



Supervision

Stone Arch Bridges

Belgian development agency

enabel.be



Construction - timeline

- Between 1 and 4 months
- Factors for delay
 - 1. Local contribution
 - 2. Heavy rainfall
 - 3. Local leadership change
 - 4. Small pool of experienced masons
 - 5. Accessibility roads





Stone masonry

Materials

Mortar

Method

Preparation

After works

- Quality of materials
 - Size of the trips delivered
- Stones
 - Size of the stones
 - Shape of the stones
 - Strength of the stones
- Sand
 - Cleanliness of sand
 - Silk/clay content sand
 - Storage of sand



Stone masonry

Materials

Mortar

Method

Preparation

After works

- Quality materials
- Mix well
 - Uniform, 1 colour
- Ratio
 - Cement:sand – 1:3
 - Ratio water:dry materials



! More water: easier to work, bad for quality

- Avoid spilling mortar
- Reuse mortar





Stone masonry

Materials

Mortar

Method

Preparation

After works





Stone masonry

Materials

Mortar

Method

Preparation

After works

- Correct selection for correct purpose





Stone masonry

Materials

Mortar

Method

Preparation

After works

- No air gaps
- Right shapes to fit
 - Put small stones in between
 - Fill gaps with mortar





Stone masonry

Materials

Mortar

Method

Preparation

After works

- Horizontal
- Corner stones





Stone masonry

Materials

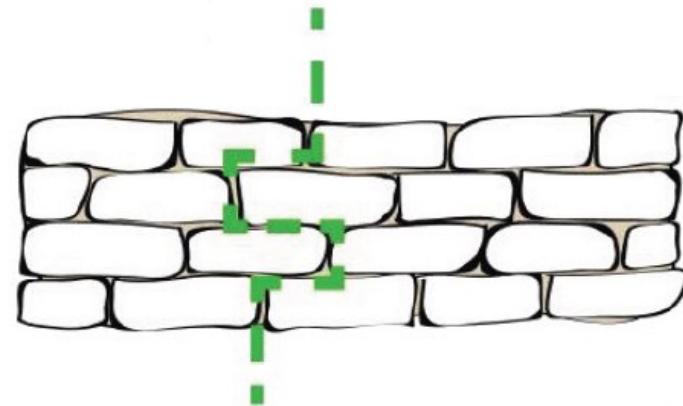
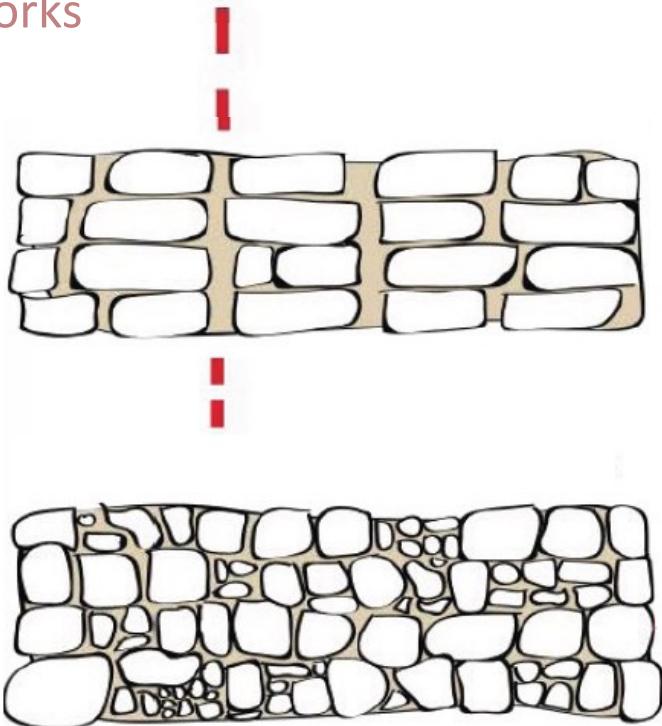
Mortar

