VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

FACULTY OF CIVIL ENGINEERING

DEPARTMENT OF CONSTRUCTION TECHNOLOGY AND MANAGEMENT

Student: Joan Ferrís Gimeno

Supervisor: Jonas Šaparauskas

Language – English

Daugiabučio gyvenamojo namo Trakų g. 14 Vilniuje rekonstrukcijos projektavimas
Reconstruction planning of the multi-dwelling residential building at Traku str. 14 in Vilnius

FINAL THESIS WORK

VILNIUS, 2013

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APPROVED

Head of Department:
Edmundas Kazimieras Zavadskas

Student: Joan Ferrís Gimeno

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Supervisor: Jonas Šaparauskas.....**date:** 2013.06.10

Consultant: Mykolas Daugevičius.....**date:** 2013.06.10

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DEPARTMENT OF CONSTRUCTION TECHNOLOGY AND MANAGEMENT

Study area: CIVIL ENGINEERING
Study program: CONSTRUCTION MANAGEMENT
Specialization: CONSTRUCTION TECHNOLOGY AND MANAGEMENT

APPROVED
Head of Department
(signature)
Edmundas K. Zavadskas
(name and surname)

THE TASK OF FINAL BACHELOR'S THESIS
.....No. .....
Vilnius

Student: *Joan FERRIS GIMENO*

The title of final thesis: *Reconstruction planning of the multi-dwelling residential building at Traku str. 14 in Vilnius*

Approved *by Dean's order No 296st*

The term of completion of the Thesis: *10 of June 2013.*

THE TASK OF FINAL THESIS

Initial information: architectural drawings.

Workbook
Architectural and Structural Part: describe characteristics of building under re-construction and building plot. Make calculation of steel beam and supports.
Technological and Organizational Part: compile technological cards of flooring works and rehabilitation of facade. Perform calculations of construction masterplan, compile schedule of whole re-construction process.
Economical Part: perform calculations of costs for both technological cards.

Drawings
Architectural part - 1 item; Structural part - 1 item; Technological cards - 3 items; Construction masterplan - 1 item; Construction schedule - 1 item.

Consultant of bachelor's final thesis: Assoc Prof Dr Mykolas Daugevičius Demolition of wall fragment on the first floor (axes B and between axes 3-4). Designer limited in demolished wall fragment. M. Daugevičius
(position, name and surname)

Supervisor ..... Assoc Prof Dr Jonas Šaparauskas
(signature) (given name and surname, academic degree and name)

I got the Task
.....
(signature)

Joan FERRIS GIMENO (name and surname)
2013-01-28
(date)

(the document of Declaration of Authorship in the Final Degree Project)

VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

Joan Ferris Gimeno, 20130115

(Student's given name, family name, certificate number)

Faculty of Civil Engineering

(Faculty)

Construction Management, STVf-09

(Study programme, academic group no.)

DECLARATION OF AUTHORSHIP IN THE FINAL DEGREE PROJECT

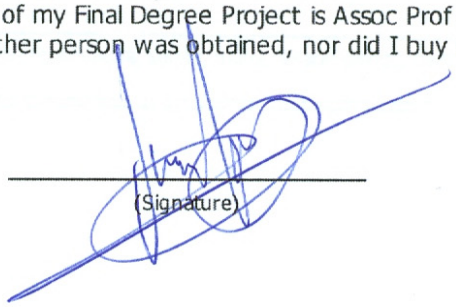
June 7, 2013

I declare that my Final Degree Project entitled „Reconstruction planning of the multi-dwelling residential building at Traku str. 14 in Vilnius" is entirely my own work. The title was confirmed on June 6, 2013 by Faculty Dean's order No. 296st. I have clearly signalled the presence of quoted or paraphrased material and referenced all sources.

I have acknowledget appropriately any assistance I have received by the following professionals/advisers: Assoc Prof Dr Jonas Šaparauskas.

The academic supervisor of my Final Degree Project is Assoc Prof Dr Jonas Šaparauskas.

No contribution of any other person was obtained, nor did I buy my Final Degree Project.



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Vilniaus Gedimino technikos universitetas
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Pirmosios pakopos studijų **Statybos valdymo** programos baigiamasis darbas 3

Pavadinimas **Daugiabučio gyvenamojo namo Trakų g. 14 Vilniuje rekonstrukcijos projektavimas**

Autorius **Joan Ferris Gimeno**

Vadovas **doc. dr. Jonas Šaparauskas**

Kalba: anglų

Anotacija

Šio baigiamojo darbo paskirtis yra " Daugiabučio gyvenamojo namo Trakų g. 14 Vilniuje rekonstrukcijos projektavimas ".

Baigiamasis darbas susideda iš keturių dalių:

- Architektūrinė dalis susideda iš trumpo rekonstruojamojo pastato aprašymo su pagrindinio fasado brėžiniais, vertikaliais ir horizontaliais pjūviais , sklypo geografinės padėties žemėlapiu kartu su dviem galutinėm pagrindinio fasado nuotraukomis po rekonstrukcijos.

- Konstrukcijų projektavimo dalis susideda iš vienos vidinės sienos modifikacijos. Šioje dalyje taip pat yra modifikacijos proceso aprašymas ir apskaičiavimai skirti išspręsti metalinės konstrukcijos matmenis apkrovos perdavimui.

- Techninė dalis, sudaro du darbai: skirtingos grindų dangos instaliacija, fasadų atkūrimo darbai.

- Organizacinė dalis: pagrindinio statybos plano aprašymas ir rekonstrukcijos tvarkaraštis.

Bakalauro baigiamasis darbas susideda iš:

Aiškinamoji dalis: 96 A4 lapai

Brėžiniai: 7 A1 lapai

Prasminiai žodžiai: Rekonstrukcija, reabilitacija, senas, mūro, fasado sienos, planavimas, pastoliai, darbo jėga, apdailos sluoksniai, kiemas

Vilnius Gediminas Technical University
Faculty of Civil Engineering
Department of Construction Technology and Management

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Bachelor Degree Studies **Construction Management** study programme Final Work 3

Title **Reconstruction planning of the multi-dwelling residential building at Traku str. 14 in Vilnius**

Author **Joan Ferris Gimeno**

Academic supervisor **Assoc Prof Dr Jonas Šaparauskas**

Thesis language:
English

Annotation

The purpose of this final work is the "Reconstruction planning of the multi-dwelling residential building at Traku str. 14 in Vilnius".

This final work consists of four parts:

- The architectural part, consists on a short description of the building under reconstruction with draws of the main facades, vertical sections, horizontal sections and a situation map of the plot coupled with two pictures with the final state of the principal facade after the reconstruction.

- The part of structural design, consists in a modification of one interior wall of the building. This part includes the description of the modification process and the calculations to dimensioning the metallic structure used to solve the load transmissions.

- Technological part. It consists about two different works: Installation of the different flooring types, Works in facades rehabilitation.

- Organization part: Description of Construction Masterplan and the Reconstruction scheduling.

The final thesis work consists of:

Explanatory text: 96 A4 pages

Draws: 7 A1 drawing

Keywords: Reconstruction, rehabilitation, old, masonry, facade wall, scheduling, scaffold, workforce, finishing layers, courtyard

1. ARCHITECTURAL PART

1.1 DESCRIPTIVE MEMORY

1.1.1 INTRODUCTION

This final thesis work will consist in the reconstruction of an old building in Vilnius (Lithuania), Traku Street 14. It will be an unusual analysis due to some reconstruction works were already done before the study by the company ARCHINOVA, from which I received the information and drawings about the reconstruction works.

Some of the solutions adopted about the machinery, structures and so on are done following the Spanish standards.

The Volumes of all buildings must be maintained as they were built in the end of nineteen century. Exterior facade decorations also remain as it was built at the beginning: Traku str. facade and northern courtyard housing facade are rendered and painted, all others are from yellow brick masonry. All vents of doors and windows are preserved. All building roofs are pitched covered with the red “S” type of clay tiles.

Surfaces:

- Lot area: 4948 m²
- Plot A, object of the restoration: 1873 m²

1.1.2 FIELD

The building is built together with another edification sharing a big backyard with two small edifications in the centre, the other part is used as a garden, parking and access to the plot. The area of all the plot is 4948 m², especially the area of our building is 1873 m². The shape is irregular and is composed by different rectangles with two neighbour buildings in both sides of Traku Street facade, with similar characteristics of our building. The back facades point to the backyards of another neighbour plots.

Traku street gate is used as the main access for all the workers and machinery because is the only gate of the whole plot. The characteristics of the works to be done allow to use the gate as a private access for the cars of the neighbour building as usual mode.

1.1.3 LOCATION

The plot is located in Traku Street, number 14, in the city of Vilnius (Lithuania). Buildings was built before the 1940s and they are in the old town of Vilnius. They are located at Vilnius old town territory – unique code 16073 (former code U1P) and at position of antique Vilnius city – unique code 2951. Plot containing reconstructed buildings is leased from the state, cadastral no. 0101/0041:135.

I included pictures of the aerial view (Figure 2, Figure 1) and some others about the state of the building before the company ARCHINOVA started with the reconstruction works (Figure 3, Figure 4, Figure 5, Figure 6).

Figure 2 . Aerial view of the plot obtained from Google Maps

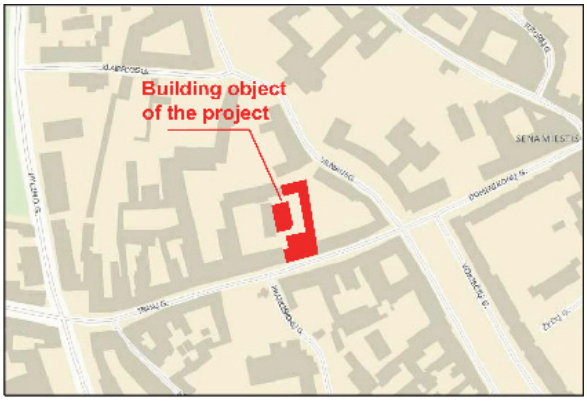


Figure 1 . Aerial view of the plot obtained from a Lithuanian web page

Figure 3 . Picture of the entrance of the work site during the works

Figure 4 . Picture of Traku street facade before the reconstruction works started

Figure 5 . Picture of the courtyard before the reconstruction works started

Figure 6 . Picture of the steel structure reinforcement for the reconstruction works

1.1.4 HISTORICAL OVERVIEW

Buildings at Traku str. 14 belongs to 28th block of Vilnius old town. Historically it has been a 395 possession. By the sixteen century there was no trace about former buildings, just known that large land tenure between Klaipėdos and Traku str. belonged to eminent GDL family – Radvilos. In XVI century at this tenure there was a palace that belonged to Radvila "the Black" and later to his son M.K. Radvila "the Thunder". In XVIII century palace was abandoned and the major part of tenure was divided into several parts. The part near Traku str. was devolved to merchant Matthew Kamsky. In Vilnius plan of 1808 no buildings are presented at the 395 possession.

In 1817 inventory material of the city recorded a big one-storey brick building near Traku Street. The possession in middle of XIX century was owned by Vigockiai, then to their heirs, and in the 1863 possession was acquired by Sofia Tiskeviciene, which in the end of nineteen century started forming new site constructions. Countess also owned the adjacent 394 possession. At that time in Traku Street, stood out wooden buildings with masonry walls beside the street base.

In 1886 the hostess of possession, Sofia Tiskeviciene, along with the tenant, merchant J. Segal, who was engaged in production of medicine and perfume, received a permission to demolish the wooden structures and in their place build a one-story brick building. In 1888 merchant J. Segal received a new permit to build a two-story building by the Traku Street, according to the project of architect K. Maciulevicius. At that time, courtyard bulks were built as well. These buildings still stand today.

Till the beginning to construct the building according to architect K. Maciulevicius project, part of basement was already build according previous project, which was adjusted. Up to the Soviet times all buildings at the site belonged to the representatives of the Tiskeviciu family and they were let by the same merchant J. Segal. At the post-war period and up to 2006 here was located the Pharmaceutical department of Ministry of Health.

Structures from post-war era wasn't repaired and has reached our days in the emergency state. Especially in poor conditions have been courtyard bulks – the former stables (one-storey building), triple part (eastern wing) and the bulk part (north building). Due to bad foundation, the backyard masonry walls were badly cracked, and they partly loosed inner connections (rotten floor).

1.1.5 TARGETS OF THE FIRST RECONSTRUCTIONS WORKS

In 2006 when A. Strolis purchased buildings, the research work began, which outcome, after preparation of project proposals and approval of conditions, in the formulation of technical project. The project was prepared by JSC "Menhyras", project manager S. Simelionis. Gained construction permit no. GR/660/07-0459, 2007-06-13

Upon of permit receipt, the reconstruction began. At that time mr. A. Strolis arbitrarily tore down part of the courtyard walls of authentic buildings (former stables). Which was obliged to restore in accordance with the ruins of measurements and fotofixation. Processing of the remaining buildings mr. A. Strolis received KPD Vilnius division consent, and he dismantled emergency northern two-storey building backyard wall, which was obligated to restore later.

Works during the reconstruction of JSC "Menhyras:

1) Demolished building walls (or parts) were restored: in place of the former stables using yellow bricks (three layer), the northern block of the southern wall was restored using red clay bricks (three layers).
2) The large part of the foundation was strengthened and enclosure of the base was made for eastern and northern wings.
3) Basement was installed under the whole west (former stables) building;
4) Monolithic intermediate floor were mounted in all structures, preserving the former wooden floor above the block of Traku str. second floor ceiling (instead of the gypsum mouldings).
5) Inner partitions and walls of the Soviet period were dismantled according to the initially approved project.
6) Authentic holes were uncovered at the basement of Traku street block and first floors.
7) Dismantled most of the windows and doors. New wooden windows were assembled at second floor of Traku str. block.
8) New wooden roof constructions were assembled at all blocks, most of the parapets and cornices were tin coated, roofs covered with clay tiles, part of storm water drainage system was installed.
9) Engineering system (ducts, racks, etc.) mounting works began.
10) Upper parts of north and east blocks post-sessional walls (firewalls) were re-bricked.
11) Traku street façade was re-plastered.
12) Part of new inner walls and partitions were bricked.
13) Blocks at Traku str. and of eastern stairwell separate marches were concreted over, including platforms.
14) Traku str. and eastern blocks stairs were concreted, including platforms.

15) “Velux” windows were installed.

In 2011 buildings were acquired by a new owner – JSC INTRACTUS – part of the previous work had to be urgently redone. Buildings stood for several years with unfinished roofs (part of the roof was covered only with wrap that tattered from atmospheric exposure) wooden structures were as well affected. Thus, when buildings were purchased by new owner, firstly all roofs were completely fixed, volumetric skylights, parapets, storm water drainage systems were installed.

1.1.6 DISTRIBUTION OF FLOORS

Traku str. block (Southern wing):

- Basement and first floor premises remain as in the original version for public space – cafes and/or stores.
- In the second floor, instead of former four apartments, three flats are designed in order to preserve and exhibit the historical door vents.
- The third floor, attic-storey floor, four apartments are designed as it was planned; just the layout is slightly adjusted.

Eastern wing: Three floors with an attic remains as it was before the reconstruction, only near the staircase room the glass elevator is included in the new design. Target solutions of the building are changing slightly.

- Thermal unit is installed in the basement along with staircase to it and underground collector for engineering networks.
- On the ground floor, as it was in the original version, three apartments and a workshop are designed.
- Former designed solutions of the second floor doesn’t change, two apartments with partial finishing are designed.
- At third and attic-storey floor apartment number doesn’t change – two apartments are designed through both storeys, just the layout of apartments is changing.

Northern wing: Two floors along with the attic are designed as the previous project with a total of 3 apartments, size remains the same as it was historically. In the planning sense the block layout had slightly changed, the layout of the attic changes vaguely.

West wing (former stables): The size of the building is completely restored at the first stage.

- At a basement section store rooms for each apartment are installed.
- In the building five apartments are designed through two floors.
- The layouts of flats at the attic-storey slightly changes from primary version.

The following drawing (Figure 7) is an example of how looks the shape of the original basement of the building with all the premises previously described.

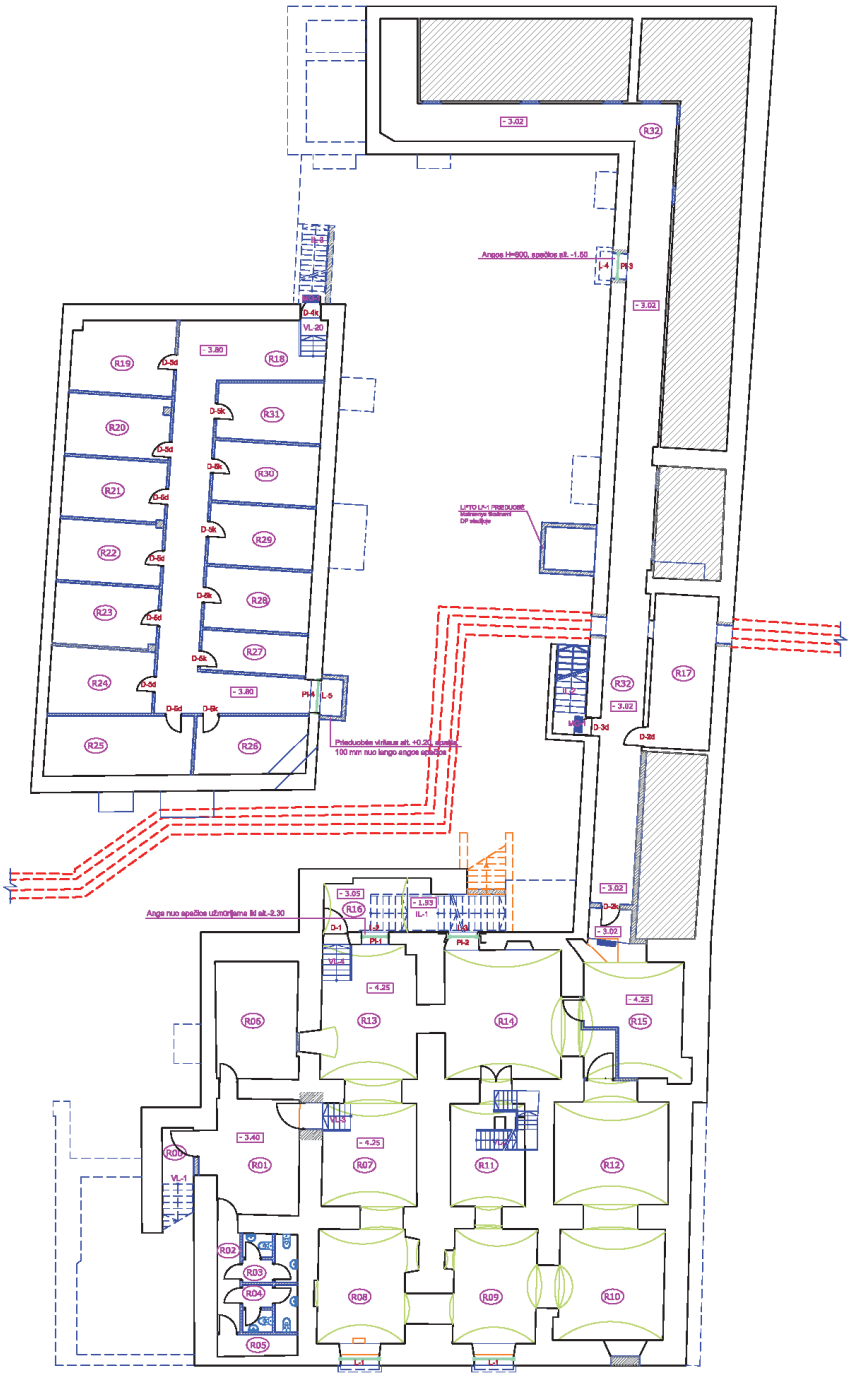


Figure 7 . Drawing of the Basement of the building

1.2 RECONSTRUCTION MEMORY

1.2.1 COLUMNS

There is no existence of columns in our building. The common structural system for old buildings to transmit the loads vertically is with load bearing masonry walls with short vains and sufficient thickness, in some of the walls of 90 cm.

1.2.2 WALLS

Only short descriptions are provided in the reconstruction files about the composition of the exterior walls. Comparing this information with the pictures is possible to difference two of them. First of all the brick yellow masonry walls in almost all the facades of the building and in the second option there is two plastered and painted brick walls in the façade of Traku street and in the courtyard facade of the northern wing.

1.2.3 SLABS

The only information available argues that was decided to preserve some of the old slabs of the south wing which state was sufficiently to load and resist with safely. In almost all the other areas included the staircases, the old slabs were changed for reinforced concrete slabs and metallic structures in some of the staircases, this works were part of the first phase of the reconstruction works done by the previous company from which the information is not provided.

1.2.4 INTERNAL WALLS AND PARTITIONS

Three different types of interior walls or partitions are described in the draws of the reconstruction works. First of all the old brick masonry walls, working as a load bearing walls. Following the description talk about the new brick masonry walls for the bathrooms and other wet areas, and finally the incorporation of plasterboard walls in a largely part of the building partitions.

1.2.5 PRIMARY DESIGNED RECONSTRUCTION WORKS (Volumetric – Target solutions)

During the reconstructions buildings were adjusted for accommodation purposes. Volumes of all buildings must be maintained as they were built in the end of nineteen century. Exterior facade decorations also remain as it was built at the beginning: Traku str. facade and northern courtyard housing facade are rendered and painted, all others are from yellow brick masonry. All vents of

doors and windows are preserved and all building roofs are pitched covered with the red “S” type of clay tiles.
Demolished and restored building parts also retain the former parameters and materiality (completed in the first stage). Areas and sizes of premises in attic-storeys and basement over the former house changes during the reconstruction.

Target solutions formulated in a version “A” slightly changes. 22 apartments are designed (was 25), one workshop, a public space at the basement of Traku str. block and café and/or shops in first floor.

According to customer's request, object will be passed on with partial indoor finishing, object must be equipped with:

- Windows, window sills, front doors (of apartments, public facilities).
- Partitioning surfaces (flats or public indoors) prepared for final finishing layer.
- Basics for floor finishing (apartments or public indoor spaces).
- Installed engineering systems that are functioning and meet the requirements;
- Apartments fitted with WC and sink, other engineering piping systems have to be closed or connected to equipment (devices).
- The works of engineering communications are performed in all the apartments: water supply and wastewater mounts, thermal appliances, electrical cables, low voltages.

1.2.6 SPECIFIC WORKS OF THE RECONSTRUCTION

1.2.6.1 Traku street block

Basement

- Historical slots in the basement are being exposed.
- Damaged brick walls and arches are restored.
- Ventilation chambers and water inlet supply facilities are formed.
- Historical window openings are disclosed and new wooden windows and external doors are mounted.
- Client’s request object has to be handed with partial interior trim, installed monolithic mixed concrete (steel and concrete) construction of an internal staircase and lower floor layers.
- Means of communication has to be adjusted.

- Sanitary partitions has to be bricked, rendered and screeded (all work has to be done to finishing layer).

Ground floor

- Street door vents are exposed (they were bricked over when reconstructions started).
- Endured plaster cornices and switches are protected.
- Main façade doors and metal bars are restored.
- According technical project the café kitchen premises are not formed, until particular owner or tenant is found, in pursuance to leave more space to adjust a specific purpose, and after it is installed according to separate project.
- Newly formed partitions are rendered and screeded; lower floor layers are fitted (before finishing).
- Stairwell from the first floor to the attic including both staircases to basement are fully mounted.
- Walls and ceiling are rendered, screeded and painted, floors and stair steps including stairwells are lined with stone tiles and metal rails (similar to courtyard block).

