Quarries National Joint Advisory Committee (QNJAC)

Information Sheet 7

(September 2017)

Quarry Design

This information sheet has been developed by the Quarries National Joint Advisory Committee (QNJAC) to help quarry operators, contractors, managers and others make health and safety improvements in the quarry industry. This guidance may go further than the minimum you need to do to comply with the law.

Approved by the Quarries National Joint Advisory Committee (QNJAC)

(Version 1: Sept 2017)
Guidance Note on Quarry design in relation to excavations and tips (QNJAC Geotechnical Face & Stockpile Operations Subcommittee)

Introduction

The requirement for “design” forms a central tenet of the Quarry Regulations 1999¹ (The term design is used more than 60 times in the Approved Code of Practice)

It is emphasised in Regulation 6 p.1

Regulation 6: General duties of the operator

(1) It shall be the duty of the operator of every quarry to take the necessary measures to ensure, so far as is reasonably practicable, that the quarry and its plant are designed, constructed, equipped, commissioned, operated and maintained in such a way that persons at work can perform the work assigned to them without endangering their own health and safety or the health and safety of others.

And the subsequent guidance note 32

Regulation 6 is the underpinning requirement of these Regulations. It is intended to secure a co-ordinated, proactive approach to the management of health and safety, which ensures that risks are properly controlled.

In particular in part vi of the Regulations the operator is given an absolute duty to ensure the design of excavations and tips avoid placing any person at risk.

Regulation 30: General duty to ensure safety of excavations and tips

The operator shall ensure that excavations and tips are designed, constructed, operated and maintained so as to ensure that -

(a) instability; or
(b) movement,
which is likely to give rise to a risk to the health and safety of any person is avoided.

The design is essential so that it can be risk assessed for hazards prior to its implementation and all risks managed as development proceeds. It may be possible to design out a significant hazard as defined.

Other regulations such as The Work at Height Regulations 2005² and Construction (Design and Management) Regulations 2015³ also emphasise the requirement for design.

It is the Operator’s duty to ensure the design is in place.

Design is essentially a process not a product and it is the detail of this process that will provide evidence that the operation meets accepted good practice and is compliant with the requirements of regulations.

The flow chart provides a possible outline of this process.

¹ QR 1999 Link available to purchase or download
² Working at Height Link
³ See Appendix 1 “Which regulations to apply?”
Outline the design process in the Health & Safety Document

Identify all relevant personal involved in design

- Overall Operations Manager
- Geologist
- Geotechnical Specialist
- Electrical Engineer
- Plant Design Engineer
- Mobile Plant Engineer
- Environment
- Health and Safety Committee
- Blasting Supervisor
- Blasting Contractor
- Estates Manager

Survey plans
- Geological plans
- Inductive blast design
- Site investigations
- Hydrogeological data
- Cross sections (3D model)
- Operating performance of mobile plant
- Competencies of the work force

This must depend on the scale of the operation but could include

Borehole Information
- Overall Operations Manager
- Health and Safety Committee
- Geologist
- Geotechnical Specialist
- Blasting Supervisor
- Blasting Contractor
- Estates Manager
- Plant Design Engineer
- Mobile Plant Engineer
- Environment
- Health and Safety Committee
- Geologist
- Geotechnical Specialist
- Blasting Supervisor
- Blasting Contractor
- Estates Manager
- Plant Design Engineer
- Mobile Plant Engineer
- Environment

Identify and gather together all relevant information to support the design

- The method of excavation or construction
- The type and size of the equipment to be used
- Overall slope of excavation
- Depth of excavation
- Final quarry profiles
- Geotechnical parameters for soil and rock
- The slope of faces, heights of faces and widths of benches
- Widths and gradients of all roadways
- Design of rock fall and edge protection
- Drainage

Operational permit details
- Overall Operations Manager
- Health and Safety Committee
- Geologist
- Geotechnical Specialist
- Blasting Supervisor
- Blasting Contractor
- Estates Manager
- Plant Design Engineer
- Mobile Plant Engineer
- Environment
- Health and Safety Committee
- Geologist
- Geotechnical Specialist
- Blasting Supervisor
- Blasting Contractor
- Estates Manager
- Plant Design Engineer
- Mobile Plant Engineer
- Environment

Develop extraction plan
- Height, slope and area of Tip and Lagoons
- Rate of excavation or construction
- Phases and timescales for development
- Stockpile area, size and location of all stock

Identify all relevant design parameters

- Non geotechnical elements (require general risk assessment)
- Geotechnical Assessment
- Non significant hazards
- Identified significant hazards
- Appraise to identify significant hazards

Not Significant

Is it possible to eliminate significant hazards?

No

Geotechnical Assessment
- Modify design parameters as required, (notify HSE as necessary)
- Set review period for Assessment

Yes

Set Approval

Identified significant hazards

- Has the Design been Approved by all relevant personal?

No

Develop the Excavations & Tips Rules
- Develop inspection regime for all Excavations & Tips

Yes

Rules reviewed as part of geotechnical assessment

Determine the frequency of Design review
Design Process

Although the nature of quarry design may be profoundly different from site to site the process by which it has been arrived at and the various elements should be clearly laid out in the Health and Safety documentation. Good practice would ensure a named individual is responsible for the maintenance of the design.