Method

Preparation

After works

- Stacking with overlap





Stone masonry

Materials

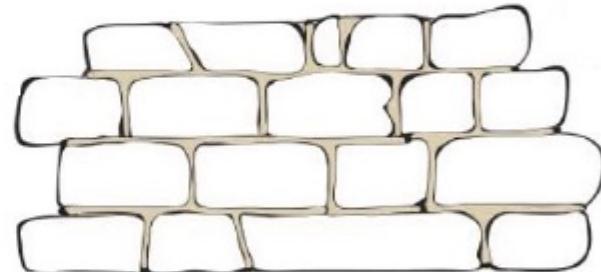
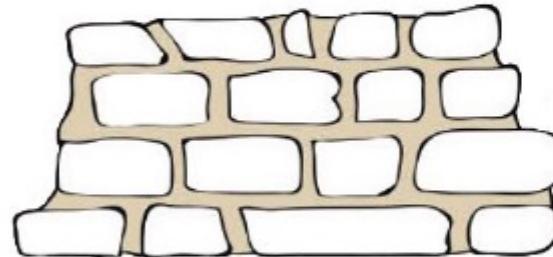
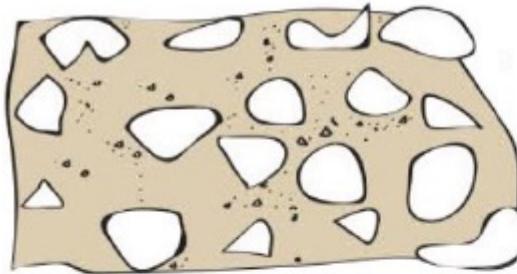
Mortar

