frictionless ramp. At the foot of the ramp is a spring of force constant k = 100 N/m. The object slides down the ramp and into the spring, compressing it a distance x before coming to rest.**

**10 (a) Find x.**

**5 (b) Does the object continue to move after it comes to rest? If yes , how high will it go up the slope before it comes to rest?**




$U = 3(9.81)(5) = 147.15$

$U_s = \frac{1}{2}(100)x^2 = 50x^2$ ...?

NO. there is an elephant in the way.

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# CONVEYANCE ARRESTING

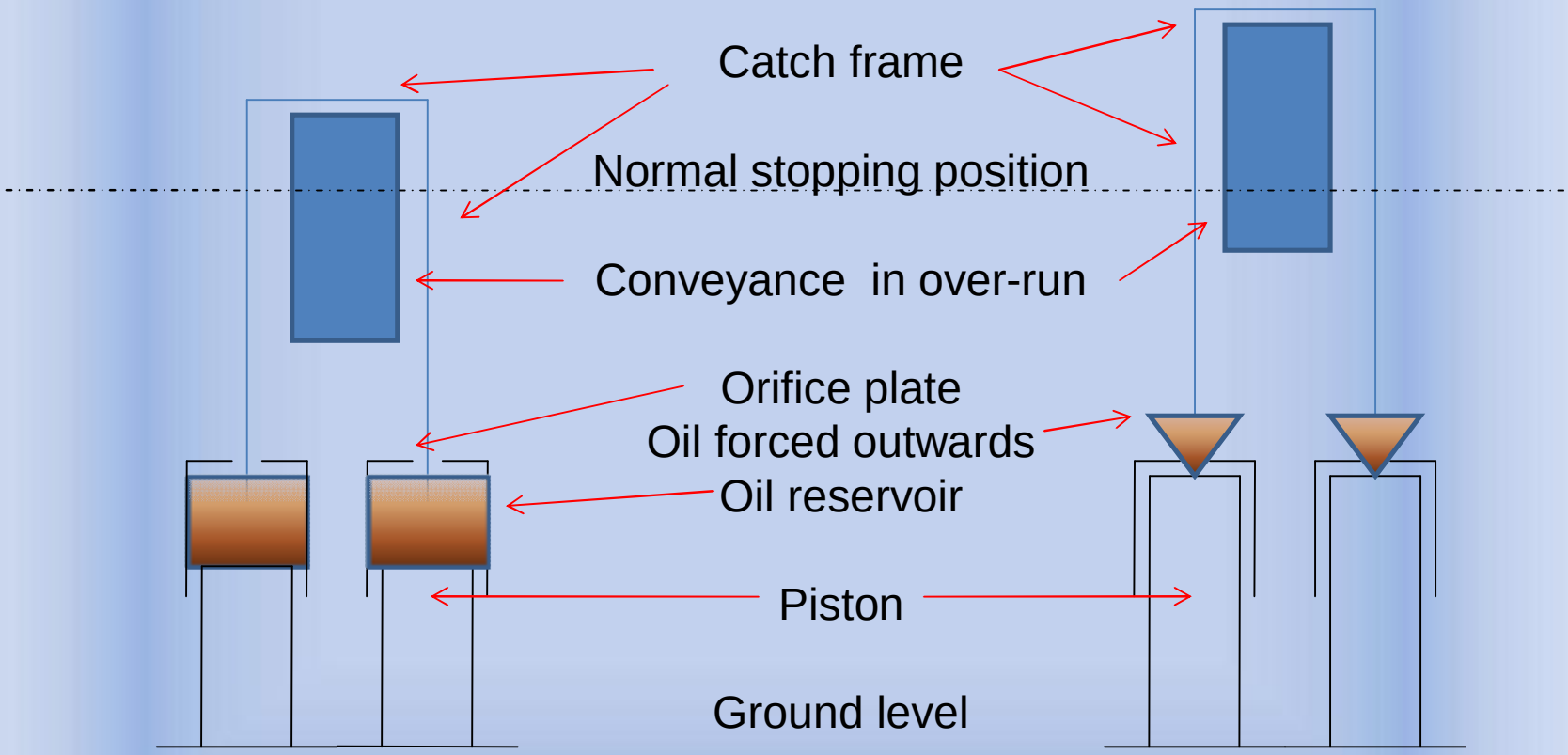
Energy sources:

- Winder and sheave inertia
- Head and tail rope velocity
- Conveyance and payload velocity
- Conveyance, payload and rope potential energy

