The Rammed Earth Planning Handbook

Planning with 100% earth

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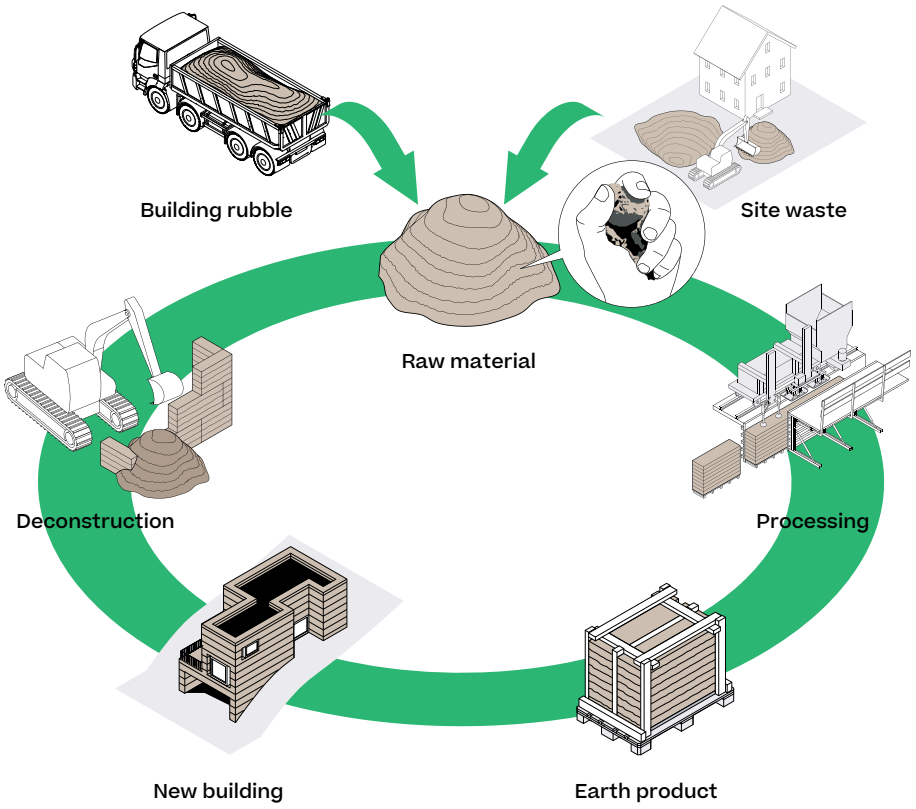
Designing with rammed earth can be complex. There are so many open questions. To make your workday a little easier and your design a little realer, we've tried to shine a light on the planning processes that make a rammed earth building come to life.

This handbook has been prepared with a European context in mind. Rammed earth, of course, works very well in other climates and contexts. However, we can only talk about the processes, costs, timelines, and even the building physics we have the most experience with.

Contents P.

Our earth

There is a scene that shows with all clarity why earthen construction makes ecological sense. Imagine a piece of land. On this plot there is nothing but earth. And from exactly this earth a house is built. That may sound a bit direct. It is. But rammed earth is just that, nothing but compacted earth. Our prefabricated building elements are 100% natural, 100% recyclable, passively control indoor climate, and offer a haptic materiality perfectly suited to contemporary architecture.



We don't aim to change this ancient material, but innovate the processes around its production. Earthen construction must adapt to modern practices to make a meaningful impact in greening the building industry. We use excavated earth, waste material from other building projects to build our walls. Prefabrication has allowed us to plan and coordinate on-site schedules more efficiently. We collaborate closely with designers, industry partners, and research institutions to further develop rammed earth construction. As public sentiment begins to ask for ecological shifts, our earth must be ready to provide the answers.

Quick numbers

These rough figures are based on our experience and testing throughout many realised projects. They're good rule-of-thumb values. The real numbers will vary, though, depending on the excavated material. So when implementing a project, material testing with our engineering partners takes place each time.