Method

Preparation

After works

- Mortar thickness





Stone masonry

Materials

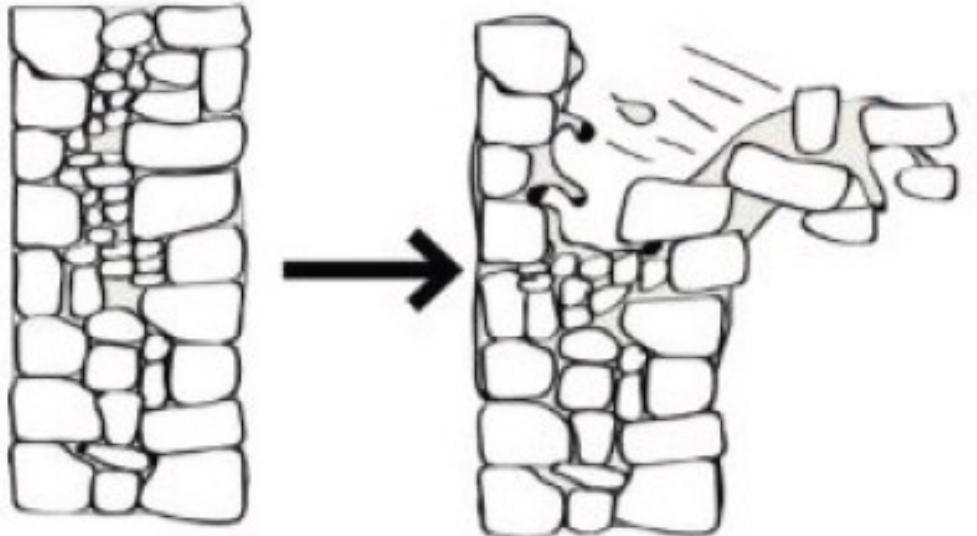
Mortar

Method

Preparation

After works

- Tie stones





Stone masonry

Materials

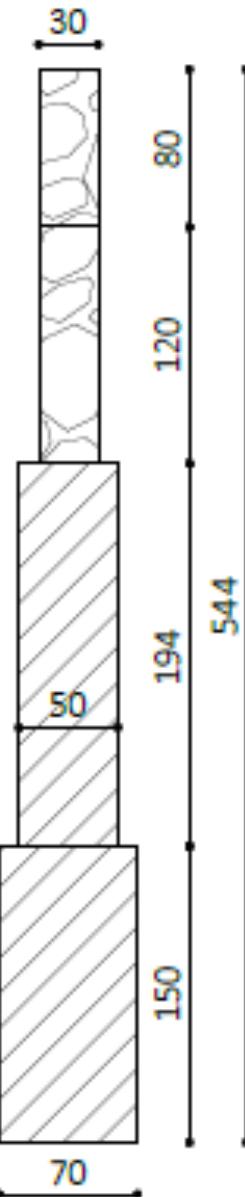
Mortar

Method

Preparation

After works

- Thickness to height



SECTION
WINGWALL



Stone masonry

Materials

Mortar

Method

Preparation

After works

- Stones
 - Wash before use
 - Keep clean until use
 - Make wet before placing in masonry
- Mortar ready in karai
- Clean surface where works will start
- Water bottle next to works