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# CONVEYANCE ARRESTING

## Traditional method: oil-dashpot system

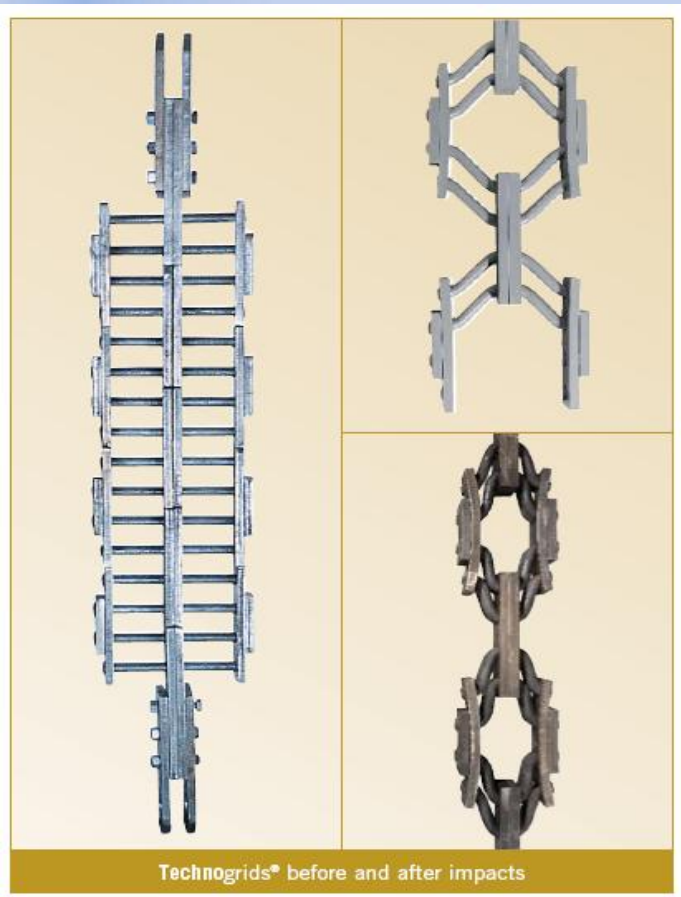



The biggest drawback to the use of this method is the lack of consistency and predictability of energy absorption

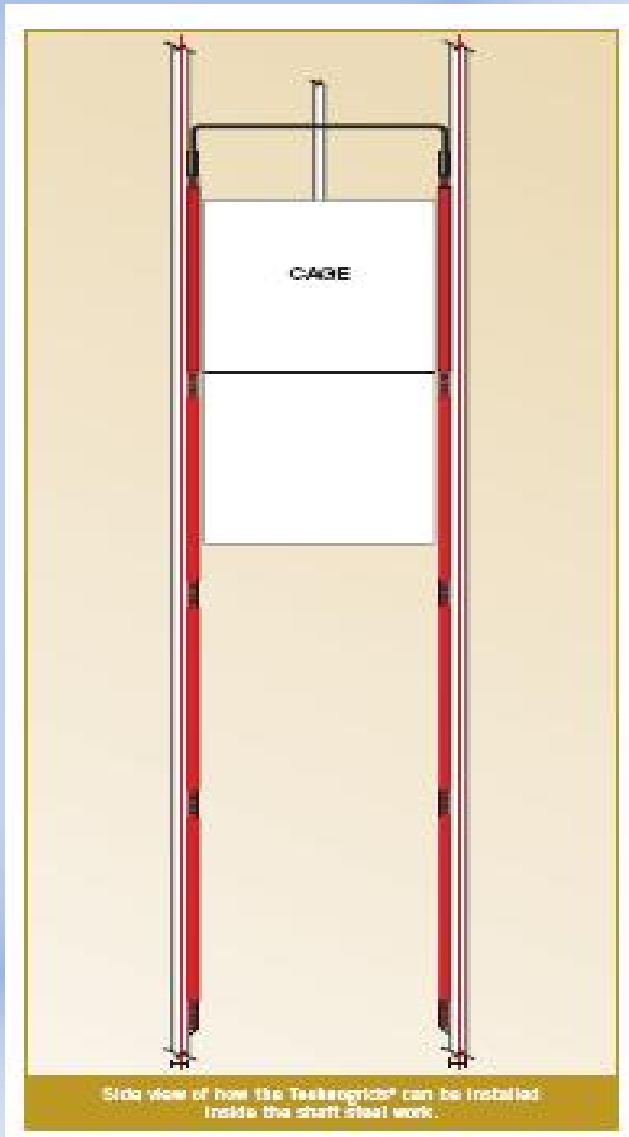
COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# CONVEYANCE ARRESTING