Average compressive strength

2.4 N/mm^2

Mass

2250 Kg/m^3

Flexural strength

0.52 N/mm^2

Shear strength

0.62 N/mm^2

Permissible compressive stress

0.34 N/mm^2

Thermal conductivity

λ = 0.9 W/mK

Minimum exterior wall thickness

350 mm

Minimum interior wall thickness

70 mm

Rated sound reduction index

53 dB for 20 cm wall thickness

Drying time

4–6 Weeks

Shrinkage

0.25 % — 1 %

Creep deformation

0.2 %

Thermal expansion

0.005 mm/mK

Fire classification

RE(I)90 for 25 cm wall thickness

CO_2 emissions from production*

46 Kg/m^3

Production energy*

930 MJ/m^3

*Source: KBOB: Ökobilanzdaten im Baubereich 2009/1:2016. URL: https://www.kbob.admin.ch/kbob/de/home/themen-leistungen/nachhaltiges-bauen/oekobilanzdaten_baubereich.html, accessed 02.02.2021.

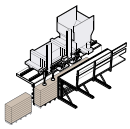
Questionnaire

Earthen construction is difficult to standardise because every excavation soil is different. But often, that's what you want, to use your own earth, a possibility not available with most other building material. For this to be feasibly, there are some important questions to answer first. This short questionnaire can help us understand your priorities and define the process.

Is the project close to Schlins, Austria?	No, it's far away	Yes, less than 400 kms away
Which earth do you want to use?	Our own earth	LTE earth
Do you need LTE to develop a material recipe?	No, we'll use a LTE mix	Yes, we need help
Do you need engineering support?	No, our engineer knows the material	Yes, we need help with calculations
Does your design feature 1000 m^2 of rammed earth surface?	No, it's a smaller project	Yes, the project is big!
Who will build your rammed earth project?	We have a local contractor	We want LTE to build it
Do you have a local contractor who knows rammed earth?	Yes, we have an experienced builder	No, our builder needs support
Do you have space on site for mixing, production, etc?	Not really	Yes, plenty of space

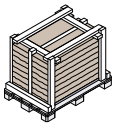
Timeline

Prefabrication allows us to plan our production better, reducing the time spent on site to a predictable minimum. The following timeline is a typical schedule for a 50 m² production series of rammed earth elements.



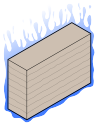
Formwork & ramming

3.5 days per production series



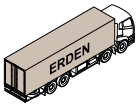
Packing & post-production

2.5 days



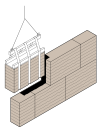
Drying time

4-6 weeks



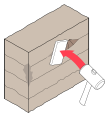
Transport

3 days



Assembling on-site

17 days



Retouching

8 days net (1 craftsmen)

Finishing

3.5 days net

Planning Processes

Extensive experience has taught us how to realise projects of all kinds with an unstandardised material. Here are a series of processes we undertake depending the proposal. Each process includes most of the packages from the preceding processes, except Process B. Collaboration with our team will define the process needed to make your design a reality.

Process A includes 1 2

Prefabrication with LTE earth

- Small and large scale projects
- Project within 400 kms of Schlins
- Suitable design for prefab

Process B includes 1 3

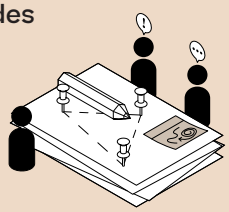
In situ construction

- Less than 1000 m² of wall
- Project reachable by road from Schlins
- Complex form suitable for in situ

1. Technical Consulting

Our team of architects has encountered every technical issue that could arise in a rammed earth design. We also need to ensure a proposal is suitable for production, whether in situ or prefabrication. Our consultation includes:

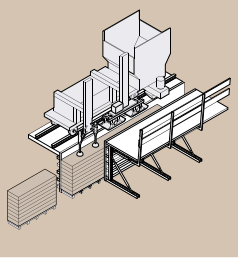
- Technical detailing support
- Planning for production
- Specification of rammed earth works
- Engineering support
- Coordination with other trades



2. Prefabricated Production

With the design finalised, we can prefabricate the walls. Our planners take the building elevations and subdivide the earthen walls into elements. The elements are put into a production schedule that is coordinated with the rest of the on-site work. Prefabricated production involves:

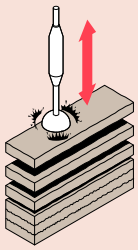
- Planning for production, ie. shop drawings
- Mixing materials according to requirements
- Ramming elements
- Drying and packaging
- Transport to site
- Installation
- On-site construction management
- Retouching



3. Local Production

Some designs are more suitable for local production. That means ramming in situ. Our construction team are able to travel for selected projects. The material for local production may come from Schlins or mixed on-site. If the project requires prefabricated local production, see Process C. Local production includes:

- Formwork set-up
- Ramming in situ
- Retouching
- Finishing and protective works



Process C includes 1 2 4 5

Prefabrication with local earth

- More than 1000 m² of wall
- Over 400 km away from Schlins
- Built in local prefab site and LTE workforce

Process D includes 1 2 4 5 6 7

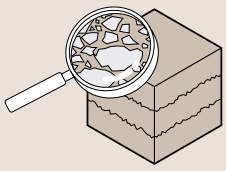
Prefabrication with local earth and local contractor

- More than 1000 m² of wall
- Over 400 km away from Schlins
- Built with local prefab site and local workforce

4. Recipe Development

To use earth from your own site, we must gather excavated material samples and create a recipe. In our experience, at least 50% of material from any site can be used. The package can include:

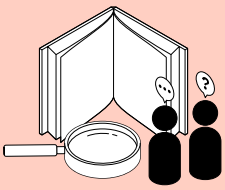
- Sampling material from site
- Developing recipe suitable for the project
- Producing test cubes
- Lab testing for compressive strength
- Report findings and recommendations



6. Feasibility Study

For international projects of a suitable scale, where our team will not be contracted for the construction, a feasibility study is needed. This research package offers a realistic understanding of how a rammed earth design can be executed within the local context, without risking an unachievable proposal at a later stage. The feasibility study involves:

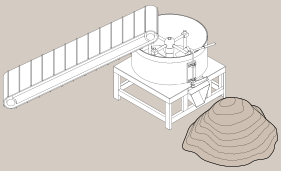
- Local material recipe
- Cost estimate for local context
- Logistical strategy
- Schedule proposal
- Regulatory compliance



5. Logistical Planning

Given the scale of the project is suitable, a local production site can be set-up to produce prefabricated rammed earth elements near to site with local material. Logistical planning can include:

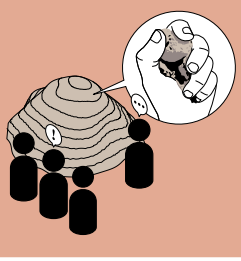
- Procuring an enclosed site
- Production site planning
- Inventory and material storage
- Logistical scheduling
- Material procurement
- Infrastructure set-up



7. Know-how Transfer

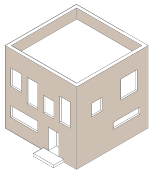
When our team is not contracted to produce the rammed earth, we can train local builders in the technique. Through in-depth workshops and on-site supervision, our specialists ensure a local builder has the understanding to deliver this and future projects. Know-how transfer involves:

- Training in mixing and recipe replication
- Rammed earth specific site management
- Equipment and machinery training
- Mock-up production
- Formwork setup
- Prefab wall assembly
- Retouching



Costing

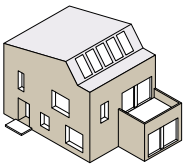
Costing rammed earth can be difficult because there is no such thing as a conventional rammed earth building. Each project requires a bespoke solution and LTE acts as a planner, a contractor, and a supplier. Positioning each design on a scale of production complexity helps determine the price.



Category 1

Complexity: Low

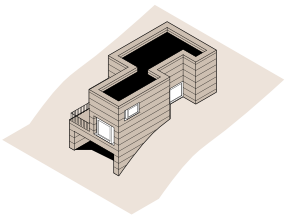
- Rectilinear design
- Internal rammed earth
- Regular openings
- Minimal corners
- Typical detailing
- ≤350 mm wall thickness
- Up to 2 storey
- Easy access to site



Category 2

Complexity: Moderate

- Rectilinear design
- Internal or external rammed earth
- Irregular openings
- Multi-storey
- 350 mm wall thickness
- Easy access to site
- Typical retouching and finishing



Category 3

Complexity: High

- Angular design
- External rammed earth
- Irregular openings
- Many openings
- Non-typical detailing
- Various wall thicknesses
- Artistic embellishment
- Difficult access to site
- Inlays and niches