Stone masonry

Materials

Mortar

Method

Preparation

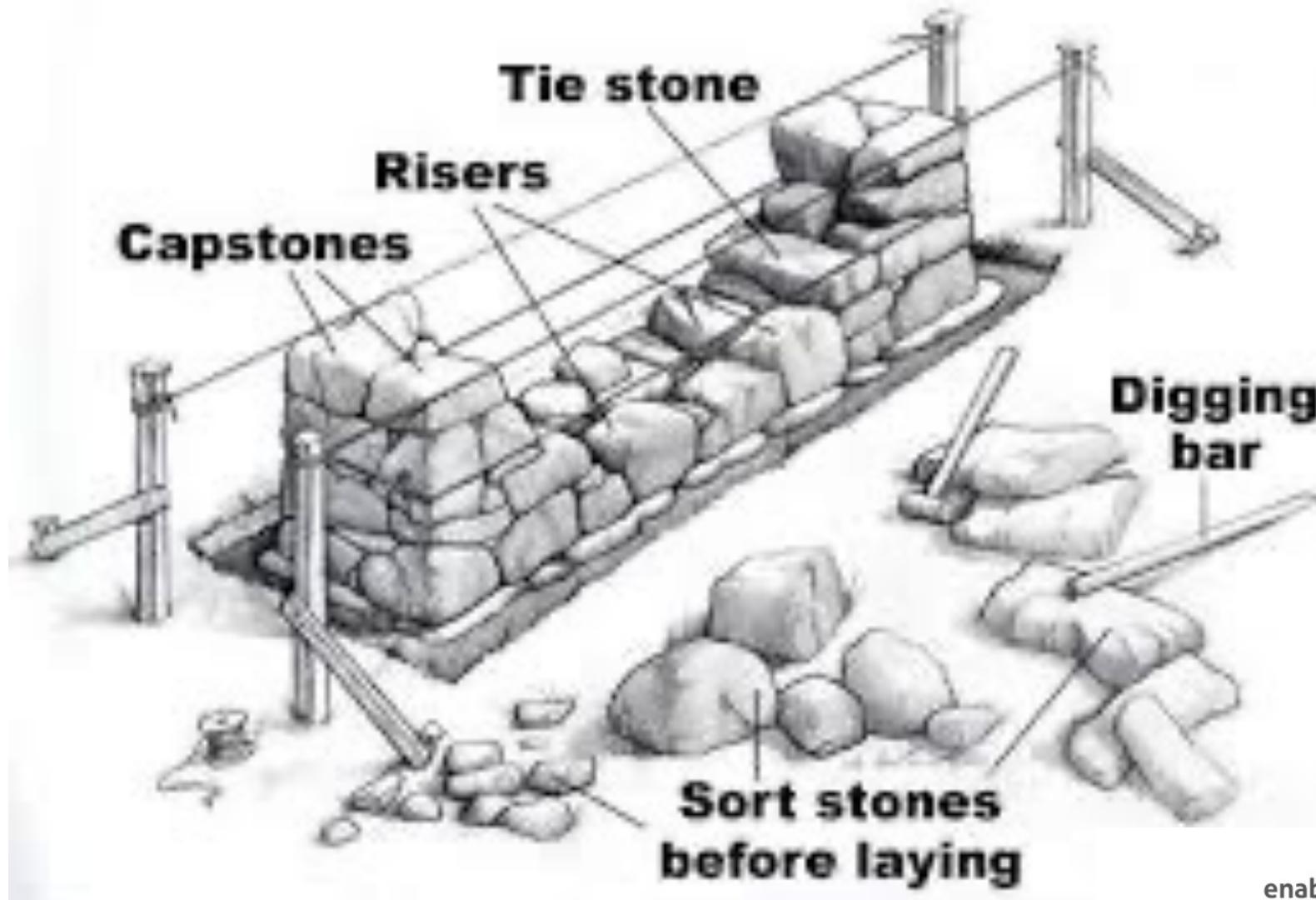
After works

- Don't walk on fresh masonry
 - Scaffolding
- Keep masonry damp for curing
 - Cover with grasses, ...
- Protect fresh masonry from rain





Stone masonry





Stone masonry

Site Instruction Ledger

Construction long stone arch bridge –

Date												
Construction stage:												
People present:												
Quality stone masonry												
No air gaps	<input type="checkbox"/> yes	<input type="checkbox"/> no	Good bond		<input type="checkbox"/> yes	<input type="checkbox"/> no	Stones clean		<input type="checkbox"/> yes	<input type="checkbox"/> no		
Large stones	<input type="checkbox"/> yes	<input type="checkbox"/> no	Rough surface		<input type="checkbox"/> yes	<input type="checkbox"/> no	Mortar recycled		<input type="checkbox"/> yes	<input type="checkbox"/> no		
Proper corner stones	<input type="checkbox"/> yes	<input type="checkbox"/> no	Right mix		<input type="checkbox"/> yes	<input type="checkbox"/> no	Watering curing		<input type="checkbox"/> yes	<input type="checkbox"/> no		
Ledgers are updated:			cement	<input type="checkbox"/> yes	<input type="checkbox"/> no	sand		<input type="checkbox"/> yes	<input type="checkbox"/> no	stones	<input type="checkbox"/> yes	<input type="checkbox"/> no
Instructions to mason												