Second floor

- In order to make better use of existing facilities the two flats with terrace are designed to have staircases from courtyard side.
- In all three rooms of Traku str. side, authentic plaster cornices are saved. Plaster is protected in historical walls and discovered polychromatic historical painting fragments are exposed.
- New walls and partitions are rendered and screeded, floor layers are made to finishing layer.
- Communication lines are installed.
- Wooden windows with window sills and flat doors are installed, except for street side windows, second floor windows (mounted as first floor).
- Clinker tiles are laid out when all draining, insulation and equalizing layers are formed on the terrace.
- An outdoor staircase and terrace enclosure from black metal is installed.

Third floor

- All the finish of the floors, walls and ceilings are prepared to the top layer of the finish.
- Communications are mounted.

- Matching skylights “Velux” has already been installed at the initial stage, and volumetric windows with window sills are installed at the present stage and apartment doors are inserted.

1.2.6.2 Eastern wing

Basement

- Technical room is equipped with the finite finish: stone floor tiles, walls plastered and painted. Clinker tile stairs, black metal railings.
- Doors from the outside and to thermal unit are installed.

Ground floor

- Vestibules at the front doors are designed with partial finish; they will be completely designed when the particular owner appears, according to his requests (size and material).
- Finishing of apartments is performed similarly to the apartments described above.
- Wooden windows with the historic subdivision are fitted along with apartment doors.

Third floor (attic-storey floor)

- Apartments are made also with partial finishing.
- Staircases between these floors in flat space are not designed at this stage. They will be mounted separately after they will be purchased by particular host.

1.2.6.3 Northern wing

- On each floor one apartment is designed with partial finish.

1.2.6.4 West wing

- At a basement section storerooms for each apartment are installed.
- The of flats at the attic-storey are made with partial finishing
- Only temporary stairs are installed between floors until particular owner turns-up (they will be installed according interior solutions).

1.2.7 WORKS IN FACADES

Plaster of main facades at Traku str. block was fixed at the first stage, the second-floor windows changed as well. After trimming its plinths, façade is painted with silicate paint according resolution colour drawing prepared by author S.Simelionis. Courtyard facades with yellow cladded bricks, restorations takes place: renewed the damaged part of brick masonry with analogous bricks, facades are being washed with strong water jet, seams are re-fluted and coated with water-repellents.

Similarly the restorations of east wing eastern, western and northern facades are done. The masonry of east and north facades is fixed by stitching and injection method. The northern wing, of yellow clay bricks is handled analogically, as described above. Southern façade was re-bricked by the previous owner; it is plastered and covered with silicate paint.

The west wing (former stables) all facades were re-bricked by previous owner (S.Strol) with yellow clay bricks, according to historical former façade measurements. They have already been sorted out and at this stage will not be processed. At the courtyard part in front of any entrance the sites and stairways are designed, covered with clinker).

Glass roofs are planned for the stainless steel constructions. Historical building foundations are being repaired coated with mineral smeared flashing and breathing membrane.

Land moving work is carried out under the supervision of the archaeologist, according to the Lithuanian regulations:

PTR 2.13.01:2011 “Archaeological heritage management” regulations.

1.2.8 INSTALLATIONS

Water supply and sewerage

Projection of the building water supply facilities in the existing urban water supply networks. Domestic sewage water collected in PVC tubes and sewage discharged into urban sewage networks.

Heating

The building is connected medium pressure gas pipeline supply, the heating system is planned with radiators around all premises of the different buildings.

Electricity

Projected building is connected to an existing nearby transformer. Power consumption remains within the specifications issued.
At the cafe and store premises, engineering communications are installed (electricity, plumbing and sewage networks, thermal system, ventilation facilities, security and fire alarms), but premises will be completely designed when the particular owner appears, according to separate project.

1.2.9 ENVIROMENT

The building will be conditioned by the environment. Domestic wastewater is led to the current urban sewerage networks and treatment plants in the city. During all the works, the needs of the environment will be satisfied, being one of the most important issue.

The building has been designed to meet the environment standards, according to the Lithuanian regulations:

STR 2.01.01(3):1999 „Essential requirements of the building. Hygiene, health, protection of the environment “.

1.2.10 FIRE SAFETY

Fire safety part is not provided for the analysis of the project. The building has been designed to meet the Fire Safety standards, according to the Lithuanian regulations:

STR 2.01.01(2):1999 „Essential requirements of the building. Fire Safety“.

1.2.11 HABITABILITY

WC and kitchen are designed in all apartments with natural ventilation system. The building has been designed to meet the habitability standards, according to the Lithuanian regulations:

STR 2.01.01(3):1999 „Essential requirements of the building. Hygiene, health, protection of the environment “.
STR 2.01.01(5):2008 „Essential requirements of the building. Protection against noise “.
STR 2.01.01(4):2008 „Essential requirements of the building. The safety of use “.

1.2.12 INSOLATION

Apartment spaces have normative amount of insolation. The building has been designed to meet the Energy requirements standards, according to the Lithuanian regulations:

STR2.01:01(6):2008„Essential requirements of the building. Energy conservation and heat retention “.

1.2.13 DISABILITY NEEDS

Public spaces are planned only at in premises located near the Traku Street, where cafes and shops have to be established. Since building was built in the end of nineteen century all slots were formed to ensure the ability for disabled people to access first floor premises. It is planned to form a sidewalk near the central door so that the stage will be only 2 cm above.
Two-leaved doors restored at this part can’t be changed to single doors due to the monument conservation regulations.

Height declension is not expected at the indoors of the first floor level. One of the bathrooms is provided for people with disabilities. The installation of a lift to Traku street block basement or other floors is not possible.

At the eastern courtyard wing lift is projected which have access to all floors also for people with disabilities. At this wing of the building apartment’s door opening width is 1050mm in normal doors and bathroom – 920mm, adjusted for people with disabilities. The building has been designed to meet the disability needs requirements standards, according to the Lithuanian regulations:

STR 2.02.02:2004 „ Public buildings “.
STR 2.02.01:2004 “Residential Buildings”.

1.2.14 CAR PARKING

According to the technical project, for which the building permit is received no. GR/660/07-0459 (2007-06-13), the constructions of parking spaces in the yard or under the buildings are not provided (lack of technical ability).

1.2.15 LIFT AND ELEVATORS

As was said before an elevator is projected in the eastern wing of the courtyard which have access to all floors also for people with disabilities. Specifically a Schindler 5400 630 VF100 1T90 lift with the EC type-approval certificate. The as the next picture (Figure 8) shows elevator is installed with a metallic and glass structure located in the courtyard.

Figure 8 . Picture of the courtyard elevator after reconstruction works

2. STRUCTURAL PART

2.1 PRUPOSE OF THE STRUCTURAL PART

The purpose of this technological card is analyse and calculate modification in one of the interior walls of the building through the use of a portico metallic structure formed by Channel and Column steel profiles.

All the structural part is done following the Spanish legislation and the knowledge obtained in my home university, the sections of the charts used to get the different coefficients are provided together with the calculations.

2.2 STUDY OF THE MODIFICATION

Thee wall object of the modification is part of the ground floor of the Traku Street block, specifically is located between the between axes 3-4 as show the picture (Figure 9) of the horizontal section. Is placed in a public area supposed to be a coffee-bar (premises 106/107). Also is important to know that the premises situated above the wall that we are going to care about later for the load analysis are bedrooms (premises V-8/T-7/S-5), one workroom (premises V-7) and one WC (premises T-8).

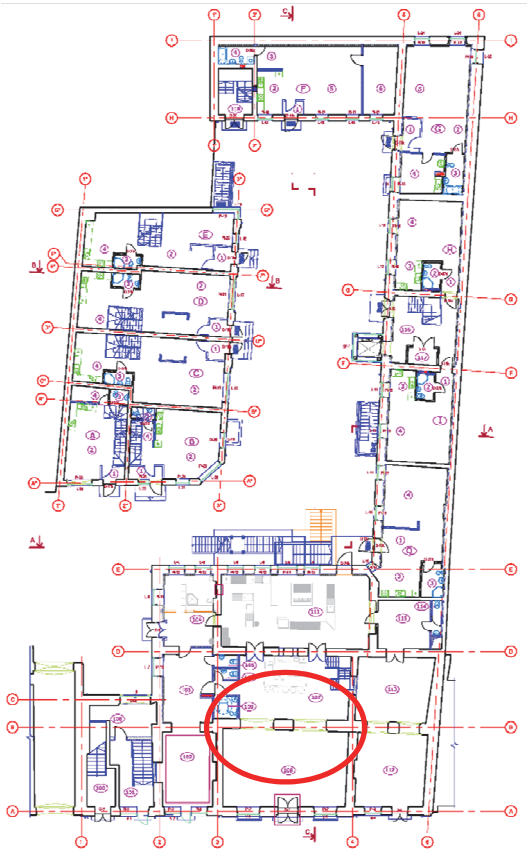


Figure 9 . Positioning of the wall object of the modification in the horizontal section of the ground floor

The main purpose of the modification is to connect the both door openings removing the wall between them to connect the areas separated by the wall and make an open space in the bar and facilitate the client's attention. A graphical description is represented in the following draws (Figure 10, Figure 11).

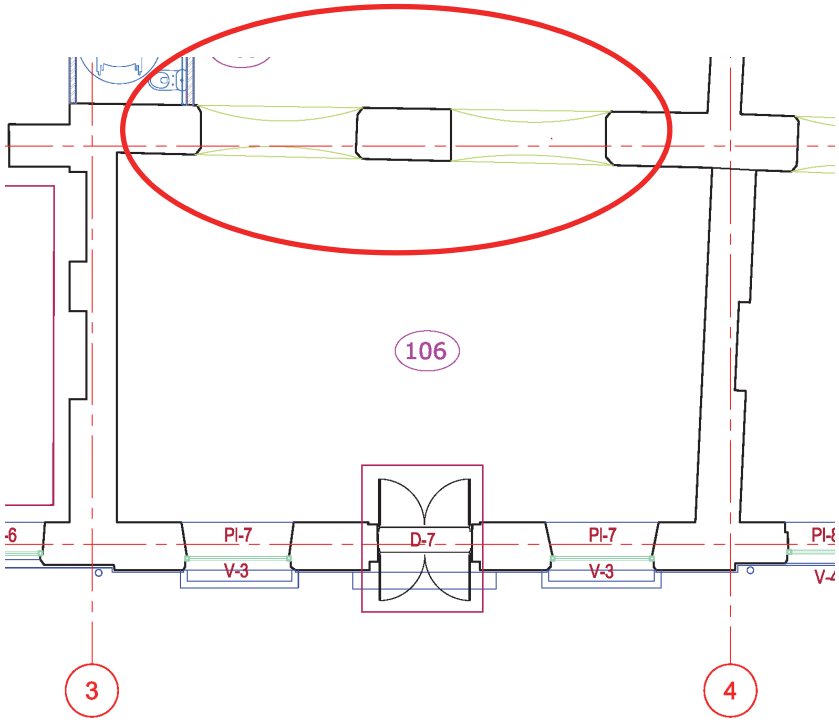


Figure 10 . Original Wall

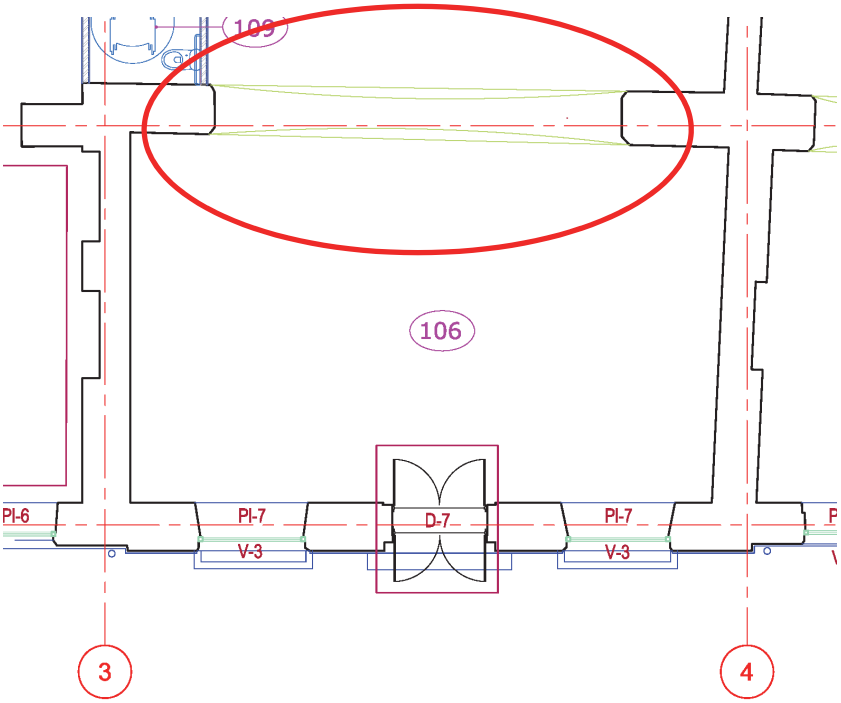


Figure 11 . Objective of the modification

2.3 DESCRIPTION OF THE WORKS

1) The works starts with the analysis of the wall and the calculations to dimensioning the metal profiles to be used.
2) Mark the axes to place the supports of the portico in both sides of the wall and make the whole for the foundation of the portico.
3) Make the recess in one of the side of the wall to place the two supports of the portico.
4) Make the whole for the foundation of the portico. Is supposed that the flooring restorations part of the rehabilitation works. So this space can be considered at the same time.
5) Make a foundation with a pedestal which is supposed to be at the same level of the cement mortar layer (last levelling layer of the flooring).
6) Placement the two supports of one side and weld to connect both supports to the sole plate of the pedestal. (The same process until here will be repeated in the other side of the wall).
7) With the supports ready is time to follow the same process in both sides with the lintels, making the recess in one side and placing the metallic profiles and screwing to connect the beam with the supports.
8) The last step is performed because of the large width of the wall, this one consist on make holes alternately and setting a profiles placed perpendicular to the direction of the portico, connected to the lintels by welding and filled by concrete to guarantee the correct transmission of the loads to the portico. It's important to specify that for this purpose I'm going to use UPN-300 steel profiles, this is not calculated together with the structure but is important to know the selected size.
9) Once the portico is finished is possible to remove the wall between the supports, carefully from the centre to the both sides at the same time to ensure that structure is not put under stress.

*Information: A description video is provided as graphic example by the University of Oviedo (Ingedix Diseño 2011) of how to make the process for openings in load bearing masonry walls of all buildings as in our case with some variations compared with my description.

2.4 METALLIC PROFILES AND PIECES PART OF THE STRUCTURE

The next figure (Figure 12) represents all the metallic profiles and plates used to perform the new metallic structure for the modification of the wall

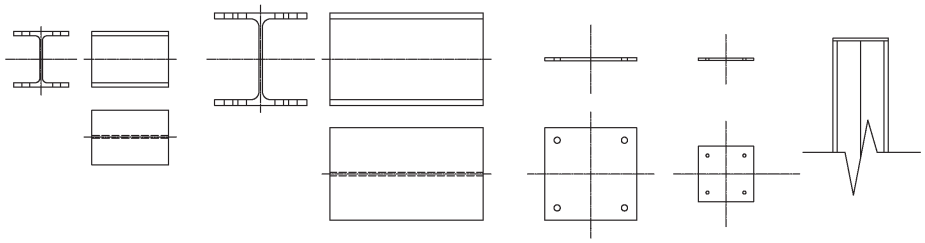


Figure 12 . Different profiles and plates used

2.5 BASES OF CALCULATIONS

Through the design and execution of a metal structure, it is intended that this remain suitable for the required use with acceptable safety. For this, the structural testing of a building requires:

- Consider sizing situations that are decisive.
- Set the actions to be considered and appropriate models for the structure.
- Perform structural analysis.
- Verify that, for appropriate sizing situations, the limit states are not exceeded.

2.5.1 CALCULATION RESISTANCE OF THE STEEL

The next chart (Figure 13) specifies the mechanic characteristics of the different steels depending on the type of steel and the thickness "t" of the plates that form the profiles.

Norma Standard Norma	Calidades Grades Tipi	Límite elástico mínimo R_{eH} Minimum yield strength R_{eH} Limite elastico minimo R_{eH} MPa. Espesor nominal (mm) Nominal thickness (mm) Spessore nominale (mm)						Resistencia a la tracción R_m Tensile strength R_m Resistenza alla trazione R_m MPa. Espesor nominal (mm) Nominal thickness (mm) Spessore nominale (mm)		Alargamiento mínimo A Minimum elongation A Allungamento minimo A $L_0 = 5{,}65 * \sqrt{S_0}$ %. Espesor nominal (mm) Nominal thickness (mm) Spessore nominale (mm)				Ensayo de flexión por choque Notch impact test Prova di resilienza	
		≤16	>16 ≤40	>40 ≤63	>63 ≤80	>80 ≤100	>100 ≤125	>3 ≤100	>100 ≤125	>3 ≤40	>40 ≤63	>63 ≤100	>100 ≤125	Temperatura Temperature Temperatura °C	Energía mín. absorbida Min. absorbed energy Energia min. assorbita J
EN 10025-2: 2004	S235JR	235	225	215			195	360-510	350-500	26	25	24	22	+ 20	27
	S235J0													0	27
	S235J2*													-20	27
	S275JR	275	265	255	245	235	225	410-560	400-540	23	22	21	19	+ 20	27
	S275J0													0	27
	S275J2*													-20	27
	S355JR	355	345	335	325	315	295	470-630	450-600	22	21	20	18	+ 20	27
	S355J0													0	27
	S355J2													-20	27
	S355K2													-20	40
	S450J0	450	430	410	390	380	380	550-720	530-700	17				0	27
	E295*	295	285	275	265	255	245	470-610	450-610	20	19	18	16		
	E335*	335	325	315	305	295	275	570-710	550-710	16	15	14	12		
	E360*	360	355	345	335	325	305	670-830	650-830	11	10	9	8		

Figure 13 . Extract from Table 7 of EN 10025-2

2.5.2 CALCULATING RESISTANCE f_{yd}

Calculating resistance is defined as the quotient between the limit tensile and the material safety coefficient.

$f_{yd} = f_y/\gamma_M$ (γ_M= partial safety coefficient for material)

In this case, with the indications of the supervisor, I'm going to give the value of 1,15 for γ_M.

2.5.3 COMMON CHARACTERISTICS OF THE STEEL

Tensile modulus: E = 210.000 N/mm2

Rigidity modulus: G = 81.000 N/mm2

Poisson's ratio: ν = 0,3

Coefficient of thermal expansion: $\alpha = 1{,}2 \cdot 10^{-5}\ (^oC)^{-1}$

Density: ρ = 7.850 kg/m3

2.5.4 CALCULATION METHODS, STEEL

The methods for testing the various limit states are classified from two points of view:

For the simplified diagram to idealize the behaviour of the material (Figure 14)

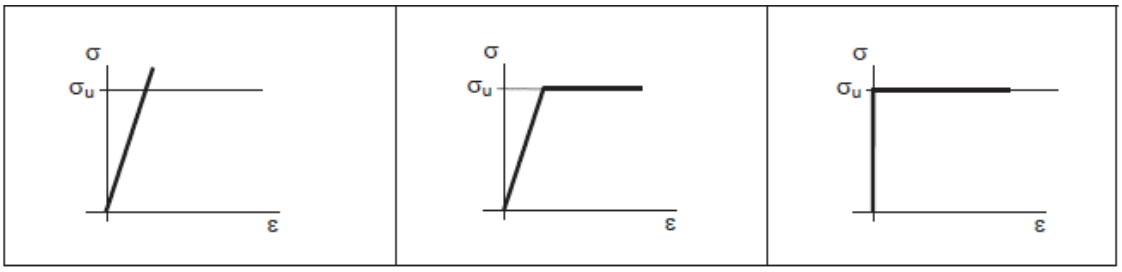


Figure 14 . Elastic, Rigid-Plastic and Elastic-Plastic behaviours of the materials

By the influence of the deformation on the actions

- First order analysis: Neglecting the influence of the deformations and raising the balance in the un-deformed geometry.
- Second order analysis. Considering that deformations modify the effect of actions and considering the balance on the deformed structure.

The suitable method should combine the simplicity of the process, with the results precision required. In this sense, **I use elastic methods, with linear behaviour of the structure, after a first-order analysis of the structure.**

2.5.5 TYPES OF SECTIONS

The thinness of the plates that make up the metal profiles, modify their behaviour by instability phenomena in the section resistance and global analysis of the structure.

In this sense the DB SE-A (Figure 15) considers four types of cross sections. The evaluation of the cross-section and member resistances is based on a classification system; four different types are identified according to the risk of early or late appearance of plate buckling phenomena in the constitutive cross-section walls subjected to compression. The specific level of resistance (plastic, elastic or even lower than elastic) varies according to this classes (Figure 16).

Chart 5.1. Effects of local buckling, classification by cross sections	
Class 1: Plastic	Cross-sections are those which can form a plastic hinge with the rotation capacity required from plastic analysis without reduction of the resistance.
Class 2: Compact	Cross-sections are those which can develop their plastic moment resistance, but have limited rotation capacity because of local buckling.
Class 3: Semi-compact	Cross-sections are those in which the stress in the extreme compression fibre of the steel member assuming an elastic distribution of stresses can reach the yield strength, but local buckling is liable to prevent development of the plastic moment resistance.
Class 4: Slender	Cross-sections are those in which local buckling will occur before the attainment of yield stress in one or more parts of the cross-section.

Figure 15. Description of the four types of sections. Chart 5.1 DB SE-A

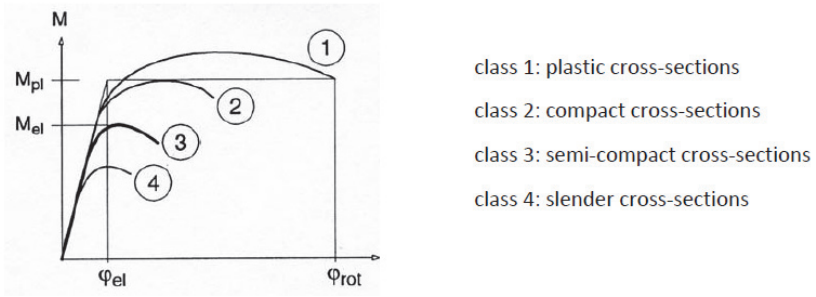


Figure 16 . Moment-rotation curve depending on cross-section classes 1 to 4

For verification of structural safety should use one of the calculation methods defined of the DB SE-A (Figure 17), in accordance with the class of cross sections.

Chart 5.2 Calculation methods		
Type of section	Methods to determine the solicitations	Methods to determine the resistance of the sections
Class 1: Plastic	Plastic or Elastic	Plastic or Elastic
Class 2: Compact	Elastic	Plastic or Elastic
Class 3: Semi-compact	Elastic	Elastic
Class 4: Slender	Elastic with possible reduction of rigidity	Elastic with reduced resistance

Figure 17 . Calculation methods according to the cross section class Chart 5.2 DB SE-A

As can be seen, this classification influences in the plastic analysis, because any section can be checked by elastic methods, in which case the type only indicates when you should take into account the local buckling , type 4.