## Use of Technogrids



Technogrids® before and after impacts



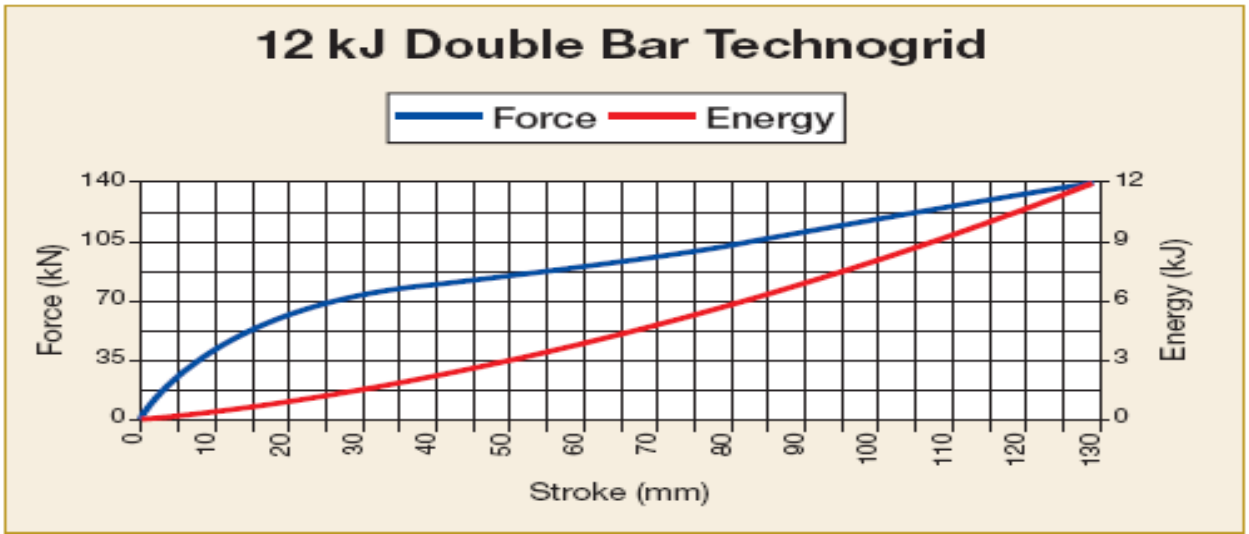

Side view of how the Technogrids® can be installed inside the shaft steel work.

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# CONVEYANCE ARRESTING

Specification of Technogrid units, the mathematical stuff:

$$h = \frac{\frac{2I_w^2}{D_w^2} + \frac{2I_s^2}{D_s^2} + \frac{1}{2}m_s + \frac{1}{2}m_s + \frac{1}{2}N_{tw}\lambda_{tw}L + \frac{1}{2}N_{tr}\lambda_{tr}L + \frac{1}{2}m_{pu}}{N_{part} * E_t + g * m_{pu}}$$




Principal force stroke diagram 12kJ

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# CONVEYANCE ARRESTING

Practical lessons learnt:

- Plan for conveyance arresting from the start
- Involve suppliers from an early stage
- Allow adequate space: over-run and compartment
- Design the system to arrest at half-speed
- Worst case scenario – top conveyance empty
- Corrosion protection – Enclosure vs galvanizing

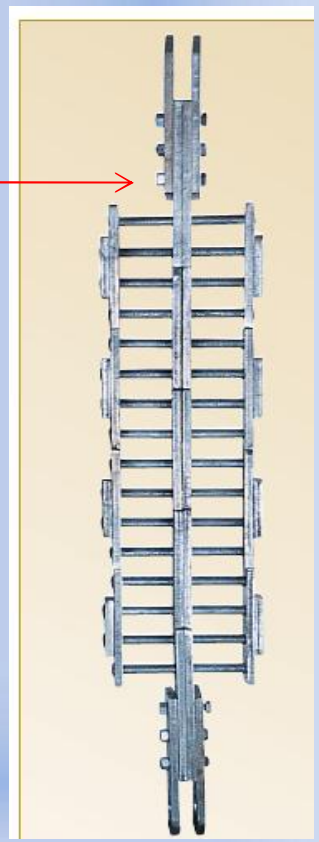
COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# CONVEYANCE ARRESTING