Supervision per element

Setting out

Foundations

Formwork

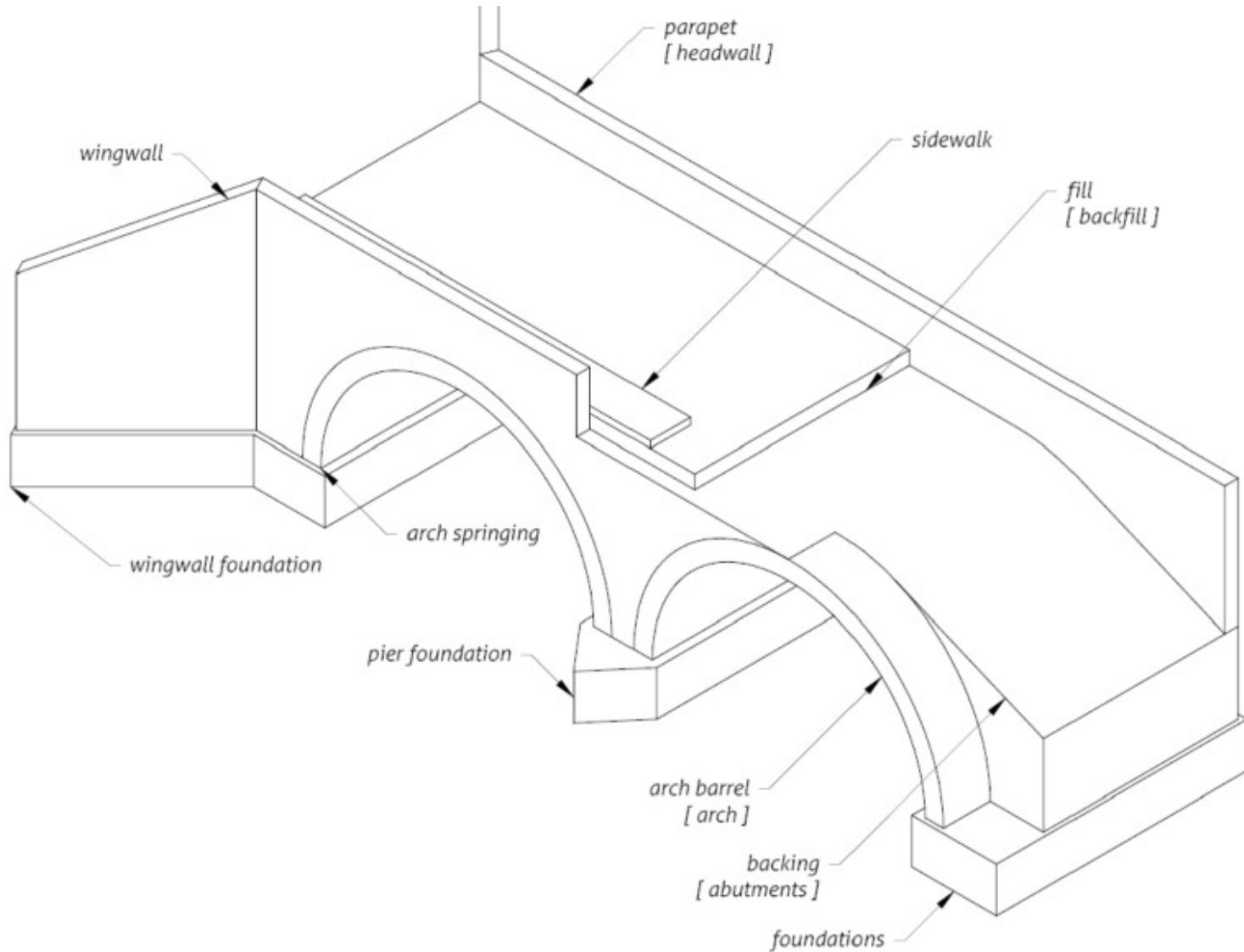
Arch

Abutments

Wingwalls

Headwalls

Deck





Supervision per element

Setting out

Foundations

Formwork

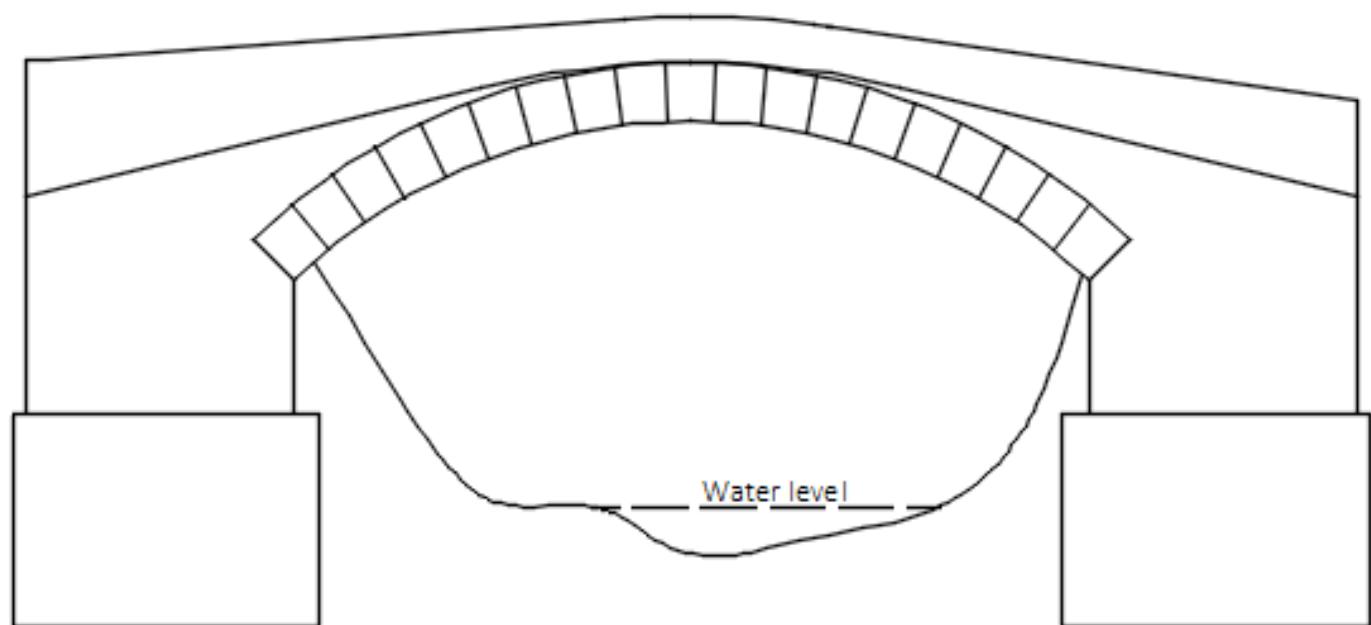
Arch

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Deck





Setting out
Foundations