Models of stress distribution in pure bending (Figure 19, Figure 18):

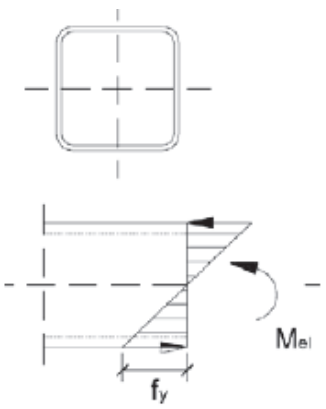


Figure 19 . Type 1 and 2, Pástic analysis

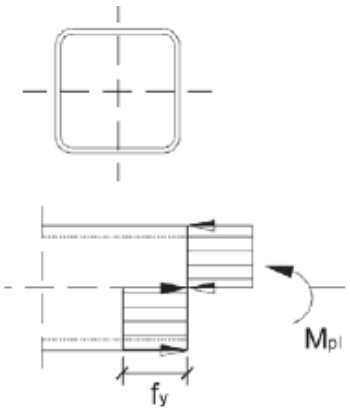


Figure 18 . Type 3, Elastic analysis

2.5.6 SIMPLIFICATIONS FOR THE CALCULATION OF STEEL STRUCTURES TAKEN INTO ACCOUNT FOR THE CALCULATIONS

Type of Steel: S-275

Tensile limit: f_y= 265.000 N/mm2 (16 ≤ t ≤40)

Calculating resistance: $f_{yd} = \frac{f_y}{\gamma_m} = \frac{265}{1{,}15} = 230{,}43\ \frac{N}{mm^2} = 23{,}04\frac{kN}{cm^2}$ $\boldsymbol{formula\ (1)}$

Calculating Method: 1st order of linear analysis

Elastic Methods

From the safety point of view, is a safe option for the classes 1, 2 and 3, the application of criteria based on elastic distribution of stresses and checking exhaustion according to Von Misses failure criterion.

2.6 LOADS ANALYSIS

In this section I'm going to analyse all the loads that may affect or be transmitted by the area of the wall that we want to remove, because of the characteristics of the modification and the planned solution this load is considered as the sum of three different resultants: weight of the flooring layers, load of the walls above, the loads of the transversal profiles and the overload for utility.
The considered area that may transmit the loads to our metallic structure is 49,86 m² (Figure 20), this area was obtained creating a rectangular shape around the wall, the resultant surface is considered greater than the actual area which concern to that wall.

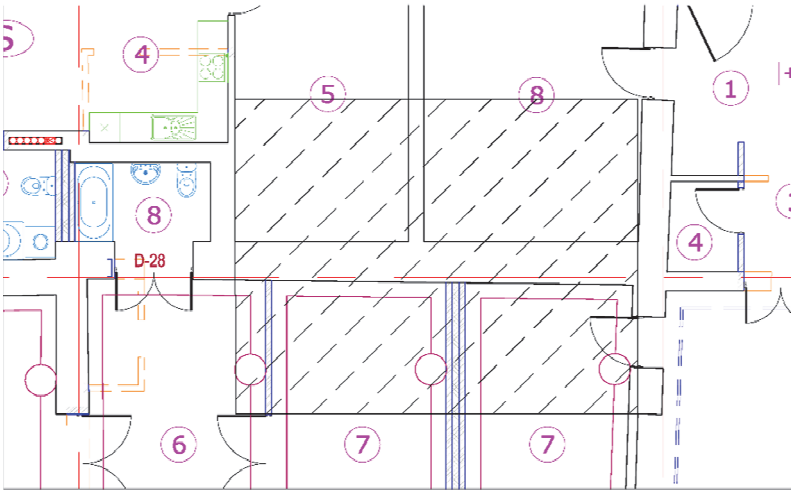


Figure 20 . Considered Load area of the second floor

2.6.1 FLOORING LAYER ANALYSIS

The only layer of flooring different between the rooms above (floor for residential and public areas – floor for wet areas) is the waterproof layer. In this case I'm going to compute the weight of this layer in all the flooring, supposing an insignificant difference.

–	Concrete Slab (H = 300 mm) =	2500 Kg/m³ · 0,3 m =	750,00 Kg/m²
–	Cement Sand mortar (H = 60 mm) =	380 Kg / m³ · 0,06 m =	22,80 Kg/m²
–	Armoured network for cement =		2,05 Kg/m²
–	Glasswool (H = 20 mm) =	22 Kg / m³ · 0,02 m =	0,44 Kg/m²
–	Levelling Sand (H = 50 mm) =	60 Kg / m³ · 0,05 m =	3,00 Kg/m²
–	Flooring Tiles (H = 20 mm) =	2400 Kg / m³ · 0,02 m =	48,00 Kg/m²

- Cement adhesive = 3,00 Kg/m²
- Waterproofing layer (X2, painted) = 0,70 Kg/m²

Total load of flooring (Kg) = 829,99 Kg/m² · 49,86 m² = **41383,30 Kg**

2.6.2 LOADS OF THE WALLS BELOW

The space occupied by the new metallic transversal profiles is not subtracted from the total area. This consideration will help to increase the weight and the safety factor in case of overload.

- Area of wall directly above the beam = 5 m · 0,55 m · 0,9 m = 2,48 m³
- Superior floor wall = 5 m · 3,68 m · 0,9 m = 16,56 m³

Wall of solid ceramic brick and lime mortar = 1500 Kg/m³

Total load of walls (kg) = 1500 Kg/m³ · 19, 04 m³ = **28560 Kg**

2.6.3 LOADS OF THE TRANSVERSAL PROFILES

The function of this profiles is the proper transmission of the loads to the beam, to perform this role is necessary to fill the profiles with Concrete composing a kind of transversal mixed beams.

- UPN – 300 (46,2 Kg/m): 12 profiles · 0,84 m · 46,2 Kg/m = 465,70 Kg
- Concrete filled (380 Kg/m³): 380 Kg/m³ · 0,024 m² · 12 profiles · 0,9 m = 98,496 Kg

Total load of transversal profiles (Kg) = **564,20 Kg**

2.6.4 UTILITY LOADS

Overloads considering the use of the rooms above the walls.

Bedrooms:	2 kN/m²
Office:	2 kN/m²
Kitchen:	2 kN/m²
Bathroom:	2 kN/m²

Total utility overload (Kg) = 200 Kg/m² · 49,86 m² = **9972 Kg**

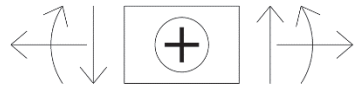
2.6.5 TOTAL SUM OF THE LOADS

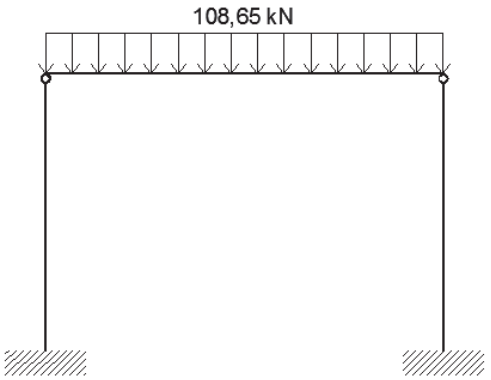
41383,30 Kg + 28560 Kg + 564,20 Kg + 9972 Kg = 80479,50 Kg

80479,50 (Kg) / 5 (m) = 16095,90 Kg/m

16095,90 (Kg/m) / 2 (porticos) = 8047,95 Kg/m = 80,48 kN/m

2.7 ANALYSIS OF THE FORCES

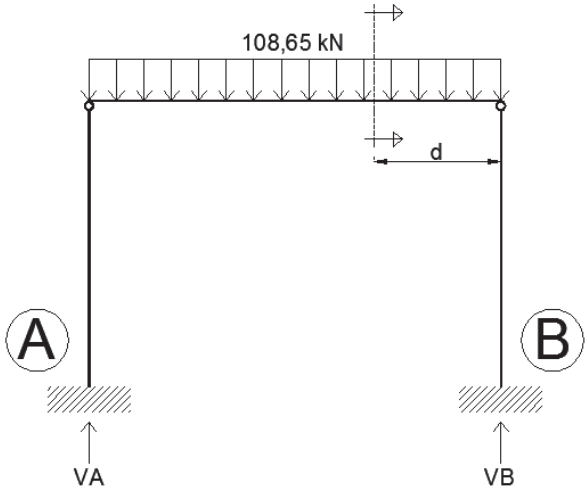




Steel type S-275, $f_y = 265\ N/mm^2$

$\gamma_g = 1{,}35$ (Safety coefficient for permanent loads)

$$L_g = 80{,}48 \cdot 1{,}35 = 108{,}65\ kN$$



$$\Sigma F_H = 0$$

$$\Sigma F_V = -108{,}65 \cdot 5 + V_A + V_B = -543{,}25 + V_A + V_B$$

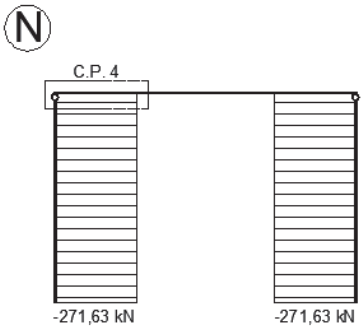
$$V_A = 543{,}25 - V_B$$

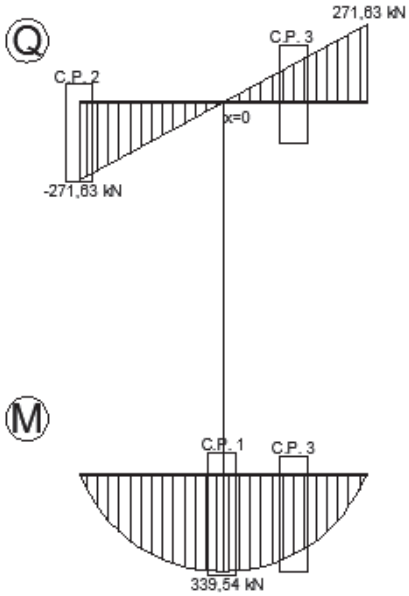
$$\Sigma M_A = 0 = 108{,}65 \cdot 5 \cdot 2{,}5 - V_B \cdot 5 = 1358{,}13 - 5V_B$$

$$V_B = \frac{-1358{,}13}{-5} = 271{,}63\ kN$$

$$V_A = 543{,}25 - 271{,}63 = 271{,}63$$

2.8 GRAPHICS





$$T_{(x=0)} = -108{,}65 \cdot d + 271{,}63 = 0$$

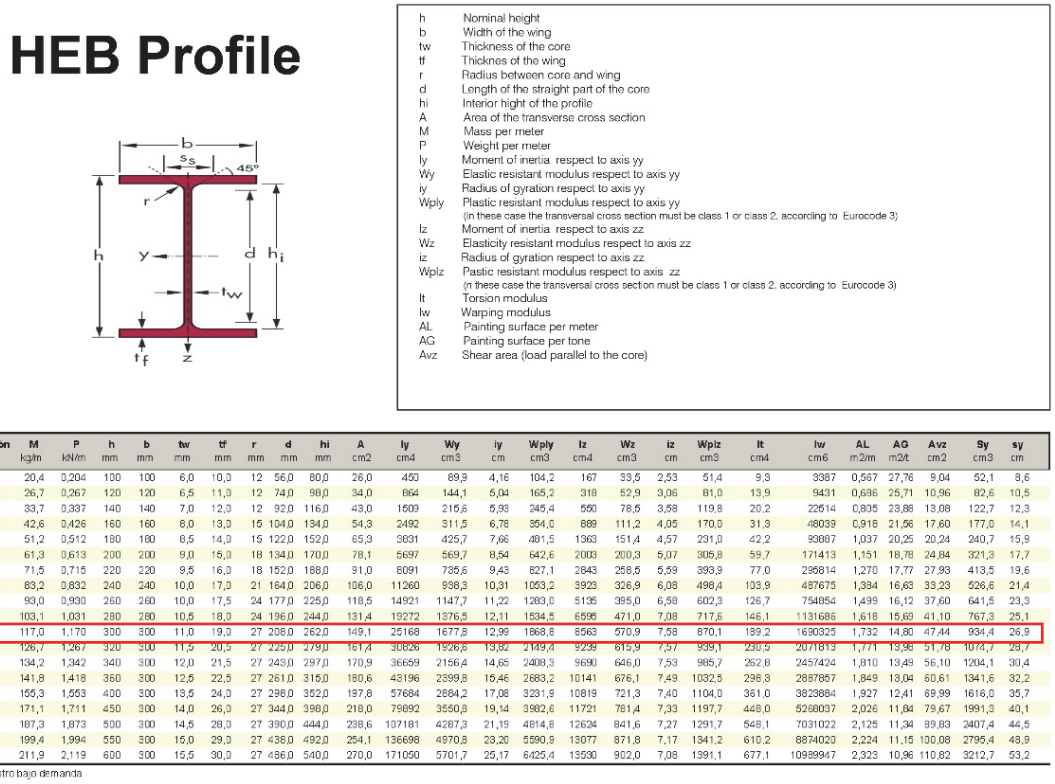
$$d = \frac{-271{,}63}{-108{,}65} = 2{,}50\ m$$

$$M_B = -108{,}65 \cdot x \cdot \frac{x}{2} + 271{,}63 \cdot x = 339{,}54\ kN$$

2.9 TEST OF COMPUTATIONAL EFFORTS IN CRITICAL POINTS

2.9.1 HEB METALLIC PROFILE CHART USED FOR THE TESTING

The next chart (Figure 21) is used to find the characteristics of the HEB profiles during the calculations



Designacion	M kg/m	P kN/m	h mm	b mm	tw mm	tf mm	r mm	d mm	hi mm	A cm2	Iy cm4	Wy cm3	iy cm	Wply cm3	Iz cm4	Wz cm3	iz cm	Wplz cm3	It cm4	Iw cm6	AL m2/m	AG m2/t	Avz cm2	Sy cm3	sy cm
HEB 100	20,4	0,204	100	100	6,0	10,0	12	56,0	80,0	26,0	450	89,9	4,16	104,2	167	33,5	2,53	51,4	9,3	3387	0,567	27,76	9,04	52,1	8,6
HEB 120	26,7	0,267	120	120	6,5	11,0	12	74,0	98,0	34,0	864	144,1	5,04	165,2	318	52,9	3,06	81,0	13,9	9431	0,686	25,71	10,96	82,6	10,5
HEB 140	33,7	0,337	140	140	7,0	12,0	12	92,0	116,0	43,0	1509	215,6	5,93	245,4	550	78,5	3,58	119,8	20,2	22514	0,805	23,88	13,08	122,7	12,3
HEB 160	42,6	0,426	160	160	8,0	13,0	15	104,0	134,0	54,3	2492	311,5	6,78	354,0	889	111,2	4,05	170,0	31,3	48039	0,918	21,56	17,60	177,0	14,1
HEB 180	51,2	0,512	180	180	8,5	14,0	15	122,0	152,0	65,3	3831	425,7	7,66	481,5	1363	151,4	4,57	231,0	42,2	93887	1,037	20,25	20,24	240,7	15,9
HEB 200	61,3	0,613	200	200	9,0	15,0	18	134,0	170,0	78,1	5697	569,7	8,54	642,5	2003	200,3	5,07	305,8	59,7	171413	1,151	18,78	24,84	321,3	17,7
HEB 220	71,5	0,715	220	220	9,5	16,0	18	152,0	188,0	91,0	8091	735,6	9,43	827,1	2843	258,5	5,59	393,9	77,0	295814	1,270	17,77	27,93	413,5	19,6
HEB 240	83,2	0,832	240	240	10,0	17,0	21	164,0	206,0	106,0	11260	938,3	10,31	1053,2	3923	326,9	6,08	498,4	103,9	487675	1,384	16,63	33,23	526,6	21,4
HEB 260	93,0	0,930	260	260	10,0	17,5	24	177,0	225,0	118,5	14921	1147,7	11,22	1283,0	5135	395,0	6,58	602,3	126,7	754854	1,499	16,12	37,60	641,5	23,3
* HEB 280	103,1	1,031	280	280	10,5	18,0	24	196,0	244,0	131,4	19272	1376,5	12,11	1534,5	6595	471,0	7,08	717,6	146,1	1131686	1,618	15,69	41,10	767,3	25,1
* HEB 300	117,0	1,170	300	300	11,0	19,0	27	208,0	262,0	149,1	25168	1677,8	12,99	1868,8	8563	570,9	7,58	870,1	189,2	1690325	1,732	14,80	47,44	934,4	26,9
* HEB 320	126,7	1,267	320	300	11,5	20,5	27	225,0	279,0	161,3	30826	1926,6	13,82	2149,8	9239	615,9	7,57	939,1	230,5	2071813	1,771	13,98	51,78	1074,7	28,7
* HEB 340	134,2	1,342	340	300	12,0	21,5	27	243,0	297,0	170,9	36659	2156,4	14,65	2408,3	9690	646,0	7,53	985,7	262,8	2457424	1,810	13,49	56,10	1204,1	30,4
* HEB 360	141,8	1,418	360	300	12,5	22,5	27	261,0	315,0	180,6	43196	2399,8	15,46	2683,2	10141	676,1	7,49	1032,5	298,3	2887857	1,849	13,04	60,61	1341,6	32,2
* HEB 400	155,3	1,553	400	300	13,5	24,0	27	298,0	352,0	197,8	57684	2884,2	17,08	3231,9	10819	721,3	7,40	1104,0	361,0	3823884	1,927	12,41	69,99	1616,0	35,7
* HEB 450	171,1	1,711	450	300	14,0	26,0	27	344,0	398,0	218,0	79892	3550,8	19,14	3982,6	11721	781,4	7,33	1197,7	448,0	5298037	2,026	11,84	79,67	1991,3	40,1
* HEB 500	187,3	1,873	500	300	14,5	28,0	27	390,0	444,0	238,6	107181	4287,3	21,19	4814,8	12624	841,6	7,27	1291,7	548,1	7031022	2,125	11,34	89,83	2407,4	44,5
* HEB 550	199,4	1,994	550	300	15,0	29,0	27	438,0	492,0	254,1	136698	4970,8	23,20	5590,9	13077	871,8	7,17	1341,2	610,2	8874020	2,224	11,15	100,08	2795,4	48,9
* HEB 600	211,9	2,119	600	300	15,5	30,0	27	486,0	540,0	270,0	171050	5701,7	25,17	6425,4	13530	902,0	7,08	1391,1	677,1	10989947	2,323	10,96	110,82	3212,7	53,2

(*) - Suministro bajo demanda

Figure 21 . Profile HEB Characteristics chart

2.9.2 COMPUTATIONAL EFFORTS IN CRITICAL POINT 1. (Beam-Lintel)

$N_d = 0$ SYMMETRIC PURE FLEXION $M_{zd} \leq W_z \cdot f_{yd}$ $(\boldsymbol{formula\ 2})$

$V_d = 0$

$M_{dz} = 339{,}54\ kN$ $As\ I\ get\ with\ the\ formula\ (\mathbf{1})\ f_{yd} = 23{,}04\ kN/cm^2$

$Using\ formula\ (\mathbf{2}),\ W_Z = \left|\frac{M_{zd}}{f_{yd}}\right| = \left|\frac{339{,}54 \cdot 10^2}{23{,}04}\right| = 1473{,}70\ cm^3$ → HEB-300 = 1677,80 cm³ (Figure 21, W_y column)

- Check of the sizing

HEB-300 → $from\ formula\ (\mathbf{2}), \left|\frac{M_{zd}}{W_z}\right| = \left|\frac{339{,}54 \cdot 10^2}{1677{,}8}\right| = 20{,}23 < f_{yd} = 23{,}04\ kN/cm^2$

2.9.3 COMPUTATIONAL EFFORTS IN CRITICAL POINT 2. (Beam-Lintel)

$N_d = 0$ SHEAR $|V_d| \leq Av \cdot \frac{f_{yd}}{\sqrt{3}}$ $(\boldsymbol{formula\ 3})$

$V_d = -271{,}63\ kN$ HEB-300 → $Av_z = 47{,}44\ cm^2$ (Figure 21, Av_z column)

$M_{dz} = 0$ $Using\ formula\ (\mathbf{3})\ I\ get = \frac{47{,}44 \cdot 23{,}04}{\sqrt{3}} = 631{,}05$

$As\ I\ get\ with\ the\ formula\ (\mathbf{1})\ f_{yd} = 23{,}04\ kN/cm^2$

- Check of the sizing

$$Using\ formula\ (\mathbf{3}), |V_d| = 271{,}35 \leq \frac{Av \cdot f_{yd}}{\sqrt{3}} = 631{,}05$$

2.9.4 COMPUTATIONAL EFFORTS IN CRITICAL POINT 3 (1,25 m FROM RIGHT SUPPORT). (Beam-Lintel)

SIMPLE FLEXION

$N_d = 0\ kN$ $As\ I\ get\ with\ the\ formula\ (\mathbf{1})\ f_{yd} = 23{,}04\ kN/cm^2$

$V_d = 135{,}82\ kN$ HEB-300 → $Av_z = 47{,}44\ cm^2$ (Figure 21, Av_z column)

$M_{dz} = 254{,}65\ kN$

$Using\ formula\ (\mathbf{3})$

If $|V_d| \leq 0{,}5 \cdot Av \cdot \frac{f_{yd}}{\sqrt{3}}$ → Is not necessary to take in account the combined effect

If $|V_d| > 0{,}5 \cdot Av \cdot \frac{f_{yd}}{\sqrt{3}}$ → For H profile sections

$$M_d \leq \left(W_{pl} - \frac{\rho A_v^2}{4t_w}\right) \cdot f_{yd} \qquad \rho = \left(2 \cdot \frac{V_d}{A_v \cdot {f_{yd}}/{\sqrt{3}}} - 1\right)^2$$

$$M_d \leq W_{el} \cdot f_{yd} \qquad W_{pl} = \ Plastic\ resistant\ modulus$$

$$W_{el} = \ Tensile\ resistant\ modulus$$

- Check of the sizing

$$Using\ formula\ (\mathbf{3}) = \frac{47{,}44 \cdot 23{,}04}{\sqrt{3}} = 631{,}05$$

$$|V_d| = 135{,}82\ \leq 0{,}5 \cdot \frac{Av \cdot f_{yd}}{\sqrt{3}} = 315{,}53$$

Is not necessary to take in account the combined effect

2.9.5 COMPUTATIONAL EFFORTS IN CRITICAL POINT 4. (Supports)

$N_d = -271{,}63\ kN$ COMPRESSION $N_d \leq A \cdot f_{yd}$ $(\boldsymbol{formula\ 4})$

$V_d = 0$ $As\ I\ get\ with\ the\ formula\ (\mathbf{1})\ f_{yd} = 23{,}04\ kN/cm^2$

$M_{dz} = 0$

$Using\ formula\ (\mathbf{4}), A > \left|\frac{N_d}{f_{yd}}\right| = \frac{271{,}63}{23{,}04} = 11{,}79\ cm^2$ → HEB-120 = 34,00 cm² (from Figure 21Figure 21)

2.10 TEST OF BUCKLING EFFORTS IN SUPPORTS

2.10.1 BASES OF BUCKLING TESTS

Resistance of compression bars, Nc, should not exceed the strength of the gross section $N_d \leq A \cdot f_{yd}$, and will be less than the ultimate buckling strength of the bar.