## The ideal and worst means of corrosion protection

Never ever hot-dip galvanize the units

The ideal is to enclose the units and then paint

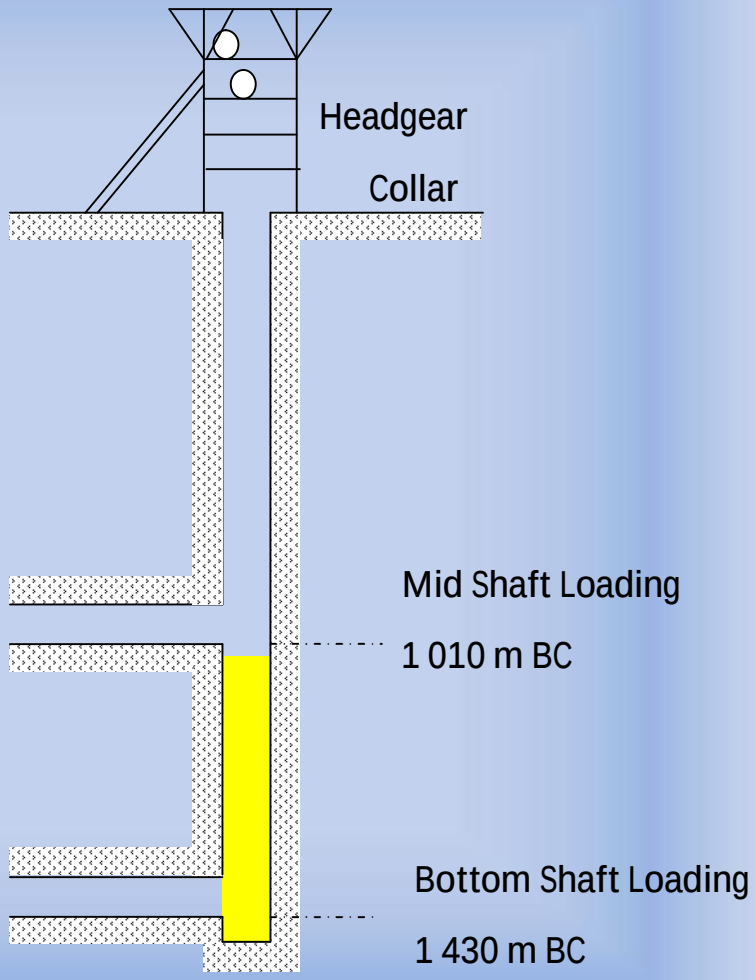
COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# FURTHER WORK

In the case of koepe winders there remains substantial work to be done to determine whether any benefit may be derived from arresting of the down-going conveyance.

# KONKOLA MID SHAFT LOADING

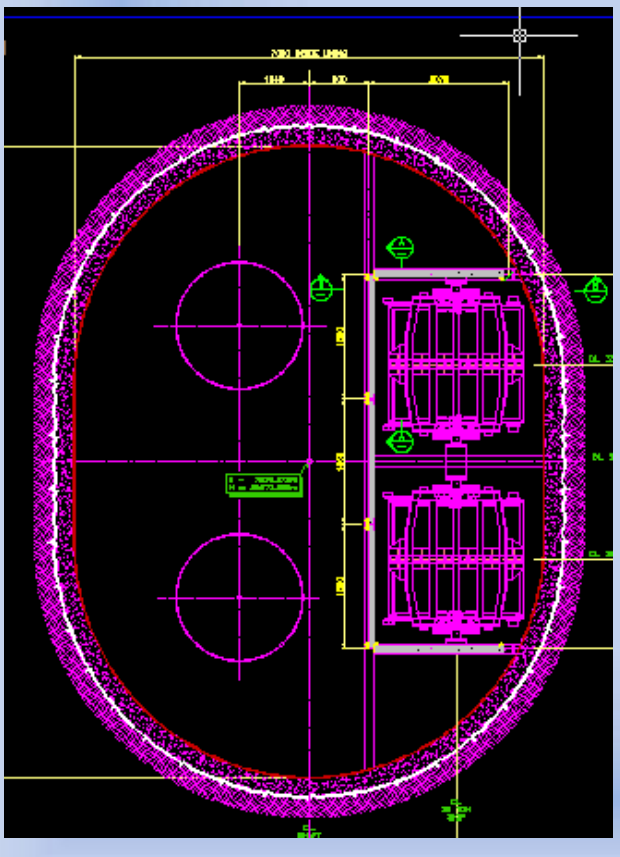
An added challenge to the Konkola project was the requirement for rock hoisting from the mid shaft level while sinking operations conditions continue below.