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Arch
Abutments
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Setting out
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Arch
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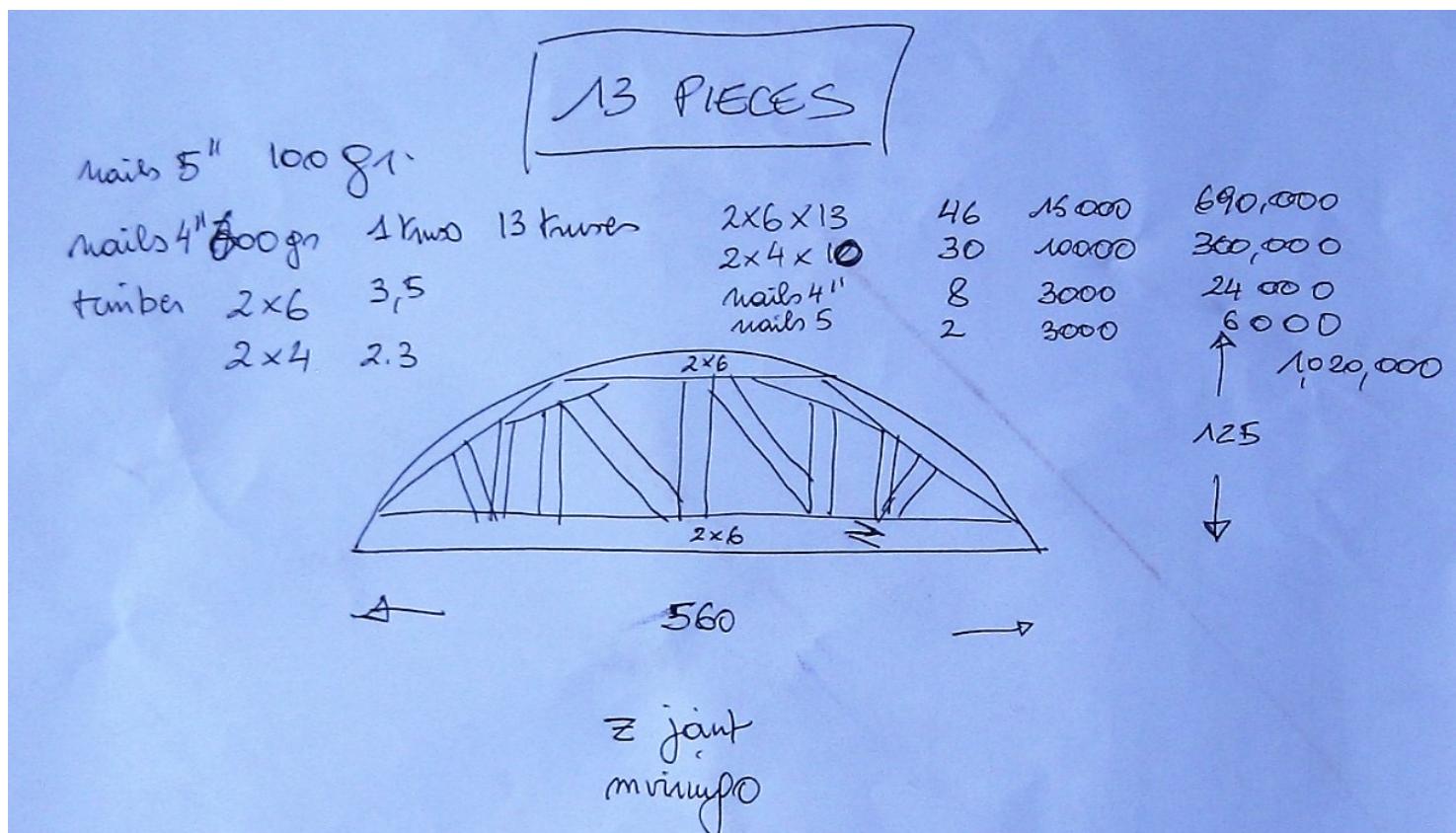
Setting out
Foundations
Formwork
Arch
Abutments
Wingwalls
Headwalls
Deck