In general it will be necessary to check the buckling strength in every possible plane in which the piece can be affected .As ability to flexural buckling in a centred compression of a bar with a constant section can be taken:

$$N_{b,RD} = \chi \cdot A \cdot f_{yd} \ (\boldsymbol{formula\ 5})$$

A: transversal section area in classes 1, 2 and 3, or effective area A_{eff} in sections of Class 4.

f_{yd}: Calculating resistance of the steel

χ: Buckling reduction factor, which value can be obtained according to the reduced slenderness ($\bar{\lambda}$) and the appropriate buckling curve to the case (charts).

2.10.2 STRAIGHT BARS CONSTANT SECTION AND CONSTANT AXIL

Reduced Slenderness is called to the relationship between the resistance of calculation section and the critical compressive of buckling, the value is:

$$\bar{\lambda} = \sqrt{\frac{A \cdot f_y}{N_{cr}}} \qquad N_{cr} = \left(\frac{\pi}{L_k}\right)^2 \cdot E \cdot I$$

E: modulus of elasticity.

I: The inertia moment of the area of the section to flex in the considered plane

L_k: Buckling length of the piece, equivalent to the distance between the inflection points of the greater buckling deformation. Defined in the following table (Figure 22), depending on the length of the piece.

Tabla 6.1 Longitud de pandeo de barras canónicas

Condiciones de extremo	biarticulada	biempotrada	empotrada articulada	biempotrada desplazable	en ménsula
Longitud L_k	1,0 L	0,5 L	0,7 L	1,0 L	2,0 L

Figure 22 . Buckling longitud for bars

In my case I'm going to consider the union beam-support as built-in/articulated union to increase the safety factor instead of bi built-in.

Introducing turning radius, $i = \sqrt{I/A}$ and the Slenderness $\lambda = l_k/i$, the equation of the reduced slenderness is transformed, being $\sqrt{\frac{\pi^2 \cdot E}{f_y}} = \lambda_1$, the value of the corresponding slenderness , in

the buckling curve of Euler (Figure 23) , to the limit tensile tension of the steel to be used. And therefore $\bar{\lambda} = {}^{\lambda}/_{\lambda_1}$ (***formula 6***).

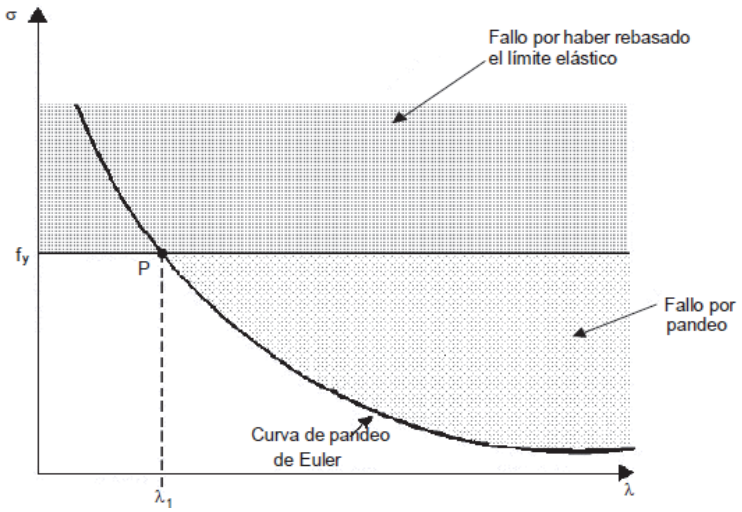


Figure 23 . Euler hyperbola and failure modes

The values of λ_1 vary for the different types of steel (Figure 24):

	λ_1
S235	93,913
S275	86,815
S355	76,409

Figure 24 . Values of λ1 for the different types of steel

The values of the coefficient χ, can be obtained from the following curve (Figure 25) or chart (Figure 26), depending of the imperfection coefficient (α) and the reduced slenderness ($\bar{\lambda}$). The elastic imperfection coefficient (α), adopts the values from the next table depending of the buckling curve. This represents the sensitivity to the phenomenon depending on the type of section, buckling plane and type of steel, according to the profiles table.

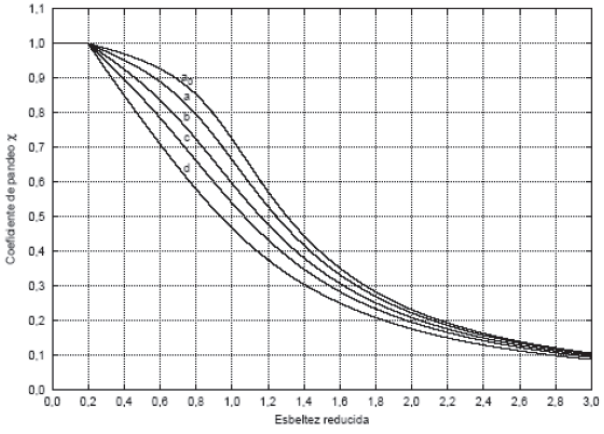


Figure 25 . Curve to obtain the values of the buckling coefficient χ

Tabla 6.3 Valores del coeficiente de pandeo (χ)

Esbeltez reducida	Curva de pandeo a_0	a	b	c	d
Coeficiente (α) de imperfección	0,13	0,21	0,34	0,49	0,76
≤ 0,20	1,00	1,00	1,00	1,00	1,00
0,30	0,99	0,98	0,96	0,95	0,92
0,40	0,97	0,95	0,93	0,90	0,85
0,50	0,95	0,92	0,88	0,84	0,78
0,60	0,93	0,89	0,84	0,79	0,71
0,70	0,90	0,85	0,78	0,72	0,64
0,80	0,85	0,80	0,72	0,66	0,58
0,90	0,80	0,73	0,66	0,60	0,52
1,00	0,73	0,67	0,60	0,54	0,47
1,10	0,65	0,60	0,54	0,48	0,42
1,20	0,57	0,53	0,48	0,43	0,38
1,30	0,51	0,47	0,43	0,39	0,34
1,40	0,45	0,42	0,38	0,35	0,31
1,50	0,40	0,37	0,34	0,31	0,28
1,60	0,35	0,32	0,31	0,28	0,25
1,80	0,28	0,27	0,25	0,23	0,21
2,00 (1)	0,23	0,22	0,21	0,20	0,18
2,20 (1)	0,19	0,19	0,18	0,17	0,15
2,40 (1)	0,16	0,16	0,15	0,14	0,13
2,70 (2)	0,13	0,13	0,12	0,12	0,11
3,00 (2)	0,11	0,10	0,10	0,10	0,09

(1) esbeltez intolerable en loe elementos principales
(2) esbeltez intolerable incluso en elementos de arriostramiento

Figure 26 . Chart to obtain the values of the buckling coefficient χ

The Buckling curves correspond to the different coefficients of imperfection, which depends at the same time on the shape of the section and buckling axe that we are taking under consideration, in our case the HEB profiles (Figure 27).

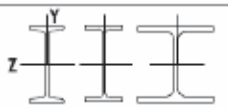
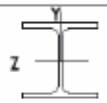
PERFILES	CURVA DE PANDEO EJE Z	EJE Y
	a	b
	b	c

Figure 27 . Chart to choose the suitable buckling curve

2.10.3 LARGE SUPPORTS BUCKLING CHECK

$Using\ formula\ (\mathbf{5}),\ \frac{N}{\chi \cdot A} < f_{yd} = As\ I\ get\ with\ the\ formula\ (\mathbf{1}) = 23{,}04\ \frac{kN}{cm^2}$

$L = 3{,}50\ m \qquad L_p = L \cdot L_k = 3{,}50\ \cdot 0{,}7\ (from\ \text{Figure 22}) = 2{,}45\ m$

- ⊾ *to axe z* (*plane* ⊾ *to the plane of the portico*)

$\lambda_z = \frac{L_p}{i_z}$ (***formula 7***) $= \frac{2{,}45\ m}{5{,}04\ cm} = \frac{245\ cm}{5{,}04\ cm} = 48.61\ cm$ — Buckling check curve "b" (Figure 27)

$Using\ formula(\mathbf{6}),\ \bar{\lambda} = \frac{48{,}61}{86{,}815} = 0{,}560$ — From chart (Figure 26) $\chi = 0{,}856$

$$Using\ formula\ (\mathbf{5}), \qquad \chi = 0{,}856 \rightarrow \frac{271{,}63}{0{,}856 \cdot 34{,}00} = 9{,}33\ \leq f_{yd} = 23{,}04 \frac{kN}{cm^2}$$

- ⊾ *to axe y* (*plane* ∥ *to the plane of the portico*)

$Using\ formula\ (\mathbf{7}),\ \lambda_y = \frac{2{,}45\ m}{3{,}06\ cm} = \frac{245\ cm}{5{,}04\ cm} = 80{,}07\ cm$ — Buckling check curve "c" (Figure 27)

$Using\ formula\ (\mathbf{6}), \bar{\lambda} = \frac{80{,}07}{86{,}815} = 0{,}922$ — From chart (Figure 26) $\chi = 0{,}587$

$$Using\ formula\ (\mathbf{5}), \qquad \chi = 0{,}587 \rightarrow \frac{271{,}63}{0{,}587 \cdot 34{,}00} = 13{,}61 \leq f_{yd} = 23{,}04 \frac{kN}{cm^2}$$

The conditions of buckling are full filled for the profile heb-120, but finally i'm going to use a profile HEB-180 because this one facilitates the union to the lintel with bolts, nuts and grommets instead of welding.

3. TECHNOLOGICAL CARDS

3.1 TECHNOLOGICAL CARD I, FLOORING WORKS

3.1.1 GENERAL DESCRIPTION

This technological card consist in the analysis of the different types of flooring used during the restoration of the building object of our studies. The main idea is to describe the different layers of the flooring used and the description of the process as well as some recommendations and considerations to perform it. Coupled with some charts with information and requirements of the materials used for this layers and general recommendations related with flooring and general works.

Specifically in this technological card I will focus the analysis in the process to perform the floor of the residential and public areas of the Ground Floor. Taking in account the plans we have a total of 745,08 m² of this type of floor. The finish layer is not specified in the plans so I'll consider the same finish layer of ceramic tiles in all the premises.

It's important to highlight that some important rehabilitation works had been done before. That's why in some sections I'm going to obviate some steps or simply consider some works as a new construction works.

3.1.2 DESCRIPTION OF TECHNOLOGY AND SEQUENCE OF WORKS

First of all I'm going to describe all the layers used to perform the different type of floors (execution, use, considerations, etc), followed by a graphical description of these types with the order of layers included.

3.1.2.1 Composition layers of the different floors

Execution of a sub-base:

The foundation of an old building cannot be considered as a foundation done with a concrete slab or a common structural floor. That's why is necessary to perform a good sub-base to improve the base and make a suitable support for the next layers. These sub-base is a compacted mixture of

soil and gravel and its mission is the distribution of the loads to the ground. By the compaction this layer acquires a good stability and becomes a suitable base.

This layer is used in the flooring types: C

Preparation of the base:

In the case of floors on concrete structure is convenient to clean all the surface before start with the next steps and manage all the waste. Is a bad practice if the worker obvious the rests of other materials and place the new layers above them. Furthermore this practice is a good guarantee for proper adherence of the next layers.

This layer is used in the flooring types: A, B, C, D

Levelling sand layer:

This steps consist in execute the main levelling layer discharging 50mm or sand and making pressure to obtain the desired consistency. The minimum thickness of this layer for a correct behaviour is 2 cm, but is common to use more than 2 cm because these helps to absorb the height differences between the other floorings (for example with laminated wood flooring, marble, etc).

In addition it's possible to talk about some other reasons to use a thicker levelling layer, one good example is to cover the installation conductions protected at the same time with an external rigid covering when the false ceilings are not designed. In this case like some regulations describe the levelling sand layer is stabilized and formed by 100 kg/m³ of cement or lime and sand with a granulometric distribution of 0/4 mm.

This layer is used in the flooring types: A/B

Cement mortar base:

The use of this layer on the terrace and the level difference indicated on the draws means that this layer is used to take out the raining water from the terrace and direct it to the raining evacuation systems installed. These mortars should have a higher resistance than 2 kg/cm2 and lacking surface irregularities that could damage the waterproofing membrane.
Some sources founded recommend the minimum thickness in 20 mm and the bigger in 300 mm. So in our case the difference of elevations in between these both numbers. It's necessary to

highlight the treatment of the expansion joints in the layers, every 15 meters with a minimum width of 12 mm and also the meeting with lateral edges and other elements in all the perimeter.

This layer is used in the flooring types: D

Waterproofing layer on mortar base:

The target of this layer is just to protect the layers and structure below from the water. In these case the layer is placed in the terrace and is composed by different elements but sharing the same role (Bituminous primer, Waterproof membrane and Draining sheet). Like in some countries is a good practice to check by an approved laboratory the correct execution of waterproofing once the bituminous primer and the waterproof membrane is placed.
It's also very important to consider the behaviour between the elements that we are planning to install to be sure that there is no bad reactions between them.

This layer is used in the flooring types: D

Sound and heat insulation:

This layer is installed to grant a suitable insulation against the sound or heat. Depending on the place where is installed and their function we have different materials like glass wool or polyester plates:

- **Glass wool:** Glass wool consists of intertwined and flexible glass fibres, which causes it to "package" air, resulting in a low density that can be varied through compression and binder content. In this case we must talk about the glass wool as a lightweight insulation product chose for the acoustic insulation properties, but also is important to remark the thermal insulation characteristic of this material.
  Fiberglass will irritate the eyes, skin, and the respiratory system, and can be cause of some other symptoms. Depending of the way to place it (blown, sprayed, panels) can be more or less dangerous, but Scientific evidence demonstrates that glass fibre is safe to manufacture, install and use when recommended work practices are followed to reduce temporary mechanical irritation

- **Polyester (EPS):** Expanded polystyrene is a rigid and tough, closed-cell foam. It is usually white and made of pre-expanded polystyrene beads. EPS is used for many things packaging, bowls, cups, etc. But the use that I'm interested in is the moulded sheets for

building heat insulation. The good thermal conductivity properties and the low density makes it a good insulation material, also is cheap, easy to produce and is used very often in terrace and exterior areas like in our case because is resistant to moisture.

Talking about the placement is a good material because is light, easy to install and there are no irritation or other symptoms on their use.

This layer is used in the flooring types: A, B, C, D

Inter-layer:

In general, geotextiles because of their properties are used for various purposes, in this case with a geotextile of 200 g/m² because of the physical, mechanical, hydraulic and durability properties. Is used for filtration, drainage, reinforcement, separation, stabilization, protection, waterproof barrier. In this case, if we analyse that the layer is place in the terrace between the polyester EPS layer and the draining sheet we can understand that the main use is to separate the both layers and at the same time work as waterproof barrier.

This layer is used in the flooring types: C, D

Waterproofing nodular draining sheet:

The role of this layer as her name says is protecting the lower materials from the water and drain it to outside in the case of the terrace. These layer is characterized by her high compressive strength because of the dimple pattern and the good drainage capacity. Coupled by a good impact resistance, and chemical and environmental stress crack resistance which ensures high durability

This layer is used in the flooring types: D

Levelling layer or pre-layer:

This layer have same different roles at the same time. First of all it can be use like final levelling layer to perform a levelled and flat surface in which is possible to place the finish layer. At the same time is possible to play with the thickness to obtain the required level of the floorings between them and finally is the main protection of the waterproofing and insulation layers placed below. The reason for use the reinforcement like the armoured network is to avoid the possible retractions that can affect the final finish and moving it from their place.

This layer is used in the flooring types: A, B, C, D

Waterproofing:

For this purpose a very elastic paste is used to waterproof floors in damp areas such as bathrooms, kitchens, quartering areas, etc. This layers is commonly very resistant to water seepage and is permeable to the diffusion of vapour therefore eliminating any risk of water accumulation protecting other sensitive surfaces from humidity.
This layer is not considered as a finishing product. It must always be protected by gluing ceramic pieces to it with flexible cement glue.

This layer is used in the flooring types: B

Finish Coatings:

Depend of the rooms and areas, the coatings will be different such as their characteristics. The selected coatings are not studied in this Technological Card. Depending on the last coating the layer may have some other treatments for a good finish.

This layer is used in the flooring types: A, B, C, D

3.1.2.2 Details of flooring types

The next pictures (Figure 28, Figure 29, Figure 30, Figure 31) are a description of the different layers that I was talking about before relating them with the type of floor where are used.

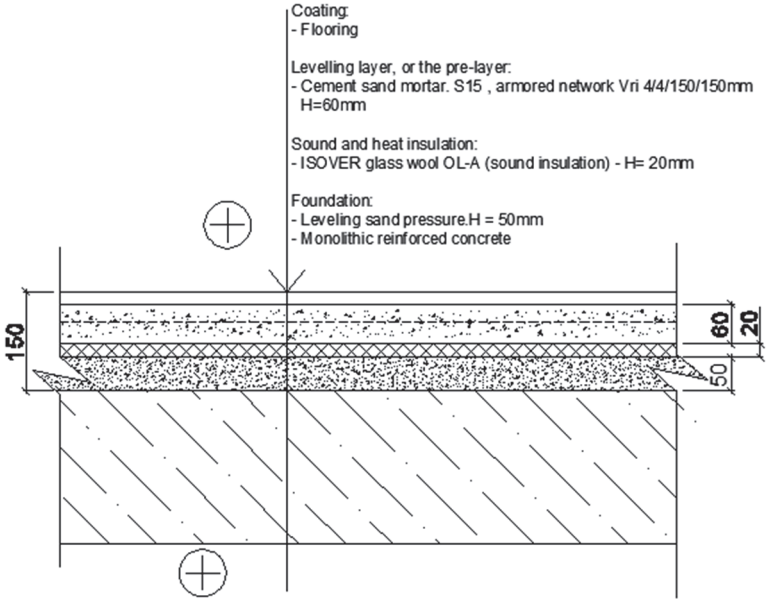


Figure 28 . Floor type A for public and residential areas

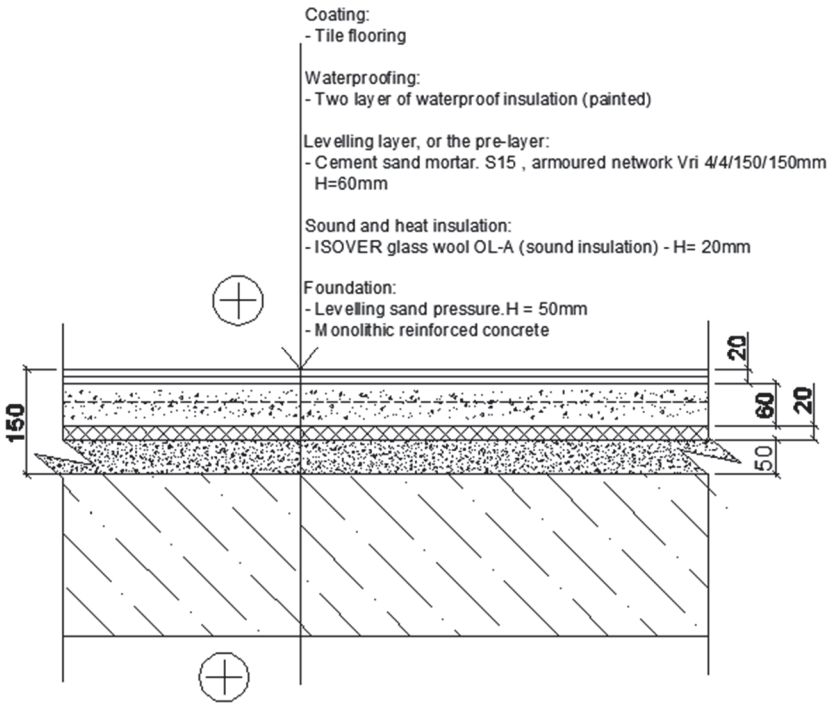


Figure 29 . Floor type B for wet areas

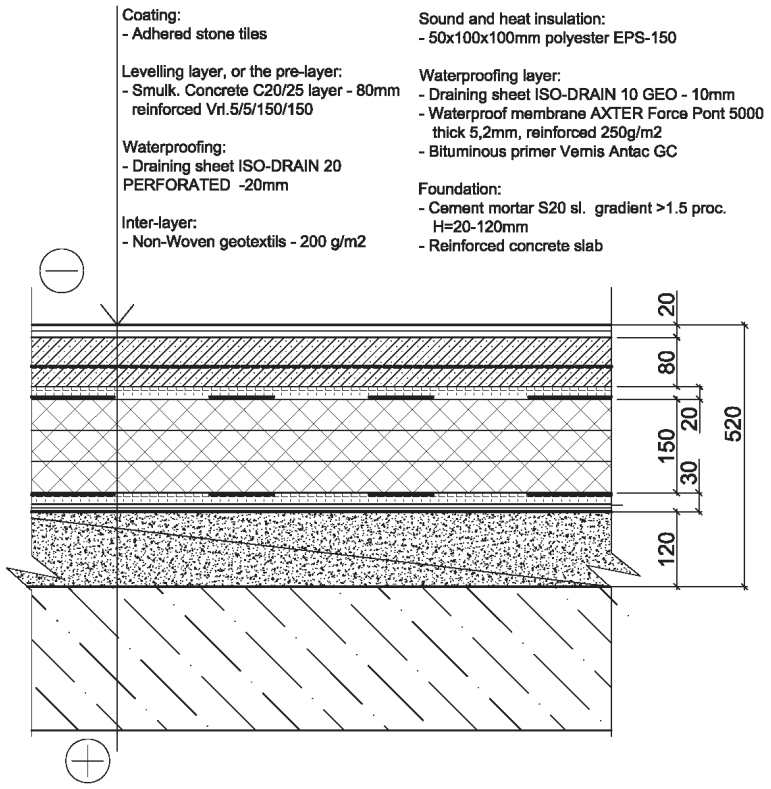


Figure 30 . Floor type B for underground terrace

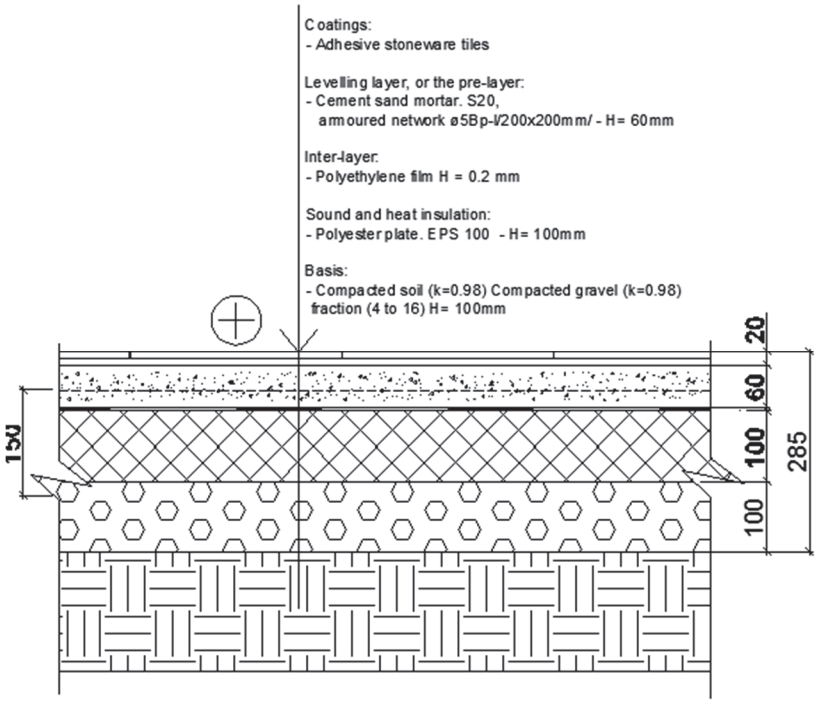


Figure 31 . Floor type C for underground areas

3.1.3 HUMAN SAFETY

The work is carried out in accordance to this general guidelines about rules of health and safety requested in constructions

- Operate correctly with the materials and work equipment (machines, tools, implement and personal protective equipment) necessary to achieve the required performance and quality, observing established safety measures while undertaking day weekend.
- Check and condition work spaces, materials and equipment required, to achieve the required performance and quality execution, complying with health and safety measures in place.
- Workers are allowed to work only with the knowledge of safety and health rules.
- Each worker must use protective equipment (special clothing, boots, gloves and respirators depend of their work)
- The tools, implement, personal protective equipment and auxiliary resources that are selected are appropriate for the activity to develop.
- Safety measures and environmental protection are adopted by the orders received through verbal and / or written.