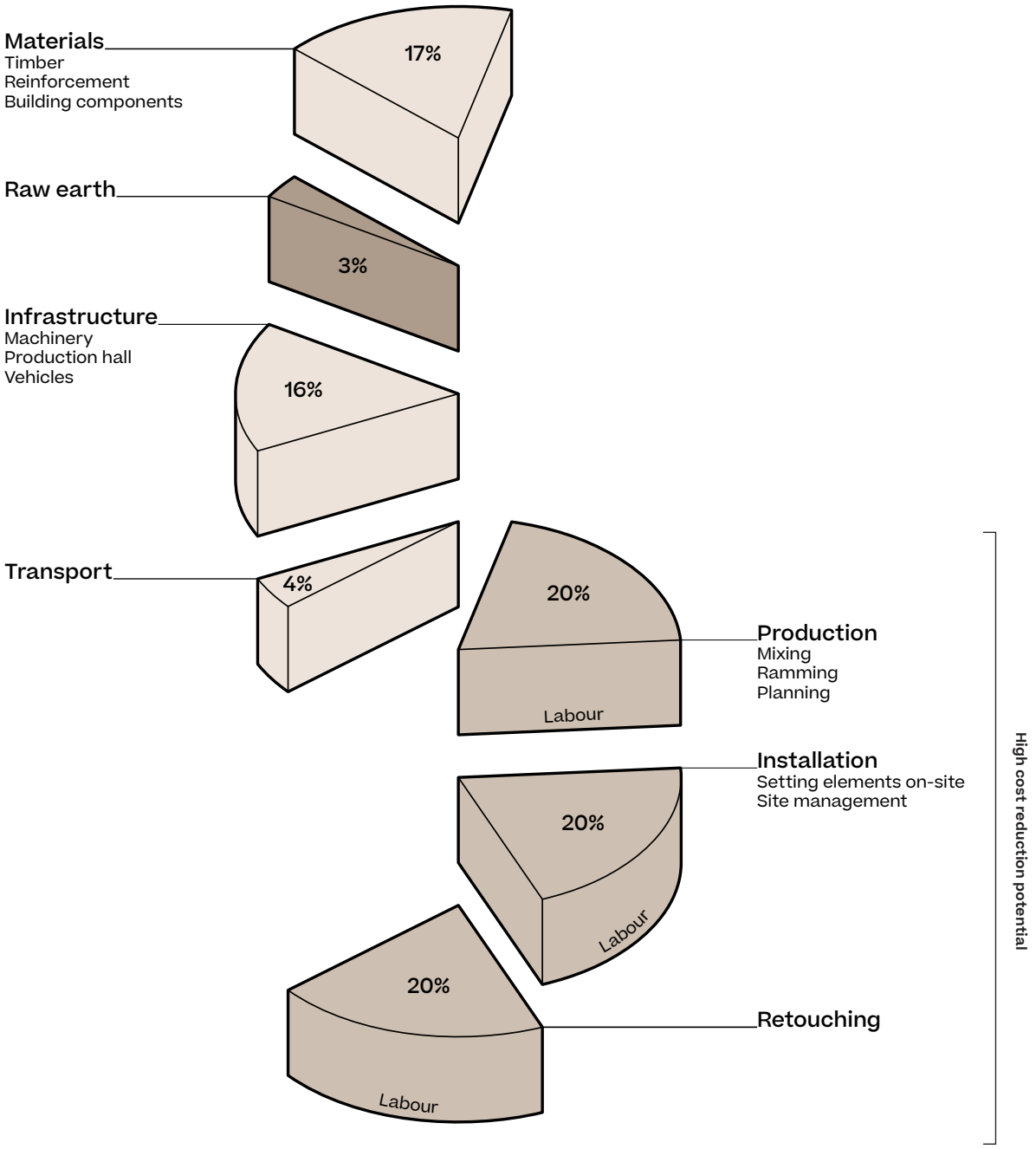
The Bottom Line

With the process identified and the design categorised, we can now give an indication of price. These numbers are a starting point and may fluctuate by ±25% for a proposal in the concept design stage. The prices include installation and retouching but don't include the rest of the wall construction such as insulation or plastering. Every project is accessed and priced individually. Projects that go through Process D are subject to local labour costs, available infrastructure, and other factors outside LTE's scope and, therefore, can't be priced with a general figure.