Setting out Foundations Formwork

Arch
Abutments
Wingwalls
Headwalls
Deck





Setting out
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Arch
Abutments
Wingwalls
Headwalls
Deck





Setting out Foundations

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Arch
Abutments
Wingwalls
Headwalls
Deck





Setting out Foundations **Formwork**

Arch
Abutments
Wingwalls
Headwalls
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Setting out
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Arch
Abutments
Wingwalls
Headwalls
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Setting out Foundations **Formwork**

Arch
Abutments
Wingwalls
Headwalls
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Arch
Abutments
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Headwalls
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Wingwalls
Headwalls
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Abutments
Wingwalls
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Headwalls
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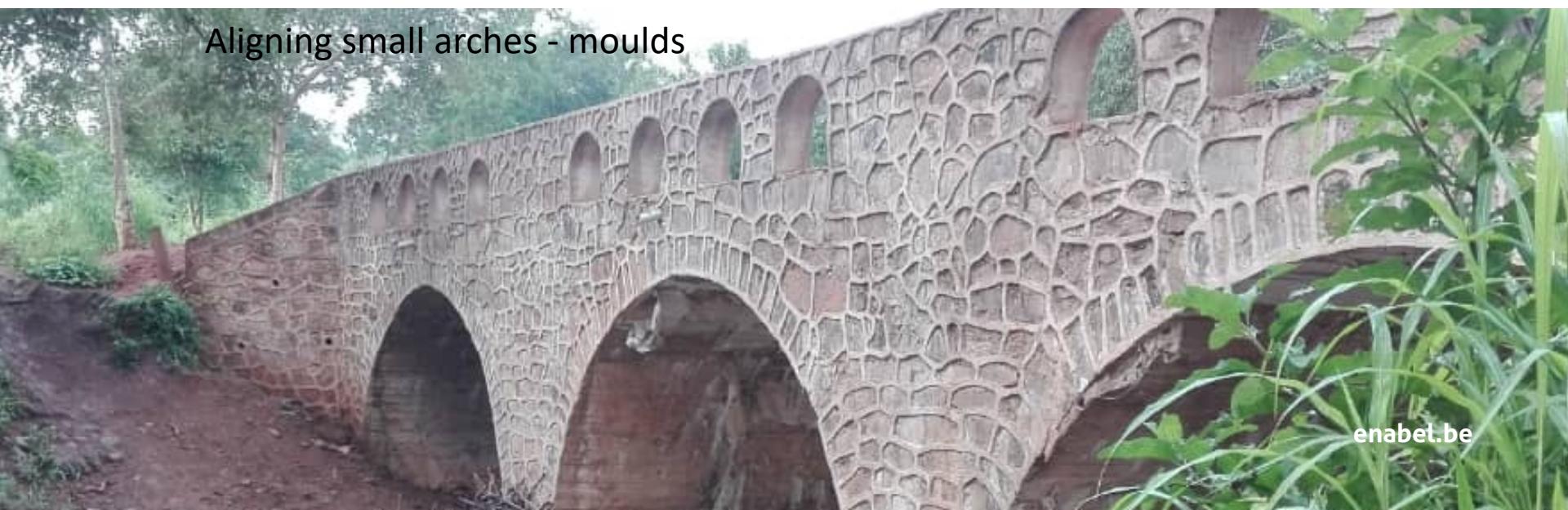