- Contingencies identified in the construction are resolved within its purview, and if it's necessary communicate responsible as quickly as necessary to enable monitoring and resolution, especially those that compromise the health and safety of workers or others, in particularly in jobs in public roads.
- The measures to minimize noise and dust emissions, and in general environmental protection measures, are collected and confirmed, respecting them during the execution of the work.
- The waste is deposited in the appropriate containers for each type of waste according to safety data sheets of the products.
- Maintenance operations are performed correctly to all work equipment used at the end of each day
- Keep clean the work area
- Guarantee a minimum of 100 lux of illumination in distance of 2m in case of lack of natural illumination.

3.1.4 QUALITY CONTROL

The election of the final coating layer depends on: transit of people (public or private), action of water and chemicals, impact sound insulation and reaction to fire.
The support of the pavement can be a slab, structural flooring or concrete bases. Before start with the flooring works the base should be cleaned, dry and totally forged.

Materials

Should be checked before and during installation each piece of the flooring if is not damaged. You cannot use pieces that look at flaws or damaged. The installation should be done only in daylight or with adequate lighting, to recognize easily if there are damaged or defective pieces.

It’s important to check that the material correspond to the material which has been ordered. Is also important to check if it meets all the requirements and have the appropriate quality stamps like the CE mark (Figure 32). That’s why is important to read the receipt of the deliver and check that all is according to what had been requested.

Figure 32 . Example of CE mark document

Installations

If there are existing canalizations covered by the lower sand levelling layer of the floor, these must have a lower thickness than the levelling layers. If the canalizations are for hot water or air is important to check the exterior temperature of them, that must be low than the maximum temperature admitted by the by adhesive or the coating.

Laminate flooring before installation

In case of using the finish layer of laminate parquet flooring, that is described in the works to be done. The laminated parquet pieces must stay a minimum of 48 hours at a temperature above 17 ° C and a humidity of 50-65% in the room where will be installed. The unopened packages must be adapted to the climatic conditions of the room. In the case of very large differences between the point of storage and room to install you have to prolong this period of acclimation.

The base state

All bases must be correctly levelled (maximum difference 3 mm by 1 m long), dry and solid enough. The large slopes must be equalled with a special product called “leveller paste”. Basement areas should not have or cracks or breaks.

Layout and position

Is a good practice to lay out with a tape the disposition of the floor before start with the placement to guarantee that the cut pieces are placed next to the partitions in hide angles where is more difficult to see them.

Waterproofing layers

In some exterior flooring like in the terrace is important to test the waterproofing layers before cover it with the next ones. Allowing to solve the problematic unions and detect the access of the water without destroy the layers above.

Joints (placement joints, expansion joints and perimeter joints)

The differences of expansion with heat and contraction with cold among the base layer, the bonding layer and the tiles themselves, is the cause that in pavement without joints will easily cause r fracture of ceramic tiles and other problems after 1-2 years of damage of heat and cold stress Is important to make a continue line in the standard joints of the pavement in all the surface.

The structural joint must be continued till the exterior finish coating to avoid the tile deformation, crowning, hollowing, fracture and other phenomena. It's also very important to place joints in all the perimeter, around supports, in elevations, and in continuous areas bigger than 50 - 70 m² (the half area is recommended for exteriors) with a minimum thickness of 5mm.

After the works this joints must be filled with an elastic sealant with good durability that must be checked and change after some years to guarantee the effectiveness of the joint.

An example of pavement joints is showed in the next picture (Figure 33), specifically the example is about expansion joints.

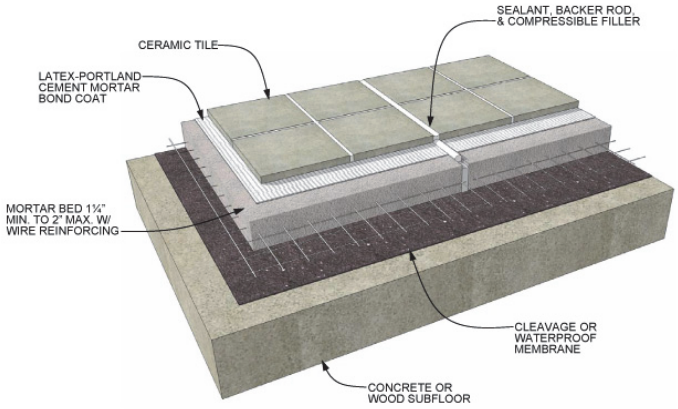


Figure 33 . Example of expansion joint in pavement

3.1.5 LOCATION OF THE FLOORING FOR PUBLIC AND RESIDENTIAL AREAS IN GROUND FLOOR

In the next draw (Figure 34) is possible to see the where will be performed the works of flooring for public and residential areas in the ground floor.

Figure 34 . Location of Flooring works for public and residential areas in the Ground floor

3.1.6 ORGANIZATION OF WORKS OF FLOORING INSTALLATION FOR PUBLIC AND RESIDENTIAL AREAS IN GROUND FLOOR

For the organization works I'm going to study the flooring schedule about the floor for residential and public areas placed of the ground floor (Figure 35). We are going to suppose that the works are performed by two teams. The surface to perform results in an amount of 745,08 m², calculations were made assuming a total of 20 working days per month with 8h day.

Work Name	Duration	Start	End
Flooring works	**37,04 días**	**mié 01/05/13**	**vie 21/06/13**
Levelling Sand layer	8,4 días	mié 01/05/13	lun 13/05/13
Insulation layer	1,86 días	jue 09/05/13	lun 13/05/13
Cement mortar armoured	16,4 días	lun 13/05/13	mar 04/06/13
Finish layer with tiles	26,96 días	mié 15/05/13	vie 21/06/13

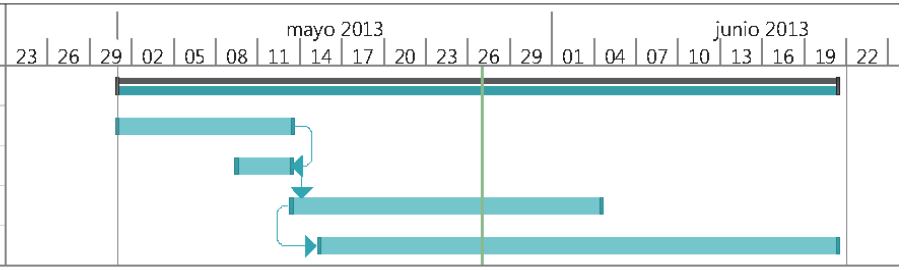


Figure 35 . Schedule of flooring for public and residential areas of the ground floor

días = days, Mayo = May, Junio = June, lun = Monday, mié = Wednesday, jue = Thursday, vie = Friday

3.1.7 MATERIAL AND TECHNICAL RESOURCES OF FLOORING INSTALLATION FOR PUBLIC AND RESIDENTIAL AREAS IN GROUND FLOOR

The objective of this sections is to list and quantify the workforce and, the materials, tools and machinery used to perform the floor for residential and public areas (Figure 36). The surface for the flooring works has been took from the information charts of the building about the residential and public areas flooring of the Ground floor, results in an amount of 745,08 m²,. We are going to suppose that the works are performed by two teams.

Nº	NAME	UNITS	QUANTITY
1	Workers		
1.1	Site manager	Pers	2
1.2	Workers	Pers	2
2	Materials		
2.1	93,33% Sand (h=50 mm) = 0,0467 m^3/m^2	0,056 t/m^3	2,086 t
2.2	6,67% Cement (h=50 mm)= 0,0033 m^3/m^2	0,004 t/m^3	0,149 t
2.3	Glass Wool	1,05 m^2/m^2	782,31 m^2
2.4	PE Sheet	1,05 m^2/m^2	782,31 m^2
2.5	Steel mesh reinforcement 15x15	1,05 m^2/m^2	782,31 m^2
2.6	Cement mortar S15	0,06 m^3/m^2	44,70 m^3
2.7	Tiles (Supose cerámic)	1,05 m^2/m^2	782,31 m^2
2.8	White cement for flooring paviment	1 kg/m^2	745,06 kg
2.9	White grout	0,001 m^3/m^2	0,745 m^3
3	Tools and machinery		
3.1	Hammer	U	2
3.1	Level	U	2
3.2	Shovel or spade	U	2
3.3	Trowel	U	2
3.4	Pliers	U	2
3.5	Re-bar cutter	U	2

Figure 36 . Information chart of flooring for public and residential areas of the ground floor

3.1.8 CALCULATION OF THE PRICE FOR THE WORKFORCE OF FLOORING INSTALLATION FOR PUBLIC AND RESIDENTIAL AREAS IN GROUND FLOOR.

We are going to suppose that the works are performed by two teams. The surface to perform results in an amount of 745,08 m², calculations were made assuming a total of 20 working days per month with 8h day. Price of tables are done with 1 site manager and 1 worker.

RSB010 **m²** **Mortar cement base**

Base for pavements of mortar M-10 armoured with a con Electrically Welded Wire Mesh ME 20x20 Ø 5-5 B 500 T 6x2,20 UNE-EN 10080, of 6 cm thickness, screeding and floating.					
Data base code	U	Decomposition	Performance	Price/U	Price
mt07ame010d	m²	Electrically Welded Wire Mesh ME 20x20 Ø 5-5 B 500 T 6x2, 20 UNE-EN 10080.	1,050	1,53	1,61
mt09mor010e	m³	Cement mortar CEM II/B-P 32,5 N type M-10, made on site with 380 kg/m³ of cement and a volume proportions of 1/4.	0,060	133,30	8,00
mo018	h	Site manager	0,352	15,67	5,52
mo104	h	Ordinary worker	0,392	14,31	5,61
	%	Auxiliary equipment	2,000	20,74	0,41
	%	Indirect costs	3,000	21,15	0,63
Approximated maintenance prince in the first 10 years: 1,09 € /year				Total:	21,78

ERSW20b **m²** **Stabilized Levelling sand layer**

Base of stabilized sand of 4 cm of thickness, Type two according to the Spanish guide for the Ceramic Tiles (DRB 01/06).					
Data base code	U	Decomposition	Performance	Price/U	Price
PBRA.1abb	t	Triturate sand 0/3 washed 10 km	0,056	10,69	0,60
PBAC.2aa	t	Portland Cement with pozzolana CEM II/B-9 32,5 N, according to the regulations UNE-EN 197-1.	0,004	91,68	0,37
M00A.8a	h	Site manager	0,180	22,91	4,12
m00a12a	h	Ordinary worker	0,300	21,90	6,57
	%	Direct complementary costs	0,200	11,66	0,02
				Total:	11,68

RSG010 **m²** **Pavement of ceramic tiles placed with adhesive**

Flooring ceramic porcelain tiles, polished 2/0/-/-, 30x30 cm, 8 € / m², received with cement normal adhesive, C1 without any additional feature, grey colour, grouted with cement and sand, L, 1/2 CEM II / AP 32.5 R, for open joint (between 3 and 15 mm), coloured with the same colour of the pieces.					
Data base code	U	Decomposition	Performance	Price/U	Price
mt09mcr021g	kg	Cement normal adhesive, C1, according to UNE-EN 12004, grey colour	3,000	0,35	1,05
mt18bcp010bae800	m²	Ceramic porcelain tiles 2/0/-/-, 30x30 cm, polished, 8,00 €/m², according to UNE-EN 14411.	1,050	8,00	8,40
mt18wwa080	U	PVC crosspiece	29,000	0,02	0,58
mt08cem040a	kg	White cement BL-22,5 X, for pavement, in bags, according to UNE 80305.	1,000	0,14	0,14
mt09lec020a	m³	Grout 1/2 CEM II/B-P 32,5 N.	0,003	120,10	0,36
mo021	h	Site flooring manager	0,579	15,67	9,07
mo056	h	Ordinary worker	0,289	14,70	4,25
	%	Auxiliary equipment	2,000	23,85	0,48
	%	Indirect costs	3,000	24,33	0,73
Approximated maintenance prince in the first 10 years: 4,26€ /year				Total:	25,06

ENTS.1abb **m²** **Glass Wool insolation for flooring MW 0,033 e 20mm**

Thermoacoustic insulation in soil under pavement, with mineral wool (MW), 20 mm of thickness, without cover, thermic conductivity of 0,033 W/mK, thermic resistance of 0,60 m2k/W, fire reaction Euroclass A2-s1, d0, designation code MW-EN 13162-T5-CS(10\Y),-CP-MU1, covered by a plastic film of polyethylene, included cleaning of the support and cut					
Data base code	U	Decomposition	Performance	Price/U	Price
PNTL.5abb	m²	Mineral Wool Panel MW 0,033 e 20 mm	1,050	1,00	1,05
PNIS.2c	m²	PE Sheet e 0,15 mm	1,050	0,16	0,17
M00A.8a	h	Site manager	0,040	22,91	0,92
m00a12a	h	Ordinary worker	0,040	21,90	0,88
	%	Direct complementary costs	0,010	3,02	0,03
Approximated maintenance prince in the first 10 years: 1,09 € /year				Total:	3,05

3.1.9 TECHNICAL - ECONOMIC INDICATORS

QUANTITY OF WORKS:

Planned to be done by two teams (2 site managers and 2 workers). The efficiency of the works will be the half and the price should be multiplied by two. So the price becomes the same amount.

745,08 m² of flooring for residential and public areas in the Ground floor

INSTALLATION AND WAGE COSTS:

The final prices are already modified with the final price if we consider that works are done by two teams. As I learn the important efficiency is the data of the site manager. So if we take in account that we want to use 2 site managers and 4 workers the price/h should be multiplied by the number of worker. But we should take the data of the site manager efficiency to determinate the real duration of the works and the real price.

Levelling sand layer: 9,05 € /m² x 745,08 m² = 6742,97 €

Insulation layer: 3,05 €/m² x 745,08 m² = 2272,49 €

Mortar cement base: 21,21 €/m² x 745,08 m² = 15803,15 €

Finish layer with tiles: 29,32 €/m² x 745,08 m² = 21845,75 €

TOTAL = 46664,35 € or 160992,03 Lt approximately

DURATION OF THE WORKS:

37,04 days. 37 days and 0 h and 58 min

3.2 TECHNOLOGICAL CARD II, REHABILITATION OF THE FACADES

3.2.1 GENERAL DESCRIPTION

This technological card consist in the analysis of the problems found of the different facades in the building object of our studies. In the main part about the technology and organization of the works I'm going to introduce the problem accompanied by some pictures of the old state before the start of the works, then I will talk about the solution adopted to solve the problem according with the information founded in the documents of the building and some pictures provided by the company ARCHINOVA responsible of the reconstruction that have been a great help throughout the study.

It's important to highlight again that some important rehabilitation works had been done before the company ARCHINOVA start their works in another previous phase entrusted to another company by the former owner. That's why in some sections I'm going to obviate some steps or simply consider some works as a new construction works.

3.2.2 TECHNOLOGY OF THE RECONSTRUCTION WORKS AND QUALITY CONTROL OF THE SOLUTIONS ADOPTED

3.2.2.1 Work 1. Masonry restoration and former ceiling joists slots

DESCRIPTION OF THE PROBLEM

The problem presented to analyse in this section is related with the conditions of the facade walls of the building. According to the plans and the pictures provided is possible to link the problem with the rising dump, the age of the façade brick walls and the lack of maintenance and cleaning for a long period of time. The problem of the age of the façade walls is a kind of unavoidable factor that have been increased by the low maintenance.

Talking about the rising dump in walls, is necessary to analyse first what type of moisture are we talking about to check which can be the possible solutions and if also this problem have a relation with another one. Once observed the pictures it's possible to figure out that the problem is caused by capillarity action; moisture in the soil can rise up through a wall by the affinity of building materials for water. And possibly related with the absence of foundation waterproofing which will be discussed below. Most old buildings were built without a damp proofing course or this may have failed due to the age of the property.

Rising damp will appear along the base of the wall forming a characteristic tide mark 500/600 mm above floor level depending on the porosity of the building fabric and the rate of evaporation. If allowed to continue unchecked, the process will cause the wall fabric to break down and also may affect timber in contact with the damp wall, like the slots in with our former ceiling joists, adding that some of them are totally exposed to the exterior.

The appearance of certain damp stains in other higher parts of the wall can be related with the poor condition of the wall, the wind-driven rain is another deposition mechanism of moisture if an adequate drainage or other protection is not provided. A graphical example of how works the rising dump is showed in the next draw (Figure 37).

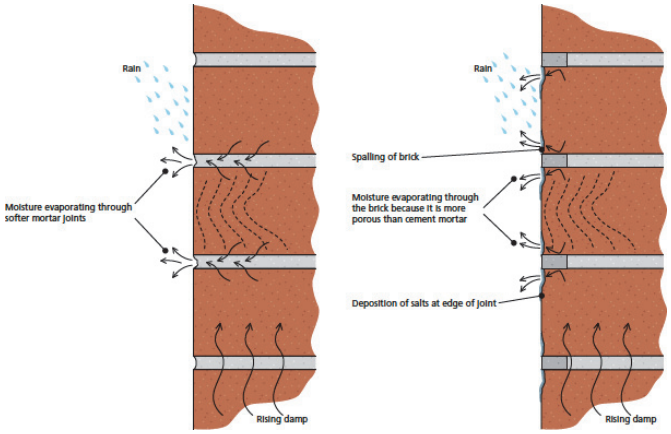


Figure 37 . Moisture and Rising Dump

The following pictures (Figure 38, Figure 39 and Figure 40) represent clearly the state of the façade found when before the reconstructions works started.

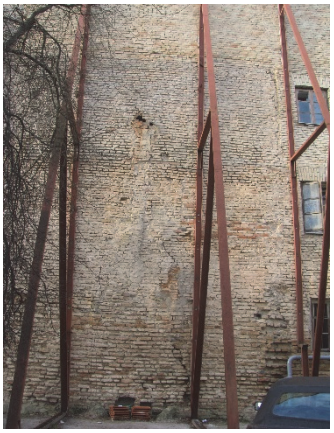


Figure 40 . Example of crack in wall

Figure 39 . Example of crack and rests of rusty iron in courtyard wall

Figure 38 . Example of moisture in courtyard wall

The most common visual symptom of this type of rising damp are the patches on walls. Another possible symptoms of penetrating damp are: Reduced thermal resistance of damp masonry, moss and mould growth, frost damage, rotting of embedded timbers, disfiguring carbonate deposits.

The spalling, dusting, or flaking of the brick masonry units may be due to mechanical or chemical damage. Mechanical damage is caused by moisture entering the brick and freezing, resulting in spalling of the bricks outer layers, this may continue or may stop accord after the outer layers that trapped the interior moisture have broken off.

SOLUTIONS

First of all the main idea should be to remove the moisture from the wall origin of the slicks and the damp patches before start the restoration.
Regulations require that all modern properties are constructed with an effective damp proof course. Older buildings which have no damp proof course or where the original damp proof course has failed due to deterioration with the passage of time, must be treated in-situ if dampness is to be prevented.

A wide range of measures are available to deal with the problem raise damp by capillarity:

- Stop water from foundation: drain systems (Figure 44) and waterproofing (Figure 46).
- Moisture concealment (hide): waterproof layer in the walls (Figure 41), auxiliary partition (Figure 43), Suspended floor (Figure 42), etc.
- Avoid the capillary ascension: Cut in the wall (Figure 45), injection system (Figure 51) and siphons system (Figure 49).
- Moisture removal: electro-osmosis system: passive (Figure 50), active (Figure 47), resonance pulses (Figure 48).

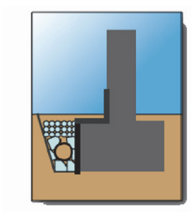


Figure 46. Drainage + Waterproofing

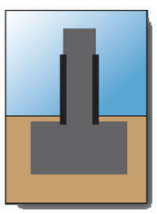


Figure 41. Waterproofing wall

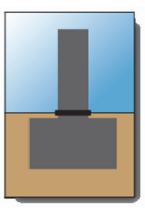


Figure 45. Cut in wall

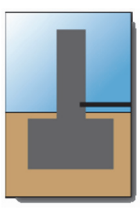


Figure 42. Suspended groundfloor

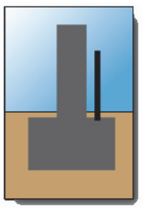


Figure 43. Auxiliary partition

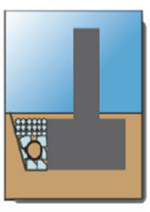


Figure 44. Drainage system

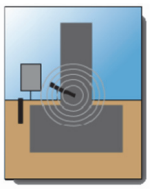


Figure 47. Active electro-osmosi

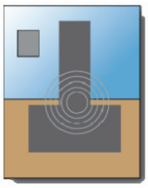


Figure 48. Resonance pulses

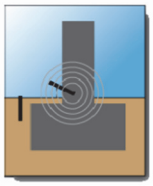


Figure 50. Passive elctro-osmosi

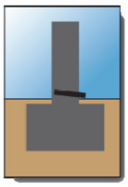


Figure 49. Siphons system

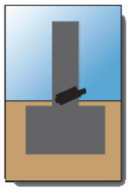


Figure 51. Inyection system

In this case the solution to solve the raise damp was the installation of a damp proof course a drainage system around the exterior walls from the foundation to the ground floor. I' not going to describe this solution in this sections because I'll talk more about it in the next sections.
Here we are going to pay the attention in the works to reconditions the facades, cleaning and repairing the brooked walls once the active that have been affecting the facades are solved.
A good practice is to draw up a Cleaning Project, some conditions must be clear before a Cleaning Project:

- Identify the problem of the dirt or soiling material to remove it in the gentlest means possible.
- Consider the historic appearance of the building.
- Consider the practicalities of cleaning or paint removal.
- It can be beneficial to study a specimen on the masonry before attempting to remove the problem.
- Previous treatments of the building should be researched and building maintenance records should be obtained, if it's available.
- Choose the appropriate cleaner, applying the wrong cleaning agents to historic masonry can have disastrous results.

Masonry cleaning methods generally are divided into three major groups:

- Water methods: soften the dirt or soiling material and rinse the deposits from the masonry surface.
- Chemical cleaners: react with dirt, soiling material or paint to affect their removal, after which the cleaning effluent is rinsed off the masonry surface with water.
- Abrasive methods: including blasting with grit, and the use of grinders and sanding discs. All of which mechanically remove the dirt, soiling material or paint (and, usually, some of the masonry surface). Abrasive cleaning is also often followed with a water rinse.