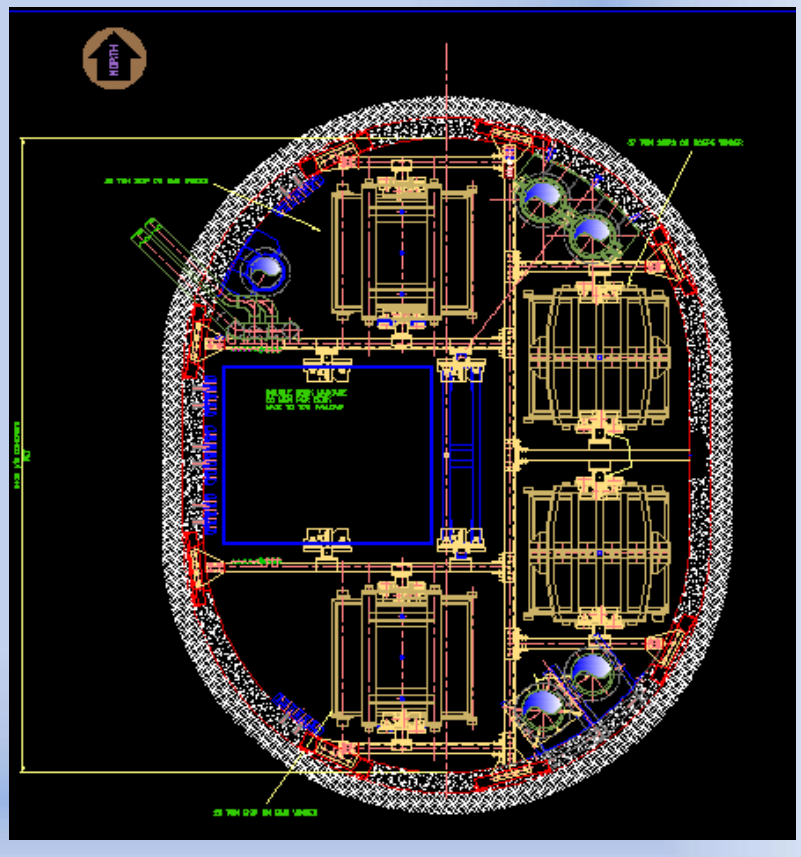


# KONKOLA MID SHAFT LOADING

COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

## SINKING AND PERMANENT SHAFT CONFIGURATIONS





# KONKOLA MID SHAFT LOADING

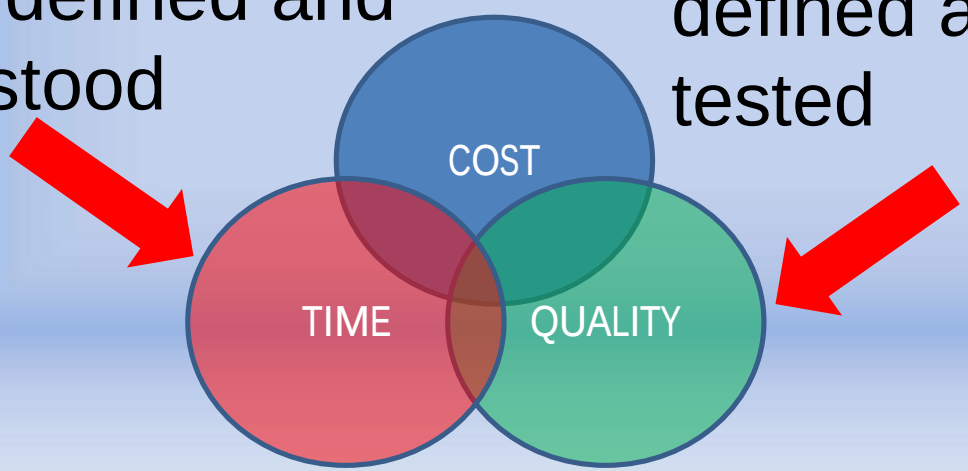
## BRATTICING CHALLENGES

**STEEL:**

- Heavy
- Expensive
- Long manufacturing time
- Well defined and understood

**POLYCARBONATE:**

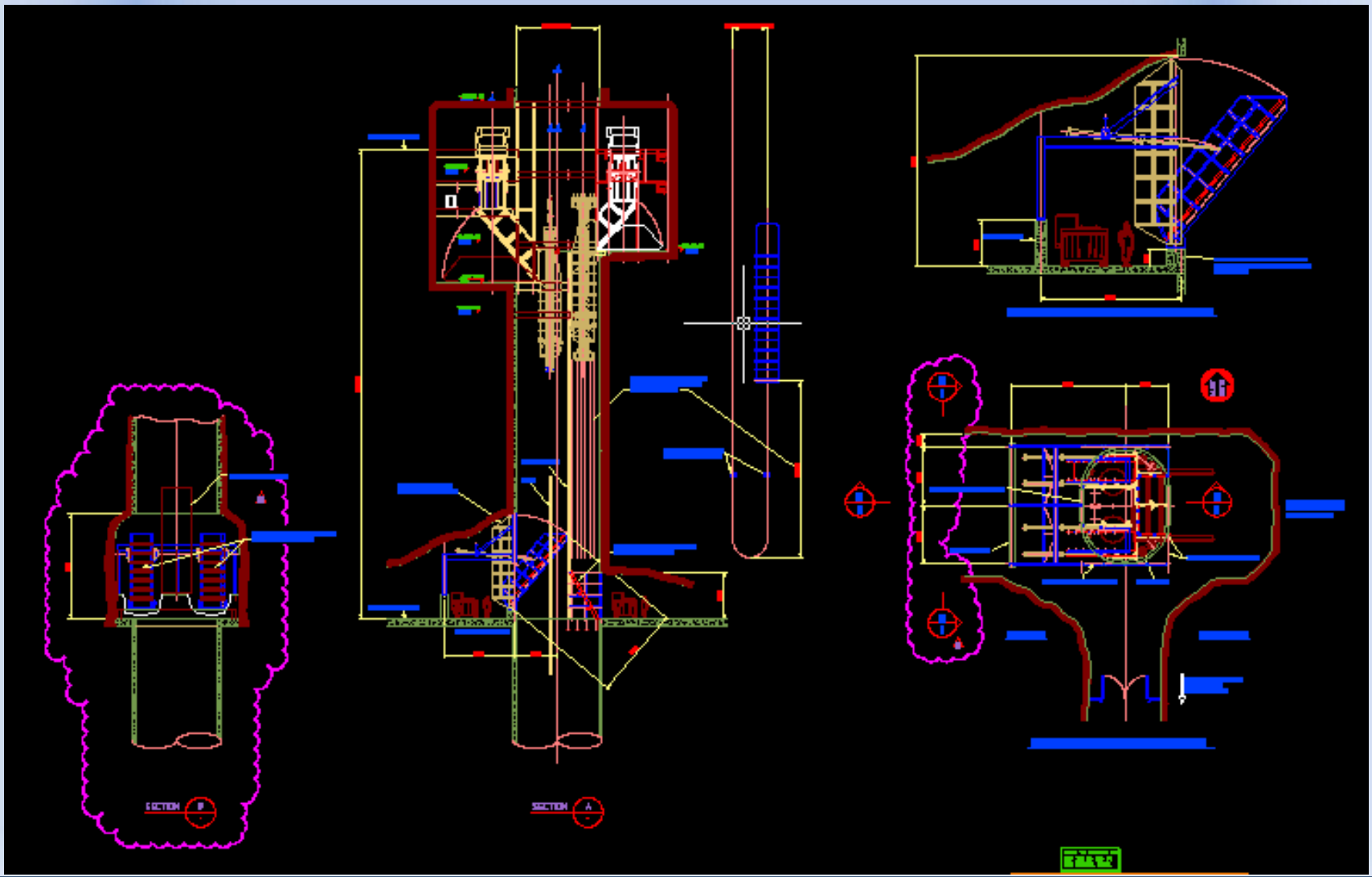
- Light
- Cheaper
- Easier to handle
- Properties not well defined and not suitably tested



COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# KONKOLA MID SHAFT LOADING

## THE SOLUTION TO SAFE SPILLAGE HANDLING



COMPLETE SOLUTIONS FOR THE MINING AND MINERALS INDUSTRY

# CONCLUSIONS

- Safety during shaft sinking and final production needs to be considered a non-negotiable
- Effective communication between client and designer is required for improvements to be realised
- There are alternatives available to the tried and tested technology favoured by the mining industry
- Any alternatives need to be backed up by solid theoretical or practical justification
- Each project has its own challenges but there is always scope to share best practice from a variety of sources

COMPLETE SOLUTIONS FOR THE
MINING AND MINERALS INDUSTRY

# QUESTIONS