Setting out
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Aligning small arches - moulds





Setting out
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Picture of bad top finishing
headwall





Setting out

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Deck

Picture of bad top finishing
headwall

Picture of badly aligned gutters

Picture of gutter not sloped
outwards

Picture of gutter above road level



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- Deck surface
 - Murram
 - Stone lining
 - Good for additional strength
 - Durability
 - Easier to work with small gutter system
 - Needs less maintenance than murram
 - DESIGN?
- Picture of Chekenya
- Picture of Kanyonza for bad example
 - Important that water flows away towards the gutters
- Picture murram – badly compacted







Supervision – completion

Bridge ID	20 21 20
Bridge name	MUHUNGA BRIDGE
Issuing date	14 th March 2023

FOUNDATIONS	assessment	remarks
Foundations haven't settled at a different rate to each other	5	
Alignment has not altered	5	
There is no scour at riverbed around foundations	5	Rest on Red rock
Pointing	1	Not finished

ARCHES	assessment	remarks
Shape of the arch	5	
Pointing	5	
No cracks on the arch ring (visible in elevations)	5	
No cracks on the arch barrel (underside)	5	
No other cracks	5	
No holes between stones without mortar or small stones	4	
All bags burnt / removed under arch	4	
No seepage of water through the arch barrel (underside)	4	

ABUTMENTS / SHOULDERS	assessment	remarks
No holes between stones without mortar or small stones		
No cracks	5	

WINGWALLS	assessment	remarks
No cracks at connection with abutment or headwall	5	
No cracks in the wingwalls	5	
Wingwall is straight, square and flat	5	
Weeping holes through open joints	3	
Pointing	3	
No erosion behind wingwalls	5	
Water is drained away from the wingwalls on road approach	9	The connection to the abutment isn't great

HEADWALLS	assessment	remarks
No cracks in headwall	5	
No cracks in small arches in headwall	3	4 heavy cracked ones
Headwall is straight, square and flat	5	
Pointing	3	not completely finished around gutters
Gutters or pipes drain water away from outer surface	5	

PIER TRIANGLE SHAPES	assessment	remarks
No cracks	5	
No cracks at connection foundation, abutment, headwall	5	
Triangle shape is straight, square and flat	3	One side isn't straight
Pointing	4	

ROAD SURFACE	assessment	remarks
No puddles remain on carriage way after rain	3-4	some standing water
All water drains through gutters or pipes	5	
Surface is smooth	4	
Murrain is well compacted on approaches	5	
Murrain is well compacted on bridge	5	
Stone lining shows no cracks	5	
Stone lining has completely filled joints	5	
Stone lining has no loose stones	5	
	+	not accessible yet

GUTTERS	assessment	Remarks
i/ Alignment of gutters	4	
ii/ Positioning of gutters	4	The alignment isn't to great
iii/ Drainage of gutters		Some protrude than others
iv/ Finishing (filling of joints)	2	Need more fine finish

remaining point
finish painting

- around gutters (first fill holes)
- around foundation piers
- around connection wingwall to vertical part arch
- front 1 wingwall after excavations

complete backfilling by TARURA

Overall remark gutters need to have the same overhang everywhere - 20 cm



Maintenance

- **Small maintenance** by village - Cleaning of debris
- **Periodic large maintenance** - TARURA is setting up strategic maintenance approach