CLEANING METHOD ADOPTED

In my point of view, and talking about what I understand about the reconstruction memory provided for the study of the project, the selected methods used to clean the facades of the building are:

Water Washing

With low-pressure or medium-pressure water is probably one of the most commonly used methods for removing dirt or other pollutant soiling from historic masonry buildings. Starting with a very low pressure and progressing as needed to slightly higher pressure is always the recommended way to begin. Scrubbing with natural bristle or synthetic bristle brushes—never metal which can abrade the surface and leave metal particles that can stain the masonry—can help in cleaning areas of the masonry that are especially dirty.

Non-ionic detergents added to a low- or medium-pressure water wash can be a very useful aid. (A non-ionic detergent, unlike most household detergents, does not leave a solid, visible residue on the masonry.) Adding a non-ionic detergent and scrubbing with a natural bristle or synthetic bristle brush can facilitate cleaning textured or intricately carved masonry. This should be followed with a final water rinse.

In the next picture (Figure 52) is possible to see an example of a masonry wall cleaned by the method of water washing.

Figure 52. Example of water washing

Water-Repellent Coating

Generally transparent or clear, is used to keep liquid water from penetrating the surface but to allow water vapour to enter and leave, or pass through, the surface of the masonry.

Water-repellent coatings are frequently applied to historic masonry buildings for the wrong reason, most historic masonry buildings, unless they are painted, have survived for decades without a water-repellent coating and, thus, probably do not need one now. But there are some instances when a water-repellent coating may be considered appropriate to use on a historic masonry building; soft, incompletely fired brick from the 18th-and early-19th centuries may have become so porous that paint or some type of coating is needed to protect it from further deterioration or dissolution. When the masonry building has been neglected for a long period of time, necessary repairs may be required in order to make it watertight.

All the works are done using the fabricated frame scaffold placed in front of the areas of the facades where the required works make it necessary. In other areas the help of a lifting platform is used to perform the works where is necessary.

CONSIDERATIONS AND QUALITY CONTROL

Complete removal may not always be possible. Sometimes De-icing salts used near the building that have dissolved can migrate into the masonry. Cleaning may draw the salts to the surface, where they will appear as efflorescence (a powdery, white substance), which may require a second treatment to be removed.

Cleaning Method

In the use of Water washing projected with low-medium pressure, we must guarantee that all mortar joints are sound and that the building is watertight. Otherwise water can seep through the walls to the interior resulting in rusting metal anchors and stained and some other problems
Must be checked that water supply don't have iron or copper that can discolour masonry. Adding a chelating or complex agents to the water, inactivates other metallic ions, and help to prevent staining on light-coloured masonry.

Is not allowed to use this method in cold weather due to freezing and cracking. Since a masonry wall may take over a week to dry after cleaning, no water cleaning should be permitted for several days prior to the first average frost date.

Never use water at too high pressure because can be abrasive. In addition, the distance of the nozzle from the masonry surface and the type of nozzle, as well as pressure, are also important variables in a water cleaning process that can have a significant impact on the outcome of the project. This is why it is imperative that the cleaning be closely monitored to ensure that the cleaning operators do not raise the pressure or bring the nozzle too close to the masonry in an effort to "speed up" the process. The appearance of grains of stone or sand in the cleaning effluent on the ground is an indication that the water pressure may be too high.

Mortars

It is very important that the replacement mortar is compatible with the historic mortar. Incompatible mortars can cause irreversible damage to historic brickwork, including spalling (deterioration of the brick themselves), cracking, and interior mortar rot. The characteristics of the mortar are a key factor in controlling the height of rising damp and the amount of subsequent evaporation, traditional mortars - such as lime mortar - allow historic masonry to breathe and move, giving new life to historic masonry. The work can look unattractive, but as long as you are using good materials, you're not causing additional problems.

Water-Repellent Coating

In theory, waterproof coatings usually do not cause problems as long as they exclude all water from the masonry. If water does enter the wall from the ground or from the inside of a building, the coating can intensify the damage because the water will not be able to escape. During cold weather this water in the wall can freeze causing serious mechanical disruption, such as spalling. In addition, the water eventually will get out by the path of least resistance. If this path is toward the interior, damage to interior finishes can result; if it is toward the exterior, it can lead to damage to the masonry caused by built-up water pressure.

In most instances, waterproof coatings should not be applied to historic masonry. The possible exception to this might be the application of a waterproof coating to below-grade exterior foundation walls as a last resort to stop water infiltration on interior basement walls. Generally, however, waterproof coatings, which include elastomeric paints, should almost never be applied above grade to historic masonry buildings.

Materials

It's important to check that the material correspond to the material which has been ordered. Is also important to check if it meets all the requirements and have the appropriate quality stamps like the CE mark. That's why is important to read the receipt of the deliver and check that all is according to what had been requested.

RESULTS

These pictures (Figure 53, Figure 54) taken during the month of May represents the current state of the building where is possible to see the tonality change of the façade and the good state of the repaired masonry.

Figure 53. Courtyard facade, picture after the restoration

Figure 54. Exterior wall facade, picture after the restoration

OPINION

In my opinion may be a good idea to plan an auxiliary system based on the moisture removal method like the resonance pulses. This one adds a big grade a high security level against raise dump in walls. There is another method to control the raise dump by monitoring with sensors (Figure 55, Figure 56). The price of the both systems shouldn't be very different.

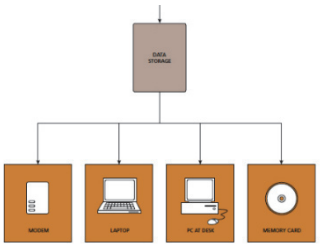


Figure 55. Example of monitored raising dump

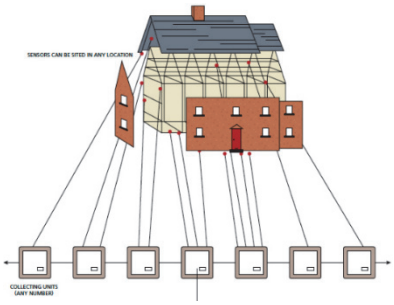


Figure 56. Example of monitored raising dump

3.2.2.2 Work 2. Vertical wall cracks

DESCRIPTION OF THE PROBLEM

This problem occurred specially in the facade between axes D-I. Cracks on the walls may be produced by different causes: differential settlement of foundations, drying shrinkage, expansion and contraction due to ambient thermal and moisture variations, improper sup-port over openings, the effects of freeze-thaw cycles, the corrosion of iron and steel wall reinforcement, differential movement between building materials, expansion of salts, and the bulging or leaning of walls.

A common masonry wall crack probably is caused by thermal or moisture expansion. Cracks should always be evaluated to determine their cause and whether corrective action is required. Look for signs of movement. A clean crack indicates recent movement; a dirty or previously filled crack may be inactive, it should monitor such cracks over a period of time to see if they're active. Active cracks should be sealed with a flexible sealant; inactive cracks may be pointed. Cracks associated with thermal expansion and contraction may open and close with the season. If the crack is related to settlement, it may be necessary to repair or underpin the foundation walls before repairing the crack in the brick masonry.

The mortar is very important factor when we are talking about cracks, two important qualities of mortar are its ability to bond to masonry and its internal strength. A sign of poorly made mortar may be random cracking at the bond joint. Until about the end of the 19th century, the standard mortar for masonry was a mixture of sand and pure lime or lime-pozzolana-sand. These low-strength mortars gave masonry the ability to absorb considerable strain.

The following pictures (Figure 58, Figure 57) represent clearly the state of the facade found when before the reconstructions works started.

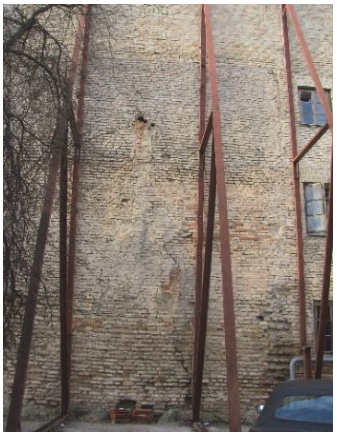


Figure 58. Exterior eastern wing facade before the reconstruction works

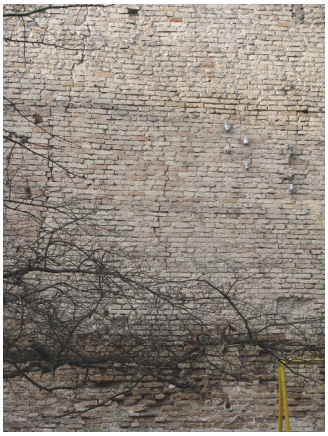


Figure 57. Exterior eastern wing facade before the reconstruction works

SOLUTIONS

Cracks associated with thermal expansion and contraction are considered such as critical cracks, which may gradually expand as accumulating mortar debris jams them farther apart after each cycle. Such cracks should be cleaned and protected by flexible sealants; re-mortaring cyclical cracks will hold them open and cause more cracking.

The method you should use to repair cracks depends on the visibility of the crack and the available budget. One method can be replace the cracked brick units along the length of the crack and grinding and pointing cracked mortar joints full depth, but in this case we are talking about no primary facade an old masonry wall so this option is not necessary. Also In historic buildings, it is important to preserve as much of the original materials as possible.

Many people will grout cracks or apply sealants over the top surface of cracks in limited areas. Although these repairs may not be as durable, they are relatively reversible and do not damage the original building materials, important to preserve as much as possible.

SOLUTION ADOPTED

Our wall is in a concealed area and we are searching an economic method to repair the crack, so this method can be, grinding out cracks and sealing them with a good quality sealant. Prior to installing sealant, grind the cracks to a width of approximately 10 mm inch and a depth of roughly twice the width. Install a backer rod to create a good joint profile and to avoid creating a sealant joint that is bonded along three sides. Sealant joints bonded along three sides are prone to failure when there is any movement across the crack. In many cases, it may be necessary to prime the masonry bond surfaces to ensure good bond between the sealant and the existing masonry.

All the works are done using the fabricated frame scaffold placed in front of the areas of the facades where the required works make it necessary. In other areas the help of a lifting platform is used to perform the works where is necessary.

The next pictures show the material (Figure 59) and the process of the Stitching (Figure 60) used for the reparation of cracks in walls with Brickfix Crack Stitching System method.

Figure 59. Material for Brickfix method reparation

Figure 60. Process of Brickfix Crack Stitching System method

CONSIDERATIONS AND QUALITY CONTROL

In some cases, the appearance of these sealant joints can be improved by applying sand onto the surface of the uncured sealant. Where significant movement is expected, the sealant manufacturer should be contacted to evaluate the suitability of this approach.

Placing mortar or grout in cracks will typically not be an effective long-term repair. The mortar will not accommodate any movement across the crack. For this reason, cracks filled with mortar will likely crack again, increasing water penetration and deterioration.

In most cases, the repair program will need to include appropriate vertical or horizontal expansion joints to accommodate the differential movement of the masonry that caused the crack in the first place. If the crack is related to settlement, it may be necessary to repair or underpin the foundation walls before repairing the crack in the brick masonry.

The horizontal slots may be cut directly into the masonry but will typically be cut into the mortar beds when stitching face brickwork to ensure a hidden repair. The slots may be cut using a mortar chisel, brick saw, wall chaser or angle grinder with vacuum attachment. Each slot should be cut to the full mortar joint height, minimum 8mm, if cutting into the mortar bed.

Multiple cracks may be stitched using single lengths of bars that are long enough to extend 500mm beyond the outer cracks. All mortar must be removed, together with any loose debris, to ensure a sound bond.

Prepare the slot with a water-based primer or thoroughly wet the slot with clean water.

RESULTS

The next pictures (Figure 62, Figure 61) taken during the month of May represents the current state of the building where is possible to see the repaired cracks of the facade

Figure 62. Exterior eastern wing facade after the reconstruction works

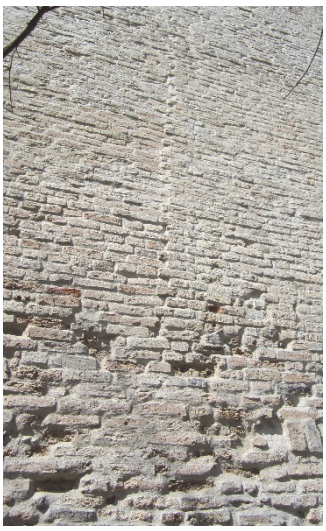


Figure 61. Exterior eastern wing facade after the reconstruction works

OPINION

Once checked the final solution in the present state is possible to conclude that the restoration was successful and all the walls of the facade between axes D-I seems stable and without active movement which can open again the same or new crack. The finish is not a continuous flat surface but the position of the wall is in a concealed area and the objective was to find an appropriate and economic method to repair the cracks.

3.2.2.3 Work 3. Foundation Waterproofing

DESCRIPTION OF THE PROBLEM

The objective of this solution is to solve the problems of the raise dump in the Facade walls. In general words we can talk about two principal types of deposition moisture mechanism in buildings (Gravity and Capillarity moisture). In this case the solution the solution adopted is used to avoid the mechanism of moisture by gravity so we are going to talk about this.

This mechanism occurs whenever liquid water is able to transit through or around a material by virtue of a hydrostatic head. It is potentially the most powerful of all the transport mechanisms and is normally controlled through use of waterproof materials or by draining the source of water. This moisture affects the ground floors and basements it's caused by an external penetration laterally through walls of the building. There are different measures developed to prevent this

problem but the best way to act is avoiding the water contact with the surface and penetrating inside the building.

The next pictures (Figure 63, Figure 64) represents the state of the foundation before the start and in the first steps of the installation of the foundation waterproofing.

Figure 63. State of the courtyard walls and foundation during the waterproofing works

Figure 64. State of the courtyard walls and foundation during the waterproofing works

SOLUTION ADOPTED

The systems adopted consist to make a waterproof barrier on the foundations, the system consists on:

- Drainage interior and / or external
- Waterproofing with additives added to fresh concrete
- Liquid membrane applied in situ on the existing surface
- Post formed membrane applied over the surface

Taking the plans and the picture as a guide it's possible we can see that the system adopted is an external drainage layer with exterior waterproofing. Exterior waterproofing prevents water from entering foundation walls therefore preventing the wicking and moulding of building materials.

Waterproofing an existing basement begins with excavating to the bottom sides of the footers. Once excavated the walls are then sealed with a waterproofing membrane and a drain sheet that waterproofs the wall and directs water down to a drain tile system placed at the side of foundation. A 4”-6” perforated drain tile is covered and installed beside the foundation. Clean stone is then used to cover the drain tile, which is then covered with compacted soil that slopes away from the foundation. This exterior waterproofing method will stop water from entering through walls causing leaky basement walls and wet basements when installed by a qualified waterproofing contractor.

CONSIDERATIONS AND QUALITY CONTROL

Waterproofing a structure from the exterior is the only method the International Building Code recognizes as adequate to prevent structural damage caused by water intrusion. A common basement waterproofing system is a thick, modified bitumen asphalt coating that is spray or roll applied that includes attaching a synthetic polymer membrane using mechanical fasteners or adhesives.

Materials

It’s important to check that the material correspond to the material which has been ordered. Is also important to check if it meets all the requirements and have the appropriate quality stamps like the CE mark. That’s why is important to read the receipt of the deliver and check that all is according to what had been requested.

Geo-Textile Protection

When building in areas known to contain poorly draining soils an extra layer of protection is often required to prevent clogging of the drain tile. A geo-textile can be installed on top of the required granular over the drain tile.

Site Grading and Drainage

Poor site drainage can result in ponding, and uneven settlement. In most cases drainage systems create an 'apron' around the perimeter of the house directing all free water down and away from the envelope. It is suggested that builders maintain a minimum 5% slope around the house for the first 1.5m (5 feet) and 1.5% slope for the rest of the property.

RESULTS

In these pictures (Figure 66, Figure 65) is possible to see the waterproofing foundation installed in the walls of our building and one graphic that helps to describe the used system.

Figure 66. Foundation waterproofing installed after the reconstruction works

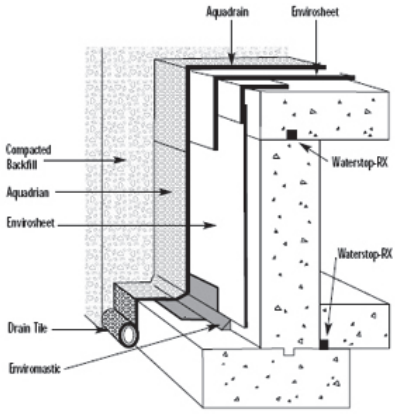


Figure 65. Description draw of foundation waterproofing works

OPINION

We can emphasize that this layer usually deteriorate as time goes on. So is a good solution to provide one waterproofing membrane under the drainage. Anyway this plus of safety against the moisture can be difficult to install because in this case we are talking about an old building reconstruction. It's also very important to follow the manufacturer instructions to install the layer and the period of time to check or change it.

3.2.2.4 Work 4. Replacement of the masonry

DESCRIPTION OF THE PROBLEM

The analysis of this case have a lot of relation with the problem nº1. It's possible to identify the reasons as a cause of the necessary replacement only with greater involvement because the solutions adopted in the problem nº1 aren't enough sufficient to keep the walls stable.
We are going to focus on the problem indicated of the facade between axles D-I, specifically on the top of this facade, and also with the works performed on the lintels of the doors and windows as show the pictures.

These are pictures of the facade state before the start of the first restoration works (Figure 67, Figure 68), during the first phase, which represents the half process of the lintels restoration.

Figure 67. Facades of courtyard before the reconstruction works. 1st phase replacement of the lintels is done.

Figure 68. Facades of courtyard before the reconstruction works. 1st phase replacement of the lintels is done.

SOLUTION ADOPTED

As show the plans, there is a big masonry area to be repaired that hadn't the sufficiently stability to be restored and keep in the wall. That's why the solution adopted was to demolish the old masonry and replace it for a new one with similar conditions and tonality.

Deterioration caused by spalling and dusting can only be remedied by replacing any unsound brick. There are no effective treatments to arrest disintegration of soft brick once it has started.

Replacing Deteriorated Units with Full-Size Bricks:

1. Carefully remove deteriorated brick units by hand using a hammer and chisel.
2. Rebuild back-up and substrate as required to replace any unsound material that was removed.
3. Clean the cavity of loose mortar and other debris by hand using a chisel and stiff bristle brushes.
4. Lightly wet the exposed brick surfaces.
5. Lay brick units with completely filled bed and head joints; Put the bricks with sufficient mortar to fill head joints and shove into place.
6. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.
7. Brush all excess mortar from the wall surface frequently during the work Protect all existing surfaces from mortar dripping and splashing.

Talking about the masonry above in the lintels of the windows and the doors of the different facades the solution adopted is to install a metallic lintels fixed by bolts and placed with the help of concrete mortar. This solution guarantee the correct load of the lintels transmitting the force to the jamb and therefore to the ground by the supports and the wall.

The next graphic (Figure 69) show a similar system, realized with a metallic profile which must transfer the loads to the jambs.

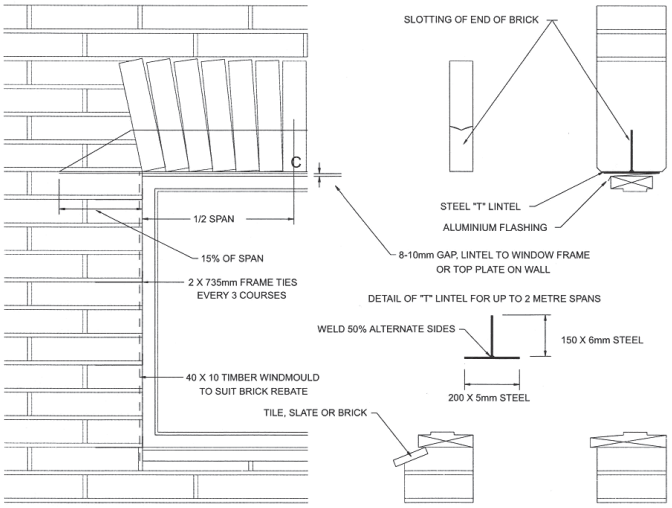


Figure 69. Example of Lintel reinforcement

All the works are done using the fabricated frame scaffold placed in front of the areas of the facades where the required works make it necessary like in this case.

QUALITY CONTROL

In the case of masonry structures with damaged or missing bricks it's possible to check with architectural salvage companies that reclaim brick from demolished historic structures. Also, many masonry supply houses offer a wide variety of brick products such as handmade brick made in the way they have been for centuries. It shouldn’t be hard to find new brick that blends with the old.

RESULTS

The following pictures were taken after the first reconstruction, when part of the restorations works have been done (Figure 72, Figure 73) and when the reconstruction works finished (Figure 41, 42) where is possible to see the replacement of the masonry bricks and lintels

Figure 72. Exterior facade wall of northern, eastern wing, after first reconstruction

Figure 73. Courtyard facade of northern wing, after first reconstruction

Figure 70. Exterior facade wall of northern, eastern wing after the reconstruction works

Figure 71. Courtyard facade of eastern wing after the reconstruction works

NOTES AND OPINION

The replacement of the bricks in the facade walls acquired a similar appearance with the whole wall after the process of the restoration was done. Also the after the works in lintels some small pieces of bricks were placed in the front, the entire solution has been good and the stability of the lintels and the walls is guaranteed.

3.2.2.5 Work 5. Protective grille restored

DESCRIPTION OF THE PROBLEM

In this case we are not talking about an existing problem that should be repaired. This is only a demand of the new owner. This consist of the installation of a protective grille in determined

access of Traku Street to improve on safety requirements of the stores that are going to be placed in this establishments.

The following picture (Figure 74, Figure 75) and the draw (Figure 76) represent the state of the access of Traku Street before the reconstruction works started and the indication of the new demand for the grille.

Figure 74. State of one of the entrances for public areas of Traku Street before the reconstruction works of the facade started

Figure 75. State of the facade and the different access for public areas of Traku Street before the reconstruction works of the facade started

Figure 76. Demand of the protection grille for some access in the Facade draws

SOLUTION ADOPTED AND RESULTS

The solution adopted is to place a gate hinged metal that will be used to protect the glass windows of the main street facade. In the next pictures (Figure 77, Figure 78) is possible to see the replacement of all the doors and windows of this facade as well as the rehabilitation of the sockets and repainting the entire facade.

Figure 77. Protection grille installed in Traku Street facade

Figure 78. Protection grille

QUALITY CONTROL

The only consideration to be taken in my point of view is to guarantee that the material used for the protective grille anticorrosive layer to prevent rust stains in the facade.

NOTES AND OPINION

In my opinion the protective grille should be installed in all the windows situated of the ground floor of Traku Street. In addition of a safety requirement, equal for all the stores placed in this facade is a matter of homogenizing the appearance of the facade.

3.2.3 HUMAN SAFETY

The work is carried out in accordance to this general guidelines about rules of health and safety requested in constructions. Before start the works demarcation of the area to intervene, placement of collective protection measures and the installation of canopies to ensure the safety of people must be carried out.