In general there are three principal steps to design, subdivided as appropriate:

1. **Pre-commencement**
   a. Define purpose of structure
   b. Research solutions and ensure all relevant data is available
   c. Identification of problems and hazards
   d. Specification of design
   e. Detail resources necessary to deliver design
   f. Presentation of design in an accessible form

2. **During construction (or use)**
   a. Test design to ensure it is fit for purpose
   b. Amend design as necessary

3. **On completion**
   a. Review implementation
   b. Evaluate and ensure lessons are learned

In practice the design process should be the same across all aspects of the quarry but as consequence of past accident inquiries, in particular into the tip failure at Aberfan\(^4\), the regulations are prescriptive as to the process to be followed in respect of excavations and tips. (Regulation 1999 part VI). In particular the outcome of the design process must be appraised for **significant hazards**\(^5\) (as required by Regulation 32) and if the potential for a significant hazard is recognised then a detailed assessment must be made by a **geotechnical specialist**\(^6\) (as required by Regulation 33).

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\(^4\) [Aberfan Link]

\(^5\) Defined by regulation as:
“hazard” in relation to an excavation or tip means having the potential to cause harm to the health and safety of any person. Guidance indicates that a significant hazard would be one that could cause death or serious injury.

\(^6\) Defined by regulation as:
“geotechnical specialist” means a chartered engineer or chartered geologist who has—
(a) three or more years relevant experience in soil mechanics, rock mechanics or excavation engineering; and
(b) is competent to perform a geotechnical analysis to determine the hazard and risk arising from the excavation or tip being assessed,
Example of design process for stockpile

Responsible individual - Quarry Manager

1. Pre construction

Purpose

Stockpile for storage of 15 000 tonnes of 20mm single size limestone sited on quarry floor.

Source of pre-processed material for sale. (as an example of use)

Under the terms of the regulations a Stockpile is both a Tip and an Excavation

Relevant data:

<table>
<thead>
<tr>
<th>Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density of 20mm limestone in stockpile</td>
<td>1.7 tonnes/m³</td>
</tr>
<tr>
<td>Angle of repose of 20mm limestone 37°</td>
<td>based on measurement</td>
</tr>
<tr>
<td>Foundation on in situ limestone</td>
<td>based on observation</td>
</tr>
<tr>
<td>Maximum stockpile height</td>
<td>8m</td>
</tr>
<tr>
<td>Area covered</td>
<td>1800m²</td>
</tr>
<tr>
<td>Available survey plan of site area</td>
<td>- update as necessary</td>
</tr>
</tbody>
</table>

Problem hazards:

Must be sited away from existing faces
Sufficient access to permit safe construction and excavation
Must not impact on safety or stability of any other tip or excavation

Specification

Construction detailed construction method, stockpile constructed in layers not more than 2m in height using loader.
Location as shown on survey plan

Resources

Size of loader must reach 8m
Required competency of personnel
Required competency of supervisor

Presentation

Design must be appraised for significant hazards as required by regulation 32 (in normal circumstances it is unlikely that a stockpile would be determined a significant hazard).
Tip (stockpile) rules for safe construction and excavation must be prepared as required by regulation 31
Inspection scheme reviewed to ensure stockpile adequately covered by inspection scheme as required by regulation 12

2. During construction (or use)

Inspections carried out in accordance with agreed scheme.
Cycle of appraisals carried out in accordance with original appraisal
Design reviewed if appraisal or inspection notes a change

3. On Completion

In the case of stockpiles material completely removed - no after care necessary.

7 QNJAC Management of Change guidance
Example of design flow chart adapted for individual needs

**DESIGN PROCESS**

**DESIGN REQUIREMENTS**
- Design Process/Project Coordinator
- Identify design team
- Define design objectives
- Design Objective Approval
- Task Delegation

(1) **PROJECT SCOPE**
- Consideration of STEX variations and field notes, if applicable.
- Development and modification of site P&ID

(2) **DESIGN CRITERIA & PARAMETERS**
- Determinate design parameters, spatial constraints, available plant, economics, etc.
- Prepare technical drawings
- Final approval with design team (group meeting)

(3) **TECHNICAL DRAWINGS**
- Final approval with design team

**IMPLEMENTATION**

**IMPLEMENTATION PROCESS**

**COMPLETION OF DESIGN PROCESS**
- Design Implementation Coordinator
- Identify implementation team
- Define implementation plan

**METHOD (1)**
- Consideration of Excavations and Trench Routes

(2) **SURVEY CONTROL & PROGRESS CHECK**
- Setting Out
- Periodic review
- Excavation following design?
- Continue survey control

Design Process
- Reproduce reviewed technical drawings
- Review design criteria and parameters
- Significant effect
- Evaluate against design objectives
- Non-significant effect

*May 2015 | Design Process & Implementation*
Appendix 1  Which regulations apply?

Quarry Regulations 1999 or Construction (Design and Management) Regulations 2015

Types of construction
- Environmental bank
- Waste Tip
- Surface water treatment bypass
- Water storage bypass
- Plant Construction

Review CDM 1999 regs 3 & 4
- A quarry includes:
  - Tidy Tip
  - Stockpiles
  - All areas used for the preparation of extracted materials
  - Temporary buildings and structures at the quarry that are used for the working of the quarry
  - Common areas (roadways and railways)
  - Sites where prospecting with a view to the extraction of minerals
- Activities covered includes:
  - Preparation for extraction
  - Extraction
  - Preparation for abandonment

CDM 2015 identifies a number of key elements to securing construction health and safety.

Design process in accordance with procedure set out in Health & Safety Document

CDM 2015 Link