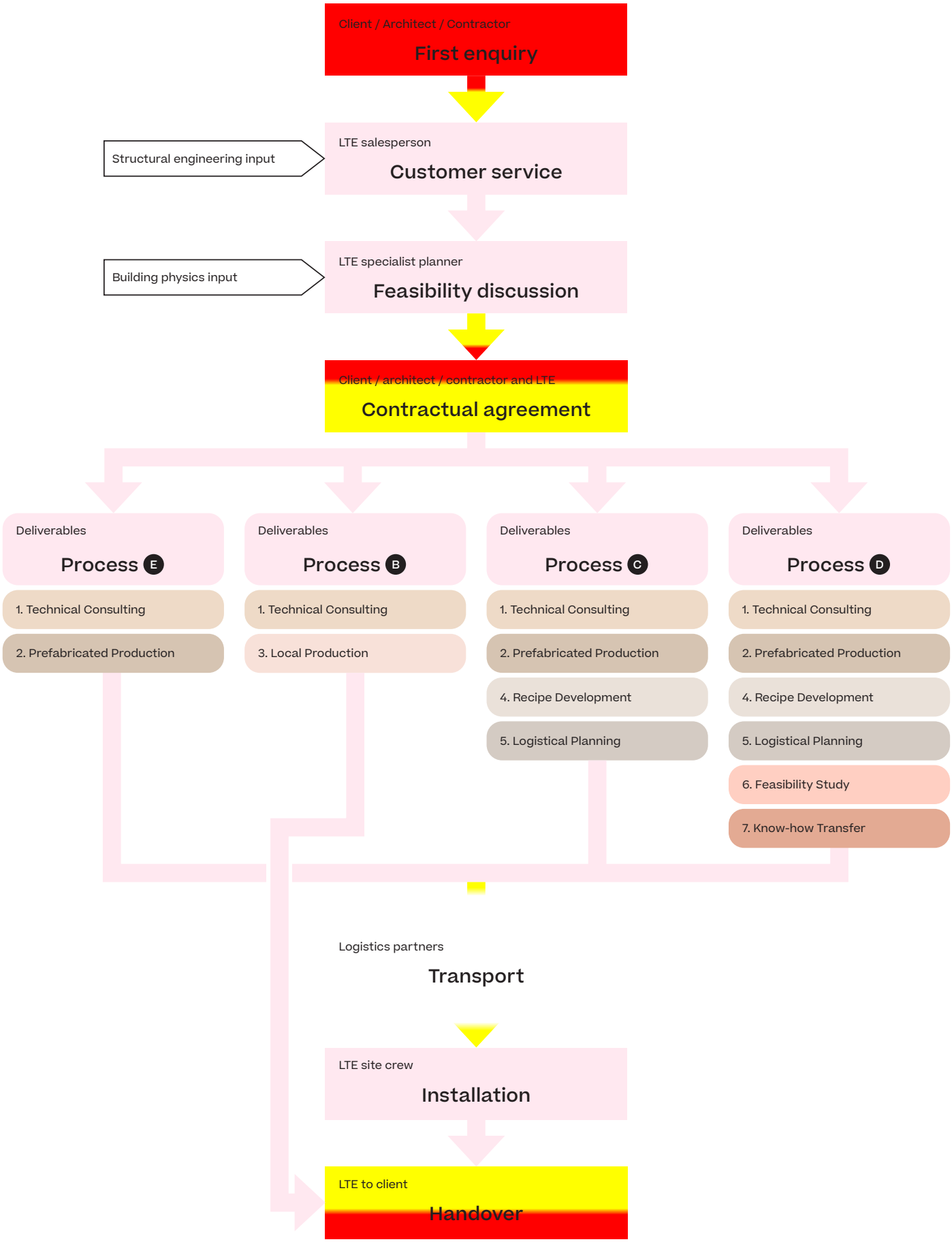
	Process A	Process B	Process C	Process D
Category 1	1000 €/m²	1200 €/m²	1500 €/m²	Context specific
Category 2	1400 €/m²	1600 €/m²	1900 €/m²	Context specific
Category 3	1800 €/m²	2000 €/m²	2300 €/m²	Context specific

Costing

The diagram below shows a breakdown of cost on a typical project. It has a prefabricated rammed earth façade produced in Schlins and installed on-site 35 kms away, corresponding to Process Ⓐ and Category ❷. Clearly, the raw material costs very little. The cost of labour, though, is where the majority of costs go and the biggest savings are made. Certain design choices will reduce manual labour and therefore reduce price. For instance, designing internal rammed earth walls that will be plastered over removes retouching work. Walls with square angles eliminate custom formwork inlays. Aligning facade openings allows for repetitive and faster production.