Recommended measures:

- Operate correctly with the materials and work equipment (machines, tools, implement and personal protective equipment) necessary to achieve the required performance and quality, observing established safety measures while undertaking day weekend.
- Check and condition work spaces, materials and equipment required, to achieve the required performance and quality execution, complying with health and safety measures in place.
- Identifying spaces, features, and finishes from the restoration period.
- In case of demolition area, this must be demarcated before start the works.
- The tools, implement, personal protective equipment and auxiliary resources that are selected are appropriate for the activity to develop.
- Safety measures and environmental protection are adopted by the orders received through verbal and / or written.
- Removing toxic building materials only after thorough testing has been conducted, without regard to personal and environmental safety.
- Providing workers with appropriate personal protective equipment for hazards found at the worksite. Potential hazards are assessed with the use of necessary public signage etc.
- Workers are allowed to work only with the knowledge of safety and health rules.
- Contingencies identified in the construction are resolved within its purview, and if it's necessary communicate responsible as quickly as necessary to enable monitoring and resolution, especially those that compromise the health and safety of workers or others, in particularly in jobs in public roads.
- The building official should organize the staff to undertake the works and avoid the interferences in the execution of various construction tips at the same time.
- The measures to minimize noise and dust emissions, and in general environmental protection measures, are collected and confirmed, respecting them during the execution of the work.
- The waste is deposited in the appropriate containers for each type of waste according to safety data sheets of the products.
- Maintenance and replacement operations are performed correctly to all work equipment used and to all collective protections at the end of each day
- Order and cleaning
- Adding a new stairway or elevator to meet health and safety codes in a manner that preserves adjacent features and spaces from the restoration period.
- It generally prohibits the use of ladders or scaffolding on stands in places with risk of falling from height.
- Use the winch to up and down the materials
- All staff/employees are fully trained in respect of health and safety to include instruction and supervision.

3.2.4 ORGANIZATION OF WORKS OF FOUNDATION WATERPROOFING

In this section we are going to study the schedule of one of the restorations works (Figure 79), particularly the "foundation waterproofing". For these works I'm going to assume the quantity of 238.13 m², the works are done by two teams, one construction team with two workers and a second waterproofing team with two workers more, calculations were made assuming a total of 20 working days per month with 8h day.

Work Name	Duration	Start	End
Process of Foundation-waterproofing	**18,78 días**	**mié 01/05/13**	**lun 27/05/13**
Trench excavation	18,65 días	mié 01/05/13	lun 27/05/13
Earthmoving	7 días	mié 15/05/13	vie 24/05/13
application asphalt emulsion of modified	5,83 días	jue 16/05/13	vie 24/05/13
Draining polyethylene nodular sheet	6,25 días	vie 17/05/13	lun 27/05/13
drainage ditch	3,88 días	mar 21/05/13	lun 27/05/13

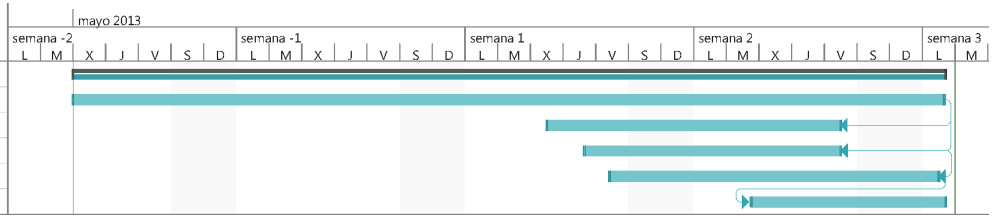


Figure 79. Schedule of Foundation Waterproofing works *días = days, Mayo = May, lun = Monday, mié = Wednesday, vie = Friday*

3.2.5 MATERIAL AND TECHNICAL RESOURCES OF ALL THE FAÇADE RESTORATION WORKS

This sections is a list to quantify the workforce and, the materials, tools and machinery used to perform the different restoration works (Figure 80). I'm going to list the materials and machinery and workforce used in each work without specifying the units because for the moment the duration and the workforce is an unknown data.

Figure 80. Information chart Facade restoration works

MASONERY RESTORATION			VERTICAL WALL CRACKS			FOUNDATION WATERPROOFING			REPLACEMENT MASONERY			PROTECTIVE GRILLE INSTALLATION		
Nº	NAME	UNITS	Nº	NAME	UNITS	Nº	NAME	UNITS	Nº	NAME	UNITS	Nº	NAME	UNITS
1	**Workers**		**1**	**Workers**		**1**	**Workers**		**1**	**Workers**		**1**	**Workers**	
1.1	Site manager	Pers	1.1	Site manager	Pers	1.1	Site manager	Pers	1.1	Site manager	Pers	1.1	Site manager	Pers
1.2	Workers	Pers	1.2	Workers	Pers	1.2	Workers	Pers	1.2	Workers	Pers	1.2	Workers	Pers
2	**Materials**		**2**	**Materials**		**2**	**Materials**		**2**	**Materials**		**2**	**Materials**	
2.1	Water-Repellant for facade	kg	2.1	Mortar	m^3	2.1	asphalt emulsion	kg	2.1	Bricks	u	2.1	Grille	u
2.2	Sand for abrasive blasting	m^3	2.2	Backer rod	kg	2.2	Modified bitumen sheet	m^3	2.2	Mortar Cement	m^2	2.2	Screw	u
2.3	Mortar	m^3	2.3	Sealant	kg	2.3	Draining polyethylene nodular sheet	m^3	2.3	Steel doble T lintel	kg	2.3	Nuts	u
			2.4	Sand	m^3	2.4	perforated drain tile	m^3	2.4	Nuts	u	2.4	Groomets	u
						2.5	gravel	kg	2.5	Bolts	u	2.5	Grille fix accesories	u
									2.6	Grommets	u			
3	**Tools and machinery**		**3**	**Tools and machinery**		**3**	**Tools and machinery**		**3**	**Tools and machinery**		**3**	**Tools and machinery**	
3.1	Abrasive Blasting machine	U	3.1	Radial saw	U	3.1	backhoe	U	3.1	Trowel	U	3.1	Level	U
3.2	Trowel	U	3.2	Trowel	U	3.2	Shovel or spade	U	3.2	Level	U	3.2	Screwdriver	U
			3.3	Sealant applier	U	3.3	paint roller	U	3.3	Adjustable wrench	U			
						3.4	asphalt emulsion machine	U						
						3.5	oxyacetylene torch	U						

3.2.6 CALCULATION OF THE PRICE FOR THE WORKFORCE FOR FOUNDATION WATERPROOFING WORKS

Calculations were made assuming a total of 20 working days per month with 8h day. Price of tables are done with 1 site manager and 1 worker. The length of the waterproofing installation is 192,8m, a quantity of 238.13 m² for the foundation waterproofing installation and the dimensions of the trench to perform the works are 1,5 m of deep and 1,5 m of width.

ADE010 m³ Excavation of the trench

Excavation in trenches for installations in any type of terrain, mechanical means, removal of excavated materials and loading on truck.					
Data base code	U	Decomposition	Performance	Price/U	Price
mq01ret020b	h	Wheeled Backhoe 75 CV.	0,344	35,52	12,22
mo104	h	Ordinary worker	0,180	14,31	2,58
	%	Auxiliary equipment	2,000	14,80	0,30
	%	Indirect costs	3,000	15,10	0,45
				Total:	15,55

GTA010 m³ Soil transport with truck

Soil transport with truck to specific dumping site situated at a distance of 10 km, and waste disposal					
Data base code	U	Decomposition	Performance	Price/U	Price
mq04cab010c	h	Dump truck, 12 t de carga, 220 CV.	0,129	40,17	5,18
	%	Auxiliary equipment	2,000	5,18	0,10
	%	Indirect costs	3,000	5,28	0,16
				Total:	5,44

NIM011 Exterior waterproofing of the wall in contact with the land, with modified bitumen sheet m²

Waterproofing of the basement wall or buried structure, in the outer face, with modified bitumen sheet with elastomer SBS, LBM(SBS)-30/FV (50), with asphalt emulsion primer, type EB (eff 0,35 kg/m²)					
Data base code	U	Decomposition	Performance	Price/U	Price
mt14iea020c	kg	Asphalt emulsion prime type EB, UNE 104231.	0,350	2,16	0,76
mt14lba010a	m²	Modified bitumen sheet with elastomer SBS, UNE-EN 13707, LBM(SBS)-30/FV (50), armoured with fiberglass mat 60 g/m², non-protected surface.	1,100	6,64	7,30
mo027	h	Site Manager	0,196	15,67	3,07
mo062	h	Ordinary Worker	0,196	14,70	2,88
	%	Auxiliary equipment	2,000	14,01	0,28
	%	Indirect costs	3,000	14,29	0,43
Approximated maintenance prince in the first 10 years: 0,79 €/year				Total:	14,72

NIM030 m² Outdoor drainage layer for walls in contact with the land, with nodular sheets.

Drainage of basement wall or buried structure, in the outdoor face, with drainage nodular layer, of high density polyethylene, with 7,3 mm of nodular height, compression resistance 180 ± 20% kN/m² according to UNE-EN ISO 604 and draining capacity of 4,8 l/(s·m),subject to the wall by adhesive fasteners, and topped with metal profile					
Data base code	U	Decomposition	Performance	Price/U	Price
mt14lbd190C	m²	drainage nodular layer, of high density polyethylene, with 7,3 mm of nodular height, compression resistance 180 ± 20% kN/m² according to UNE-EN ISO 604 and draining capacity of 4,8 l/(s·m).	1,100	2,74	3,01
mt14lbd195b	U	Adhesive fasteners	6,000	0,59	3,54
mt14lbd245b	m	Metal profile for the top	0,300	1,13	0,34
mo027	h	Site manager	0,210	15,67	3,29
mo062	h	Ordinary worker	0,210	14,70	3,09
	%	Auxiliary equipment	2,000	13,27	0,27
	%	Indirect costs	3,000	13,54	0,41
Approximated maintenance prince in the first 10 years: 0,70 €/year				Total:	13,95

ASD010 m Drainage ditch

Drainage ditch, filled with gravel, in the bottom of which has a slotted a high density flexible polyethylene pipe with double cover, corrugated outside and smooth inside, buried, with 100 mm of diameter					
Data base code	U	Decomposition	Performance	Price/U	Price
mt11tdp010b	m	High density flexible polyethylene pipe (PEAD/HDPE) slotted with double cover, corrugated outside and smooth inside, buried, with 100 mm of diameter, according to UNE 53994-EX, includes joints and complementary pieces.	1,020	4,64	4,73
mt01ard030b	t	Filter gravel	0,490	9,50	4,66
mo018	h	Site manager	0,161	15,67	2,52
mo103	h	Ordinary worker	0,322	14,60	4,70
	%	Auxiliary equipment	2,000	16,61	0,33
	%	Indirect costs	3,000	16,94	0,51
Approximated maintenance prince in the first 10 years: 0,59 €/year				Total:	17,45

3.2.7 TECHNICAL - ECONOMIC INDICATORS

QUANTITY OF WORKS:

192,8 m of wall for waterproofing installation, with a trench of 1,5 m of deep and 1,5 m of width, resulting in a total of 433,8 m³. The surface for the waterproofing installation is considered in 238,13 m² according to the area reflected in the draws.

INSTALLATION AND WAGE COSTS:

Trench excavation: 15,55 €/m³ x 433,8 m³ = 6745,60 €

Earthmoving: 5,44 €/m³ x 433,8 m³ = 2359,87 €

Asphalt emulsion and modified bitumen sheet: 14,72 €/m² x 238,13 m² = 3505,27 €

Draining polyethylene nodular sheet: 13,95 €/m² x 238,13 m² = 3321,91 €

Drainage ditch: 17,45 €/m x 192,8 m = 3364,36 €

TOTAL = 19297,01 € or 66574,68 Lt

DURATION OF THE WORKS:

I'm going take in account the data of the site manager efficiency to determinate the real duration of the works.

18,78 days. 18 days and 18h and 43 min

4. ORGANIZATION PART

4.1 ANALYSIS OF CONSTRUCTION MASTERPLAN

4.1.1 DESCRIPTION OF THE TERRITORY

The plan of building lot is composed for a reconstruction for an old building in Vilnius (Lithuania), Traku Street 14. In the plan of building lot is intended:

- The main machines working places and moving tracks;
- Storages and storing sites positions;
- Temporary electricity, water-supplying, sewerage and fireplug, positions;
- Safety and dangerous zones;
- Territory and dangerous zones enclosure, roofs and so on;
- Temporary access roads and paths;
- Temporary workers buildings and room's positions.

The plan of the building lot is prepared before start the reconstruction works. The works needed to perform in the courtyard hider the placement of the temporary worker buildings in the area inside the lot, so for this purpose the garden of the twin building (same plot) is used after the suitable permit is obtained.

The interior area of the courtyard is cleaned, the soil is pushed aside and transported with truck to the dumping site. All the preparation of the work site has to be made according to the organization project. The access to the plot is surrounded by a protective fence as the facade of Traku Street, an auxiliary pedestrian path is enabled in this façade because of the disqualification of this by positioning of the protective fence. The works in the other facades, located in the courtyard of the neighbour's buildings are surrounded by a Mobile fence of protection and access prohibition.

For the characteristics of the building and the requirements of the reconstruction works the installation of a crane is not necessary, the use of a crane installed in the plot area may difficult the start of the works to waterproof the foundation and the short period of time when can be necessary the use of the crane results in an expensive costs. Instead of a crane a handler telescopic handler is used to move the materials for the works in the roof. A fabricated frame scaffold and a lifting platform are used for the works in the facades. The fabricated frame scaffold is used only

in the areas where is necessary to perform the replacement masonry works and the reinforcement of the lintels.

On the preparation stage, the following works are supposed to be done:

- Prepare the auxiliary workers and managing staff building
- Cleaning of plot area
- Installation of fences and marking and signage for the work site
- Prepare storage sites.

All the auxiliary buildings for workers and managing staff will be supplied by water and electricity by temporary connexions to the existing network. The building is also provided with electricity and water by temporary connexions to the existing former networks.

4.1.2 SELECTION OF THE FABRICATED FRAME SCAFFOLD

The criteria for the selection of the scaffold is done according to the Spanish regulations and the knowledge acquired from my home university.

4.1.2.1 Criteria for the selection of a scaffold

- Support system used
- Location and conditions of the work
- Building geometry modulation elements
- Forecast of the works to be done where the presence of the scaffold is necessary
- Staff access and materials
- Resistance of the scaffold and the supports
- Occupation of vials and collective protection

4.1.2.2 Conditions to be met by any scaffold

- Resistance: All parts must be of the suitable material and with the resist section for the work done on them, taking into account conservation and previous uses
- Stability and rigidity: The arrangement of the pieces that make up the scaffold must ensure the stability and rigidity
- Security: The accesses and the scaffold must be safe and be provided with the necessary elements to ensure the security in their use

- General Safety: Safety for other people

4.1.2.3 Safety conditions for any working scaffold

- Minimum width of working platform: 60cm. (collection of material to use at the moment)
- If material is collected for use in the day, you should add more platform width: minimum + 30 cm =90 cm
- Maximum platform length between supports: 3 m
- Unanchored maximum height: 3 m
- Maximum height without bracing modules: 2 m
- Maximum separation from the platform to the façade 45 cm
- Maximum height of working platform from which it is compulsory the use of the protective railings for falling risk: 2 m, except the sides pointing to the façade with a distance of < 20 cm between them
- Minimum height of handrail: 1 m
- Railing must be formed by railings, intermediate railings and skirting

4.1.2.4 Rules and regulations charts for tubular fabricated frame scaffold

The following charts (Figure 81, Figure 82 and Figure 83) are used for the selection and designation of the tubular fabricated frame scaffold.

Load calculations for working platforms					
1	2	3	4	5	6
Class	Uniformly distributed load KN/m²	Concentrated load in area of 500 x 500 mm KN	Concentrated load in area of 200 x 200 mm KN	Load in a partial surface	
				KN/m²	Partial surface Ac m²
1	0,75	1,50	1,00	Not applicable	
2	1,50	1,50	1,00		
3	2,00	1,50	1,00		
4	3,00	3,00	1,00		
5	4,50	3,00	1,00	5	0,4 x A
6	6,00	3,00	1,00	7,5	0,4 x A
				10	0,5 x A

Figure 81. Table 3 of EN 12811-1

Class	Type of work to be perform	Minimal dimension characteristics		
		Width	Length	Height
1	For the control and works done with light equipment and without storage of materials.	Minimum W06	From 1,50 to 3,00 Increasing in intervals of 0,30 or 0,50 m	Minimum 1,90 m 2,00 m between platforms H1 H2
2	Inspection works			
3	For operations that do not involve necessarily materials storing, only than those that are going to be used immediately, for example, paint, plaster, plaster, plastering, sealing jobs			
4	For light brickworks	Minimum W09	From 1,50 to 2,50 Increasing in intervals of 0,30 or 0,50 m	Minimum 1,90 m 2,00 m between platforms H1 H2
5	For heavy brickworks			
6	For heavy brickworks with a important material storing in the scaffold surface			

Figure 82. Table 1 of EN 12810-1

Tubular scaffold Designation form facades according to the Spanish regulation UNE en -12810-1
Scaffold EN 12810 - [Class][Falling test] - [Width of the system]/[Maximum length of the platform] - [Free height class] - [Coating type] - [Vertical communication ladder type]
• Class: 2, 3, 4, 5, 6 • Falling Test: D (Yes) N (No) • Width of the system: SW06, SW09, SW12, SW18, SW21, SW24 • Length of the platform: 1,50; 2,00; 2,50; 3,00 m • Free height class: H1 (1,75 - 1,90 m), H2 (≥ 1,90 m) • Coating type: A (with coating) B (without coating) • Vertical communication ladder type: LA (hand ladder) ST(ladder access module) LS (mixed)

Figure 83. Designation references table

4.1.3 CLASSIFICATION AND CHARACTERISTICS OF THE SCAFFOLD

Types:

7 scaffolds type SCAFFOLD EN 12810 – 3N – SW06 / 2,50 – H2 – A – ST are used in the courtyard, northern exterior facade and eastern exterior facade

1 scaffold type SCAFFOLD EN 12810 – 6D – SW09 / 2,50 – H2 – A – ST is used in Traku Street facade

General properties of the scaffolds:

- Traku Street facade: Total length: 30,00 m Working height: 9,00 m
- Courtyard northern wing: Total length: 14,00 m Working height: 7,00 m

- Courtyard eastern wing: Total length: 37,50 m Working height: 9,00 m
- Courtyard southern wing 1: Total length: 6,50 m Working height: 9,00 m
- Courtyard southern wing 2: Total length: 16,00 m Working height: 9,00 m
- Exterior facade northern wing: Total length: 16,00 m Working height: 13,00 m
- Exterior facade eastern wing 1: Total length: 19,50 m Working height: 13,00 m
- Exterior facade eastern wing 1: Total length: 12,50 m Working height: 13,00 m

The structure complies with all the imposed requirements concerning stability and deformation.

4.1.4 DESCRIPTION DRAWS WITH THE DIFFERENT PARTS OF THE SCAFFOLD

In the following draws (Figure 84) appear all the different parts which is composed the tubular scaffold.

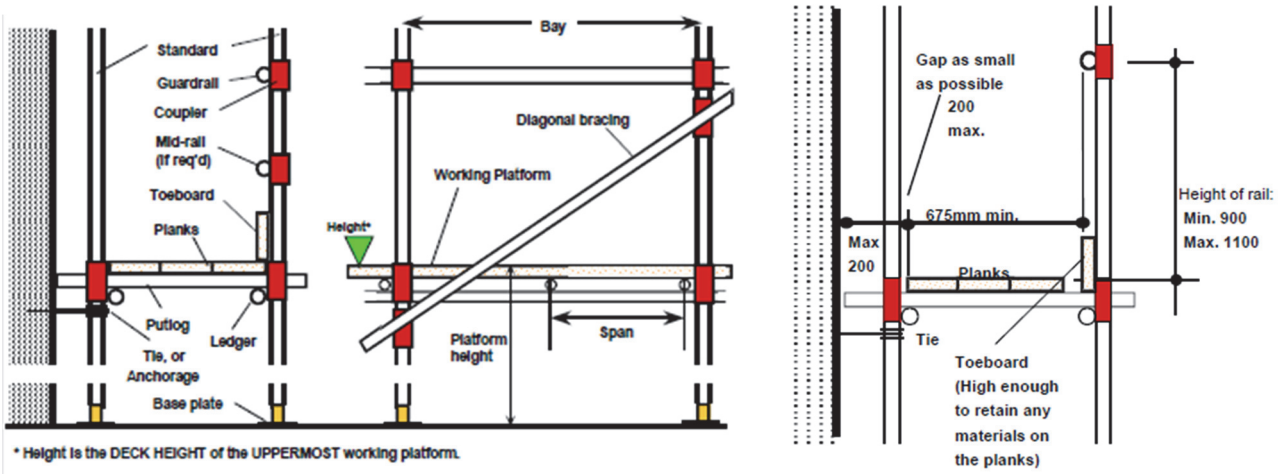


Figure 84. Parts of the scaffold

At any time, there must be at least 450mm clear walking space when stacking materials on scaffolding platform, in the pictures the platform is constructed with wooden planks but in our scaffold all the system is made with steel.

Steel base plates must be used with all tubular scaffold (Figure 85). Where the ground is anything else but concrete or other firm material, ADD timber sole plated under the steel base plates.