Project Overview

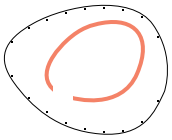


References: Structural Rammed Earth

Chapel of Reconciliation
Berlin, Germany (2000)

Construction
In situ, load-bearing walls with timber horizontal structure

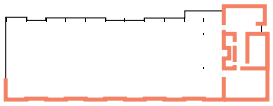
Planning processes
Process B & Category 2



Erden Werkhalle
Schlins, Austria (2023)

Construction
In situ & prefab load-bearing walls with timber horizontal structure

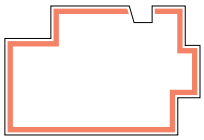
Planning processes
Process B & Category 2



Erden House
Schlins, Austria (2023)

Construction
Prefabricated, load-bearing walls with timber horizontal structure

Planning processes
Process A & Category 2

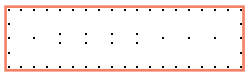


References: Façade

Ricola Herb Centre
Laufen, Switzerland (2012)

Construction
Prefabricated, self-bearing walls tied back to a concrete structure

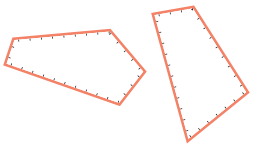
Planning processes
Process C & Category 1



Swiss Ornithological Institute
Schlins, Austria (2014)

Construction
Prefabricated, self-bearing walls tied back to steel structure

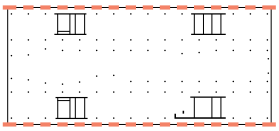
Planning processes
Process C & Category 2



Alnatura Campus
Darmstadt, Germany (2016)

Construction
Prefabricated, self-bearing walls tied back to a concrete structure

Planning processes
Process C & Category 3

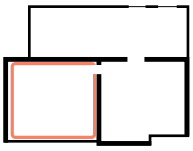


References: Internal Walls

Cinema Sil Plaz
Ilanz, Switzerland (2010)

Construction
In situ, self-bearing walls tied back to existing structure

Planning processes
Process B & Category 2



Atelier AHA
Männedorf, Switzerland (2022)

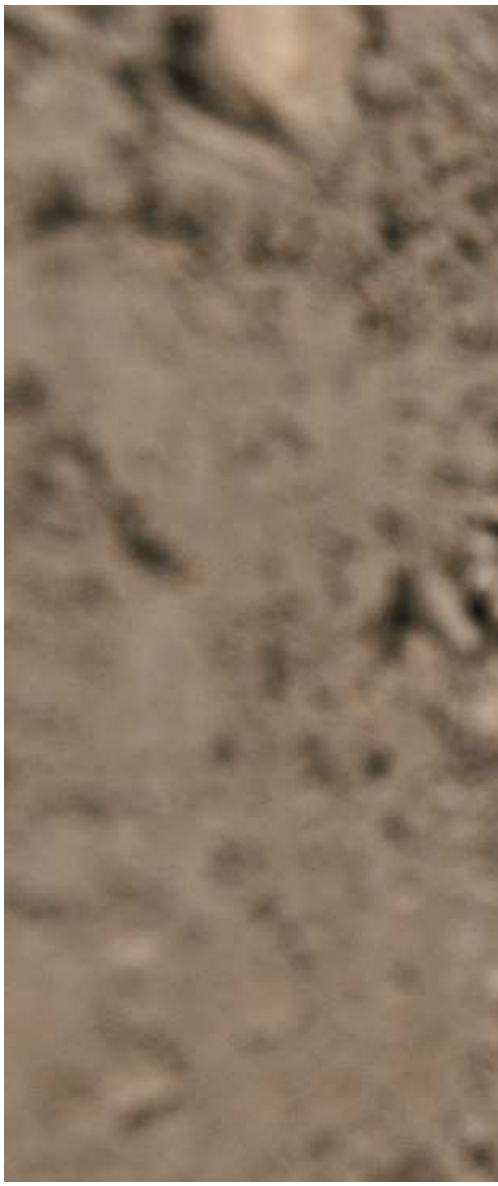
Construction
Prefabricated, self-bearing walls and heating stove

Planning processes
Process A & Category 2

Hotel Adler Spa
St. Ulrich, Italy (2022)

Construction
Prefabricated, self-bearing walls tied back to timber structure

Planning processes
Process A & Category 1



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