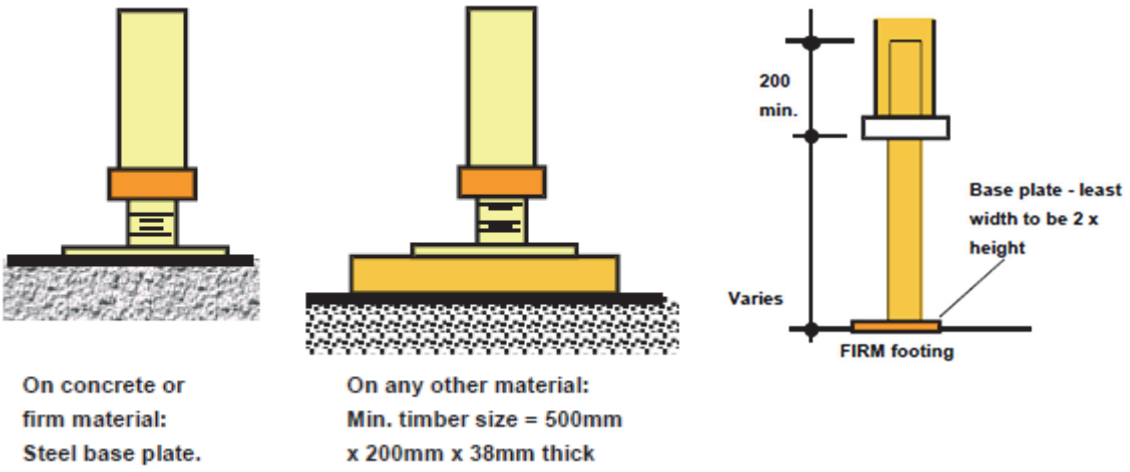


Figure 85. Steel Base Plates

4.1.5 NOMENCLATURE FOR EUROPEAN SCAFFOLD, NAME OF THE BRAND: DACAME

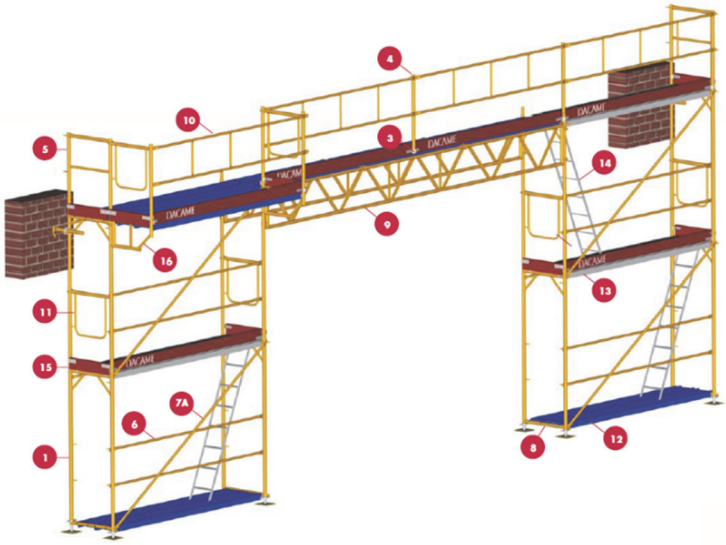
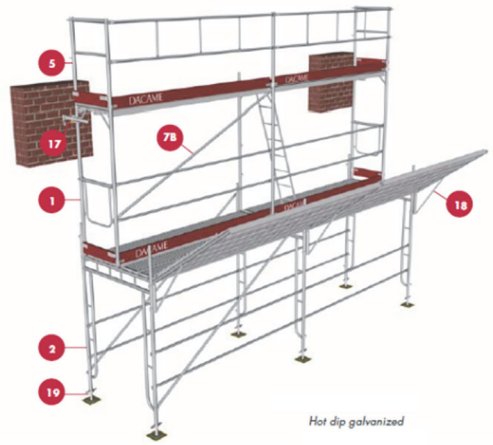


Figure 86. Nomenclatures for European Scaffold

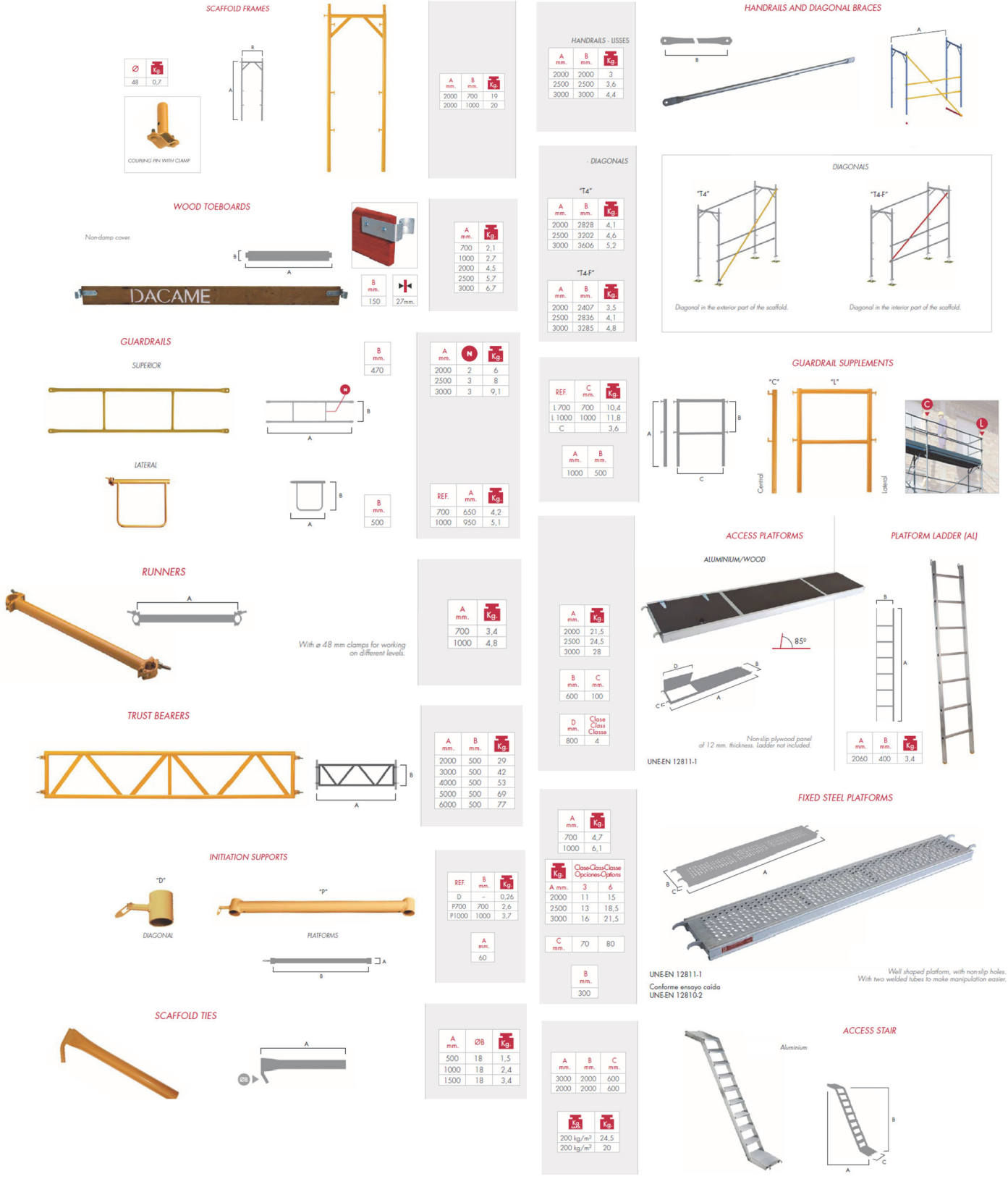


"DINO-48" SCAFFOLD

1.- SCAFFOLD FRAME
2.- WALKTHRU FRAME
3.- COUPLING PIN WITH CLAMP
4.- CENTRAL GUARDRAIL SUPPLEMENT
5.- LATERAL GUARDRAIL SUPPLEMENT
6.- HANDRAIL
7A.- DIAGONAL PIPE "T4"
7B.- DIAGONAL PIPE "T4-F"
8.- PLATFORM INITIATION SUPPORT
9.- TRUST BEARER
10.- SUPERIOR GUARDRAIL
11.- LATERAL GUARDRAIL
12.- FIXED STEEL PLATAFORM
13.- ACCESS PLATAFORM
14.- PLATAFORM LADDER (AL)
15.- WOOD TOEBOARD
16.- SIDE BRACKET
17.- SCAFFOLD TIE
18.- BRASH COLLECT SUPPORT
19.- JACK BASE

Figure 87. Nomenclatures for European Scaffold

4.1.6 EXAMPLES OF COMMERCIAL PARTS, NAME OF THE BRAND: DACAME



4.1.7 ASSEMBLY INSTRUCTIONS FOR THE EUROPEAN SCAFFOLD, NAME OF THE BRAND: DACAME (Figure 88, Figure 89, Figure 90 and Figure 91)

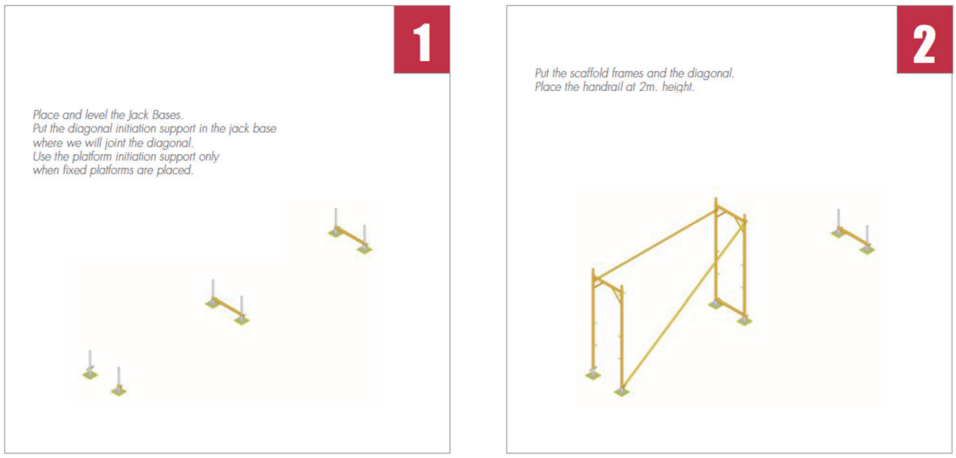


Figure 88. Instructions 1 and 2

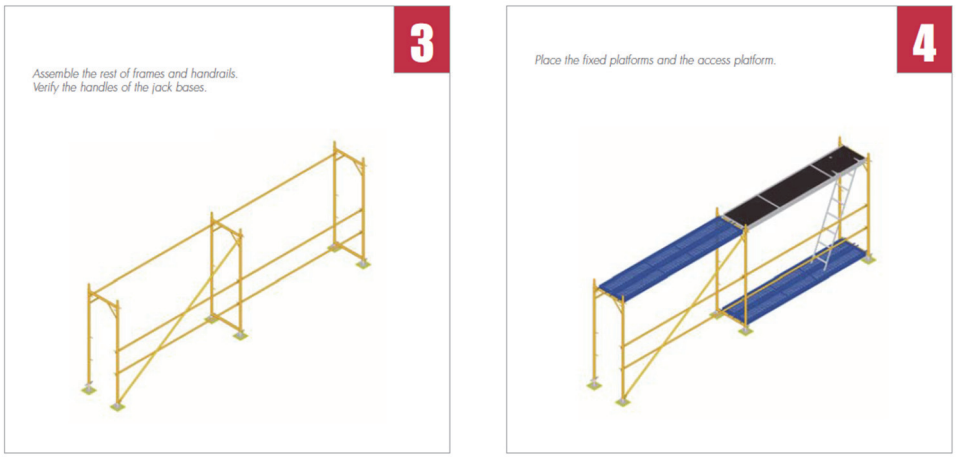


Figure 89. . Instructions 3 and 4

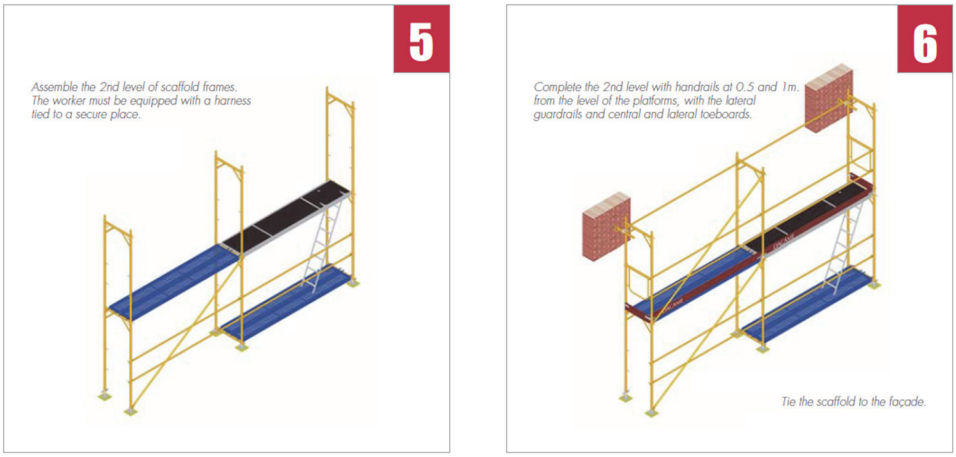


Figure 90. Instructions 5 and 6

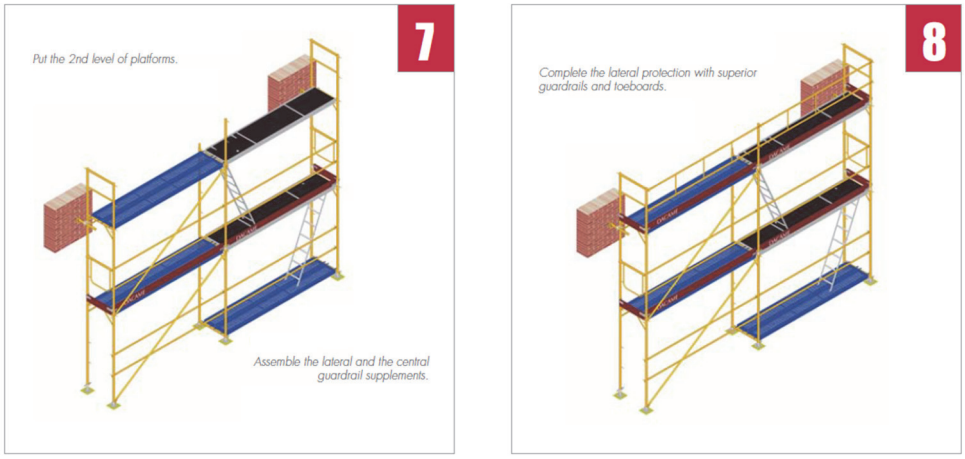


Figure 91. Instructions 7 and 8

4.1.8 TEMPORARY ACCESS TO THE WORK SITE

Two accesses are enabled, one in the main access of Traku Street and another one in the northeast through Vilniaus Street, for the works in the exterior facades in the north and east wing. These access are used to bring the material, equipment, machinery, etc. The accesses are already built so there is no work necessary to perform regarding to these part.
The width of the both access is enough to permit the passage for the machinery necessary to be used during the reconstruction but we must take these dimensions in account to ensure the correct progress of the works (3.00 of width and 3.46 of height, 4.34 in the highest point)

4.1.9 TEMPORARY STORAGE AREAS

The storage areas are planned all of them inside the work site. The main exterior storage area is placed near the work site fence (area of 6x4 m). More storage areas are planned in areas inside the building according to the schedule and the works performed in this areas.

4.1.10 TEMPORARY BUILDINGS FOR WORKERS AND MANAGING STAFF

The workers and the managing staff will have their own temporary building in one area close to the works site, this building will satisfy all the necessities of the personal and is dimensioned according to the number of workers during the whole process of the reconstruction works.

Both buildings are placed in the garden of the twin building (same plot) after the suitable permit is obtained. The managing staff will have one temporary building (7,0x 4,0x 2,3 m) where the office will be situated. The workers will have two temporary buildings (9,0x4,0 x2,3) where will

be situated the lockers, seats, tables, etc. Also they will have two modules (3,0x3,0x2,3) with showers, toilets and sinks.

Possible examples of work temporary buildings: http://www.consmetal.es/casetas-de-obra.html

4.1.11 TEMPORARY ELECTRICITY SUPPLY

Will be needed a temporary electricity supply during all the works. The general electricity counter of the building is already connected to the Street network, the General counter is located in the entrance of the Traku street facade. So we just need to link a temporary connection for the temporary buildings of workers and managing staff.
Structured electrical network for the temporary buildings, power connection for 6 elements/ provisional building:

- 2 ud. RJ45 voice and data
- 2 ud. White outlet with 16A
- 2 ud. Independent line outlet with 16A

4.1.12 CONSTRUCTION SITE LIGHTNING

An auxiliary lightning system is not planned during the reconstruction works. The schedule planned in turns of 8h/day, the existence of lights in the plot and characteristics of the works to be done (with the majority in premises inside the building object of the reconstructions) makes unnecessary the installation of a special lightning system.

4.1.13 TEMPORARY WATER SUPPLY

A temporary water supply is needed to provide the temporary buildings (shower and toilets). The building objects of the reconstruction works is already connected to the general network, so the temporary connection is not needed in this area.

A temporary counter is connected to the network that provides the twin building, next to the temporary buildings location, these temporary connection will need a counter, a general stopcock, and a tube pipe of 32 mm of diameter, derived later to the both buildings which needs the supply. All the connexion mentioned is coupled by the description draw (Figure 92).

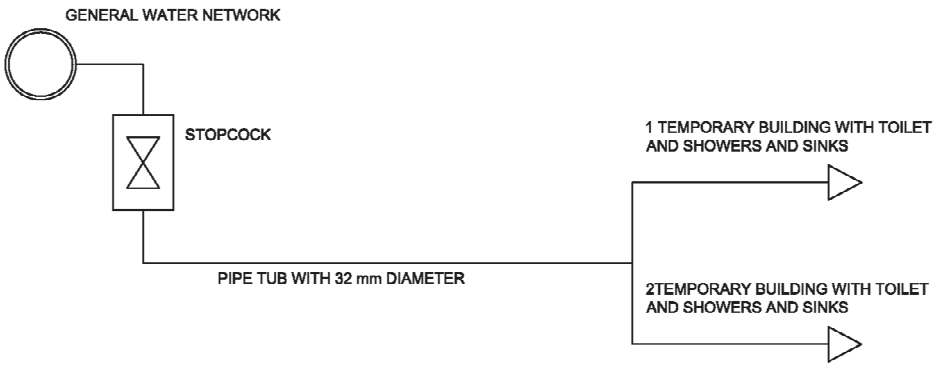


Figure 92. Provisional water supply description

4.1.14 TEMPORARY WASTEWATER CONNECTION (SEWERAGE)

The conection to the wastewater network is needed to remove water from the showers, toilets and sinks of the temporary buildings. For this purpose the buildings have a temporary connection to the wastewater network with 200 mm of diameter to connect the system with the general network. The raining water and the water used in the building is removed by the existing sewerage located in the courtyard and in some premises inside the building.

4.1.15 PROTECTION FENCE OF CONSTRUCTION SITE

The building temporary fence will translucent be formed by rigid wire mesh panels and metal poles, these will be placed in Traku street facade and in the interior access of the building, where a rigid metallic gate is also provided. This fence is ideal for construction and reconstruction works because of the rapid assembly and disassembly. The next pictures are a description draw of the installed fence with the auxiliary pedestrian path next to them, and an example of the type of fence used.

Figure 94. Example of type of fence used

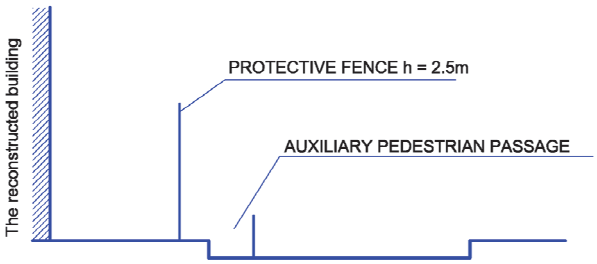


Figure 93. Description draw of the solution to protect the people from Traku Street facade

The height of the fence will be 2,50 meters and we will need 41 m of fence to close all the necessary areas.

Information: http://www.tfh.com.au/products/temporary-mesh-fencing.html

Another type of fences and barriers are used in the work site. The first is the Mobile fence for protection and access prohibition (Figure 95) of which is needed 80 m and the second consists in a kind of crowd control barrier (Figure 96) of which is needed 33, used to delimit the auxiliary pedestrian path m, and protect the people from the makes making the path more visible.

Figure 95. Example of mobile fence for protection and access prohibition

Figure 96. Crowd control barrier

Information: http://www.tfh.com.au/products/crowd-control-barriers.html, http://www.tfh.com.au/products/water-barriers.html

4.1.16 TEMPORARY COMUNICATION

The temporary communication will consists in cellular phones, and internet devices located in the temporary buildings of the construction site. One of them should be located in one of the reconstructed building areas, of which all the personal will be informed.

4.1.17 GENERAL REQUERIMENTS OF LABOR SAFETY AND PROTECTION

- Building entrance and Traku Street are surrounded of 2,5 m high wire mesh fence.
- Other facades are surrounded by a mobile fence for protection and access prohibition
- In construction site is being installed firefighting shield with fire extinguishers, crowbars, shovels, buckets, box with sand.
- All persons in the reconstruction site must wear protective helmets.
- For doing a work is being used only scaffolding and ladders of inventory.
- The fences of the construction is being posted with signs about imminent danger and is informing that unauthorized persons entering to the construction site is prohibited strictly.

- All work is being made as is required in technological requirements.
- Reconstruction contractor before work informs employees with safe working conditions.
- Dangerous zones are determined and marked with highly visible warnings.
- Develop a list of hazardous work in a construction site.
- If weather conditions are bad the works in exterior areas will stop - cancel all work.
- Workers locations are installed out of dangerous zones.
- Check whether the tools and appliances which are being used for work, complies all standards.
- For each employee for service should be given a helmet, gloves, shoes with metal ends, working clothes and more equipment depending of their works
- Reconstruction rubbish should be disposed of in appropriate locations.
- Transport and traffic routes must be maintained in good order, the road surface must be cleaned
- Ladders, scaffolding and other must comply with all safety requirements - if the scaffolds are unsteady, it should be attached with the rope to the still surface. After installation check the connections on the fasteners. If there are traffic routes near, should be installed roofs, facades and scaffolding covered with net.
- Scaffolding and ladders are being viewed every 10 days.
- Work at a height where protection is rope, should work qualified worker.
- Dig trenches in sandy soils without reinforcement is possible only up to 1,25 m.
- Raising Material or, used pallets, straps, measures preventing the lifting objects to fall.
- It is prohibited to walk under raised structures or materials.
- Constructions which are raised should be well fortified.
- The materials can be packed on the roof only in the places where allows technical project and ensure that they are falling.

4.1.18 LIST OF HAZARD WORKS OF THE RECONSTRUCTION

- Reparation masonry using the scaffold or the elevation platform
- Work with hand tools and power machinery
- Welding
- Work excavators
- Working at heights
- Roof and façade works
- Installation works

4.1.19 PERSONAL PROTECTIVE AND SAFETY EQUIPMENTS (PPE)

Material	Number
Safety Helmet	Each worker
Gloves	Each worker
Protective clothes	Each worker
Safety Boots/Footwear	Each worker
Safety Glasses or Goggles	Workers of masonry restoration
Ear Protectors	Workers of masonry restoration
Safety Harnesses	Workers who use scaffold, platform and all works in the roof
Filtering Face-piece or Respirator	Workers of masonry restoration
First Aid Kit	One in each temporary building
Fire fighting	One extinguisher in in each provisional building, and a kit for Firefighting in courtyard

4.1.20 REQUIREMENTS OF ENVIRONMENTAL PROTECTION

When reconstruction work is completed, is required to remove construction waste, unnecessary soil, clean up all the plot area

If any of these works on time of year can´t be competed, they should be finished in the next season of planting. The building has been designed to meet the environment standards, according to the Lithuanian regulations:

STR 2.01.01(3):1999 „Essential requirements of the building. Hygiene, health, protection of the environment “.

4.1.21 REQUIREMENTS OF FIRE PROTECTION

During construction, will be followed rules about fire protection - construction works and installation of fire protection rules. In the future construction site in a visible and accessible place should be a panel with inventory: two buckets, two axes, two crowbars, ladders, hook, and 0.5 of

sand box, two fire extinguishers and two spades. Extinguishers are located in the temporary buildings. The building has been designed to meet the environment standards, according to the Lithuanian regulations:

STR 2.01.01(2):1999 „Essential requirements of the building. Fire Safety“.
General fire safety rules (2010-07-27, įsak. Nr. 1-223 redakcija).

4.2 RECONSTRUCTION SCHEDULING

After the analysis of the reconstruction scheduling the finals graphics of workforce, costs and machinery are obtained. Is important to emphasize that the schedule are done taking in account 8h of work/day with a total of 20 working days/month. All the data, costs and performance time are obtained from the Cype Construction and Rehabilitation base data using the quantities of work provided in the reconstruction project documents.

The final scheduling results in a project of 266 working days with a total cost of 1.610.000,00 € or 55.454.000,00 LT.

4.2.1 WORKFORCE

The next graphic (Figure 97) shows the quantities of workers/day taking in account all the works planned to be done at the same time. All the activities are placed in the first days of their available time. So is possible to modify the schedule taking in account this available time to do the activity making a better scheduling.

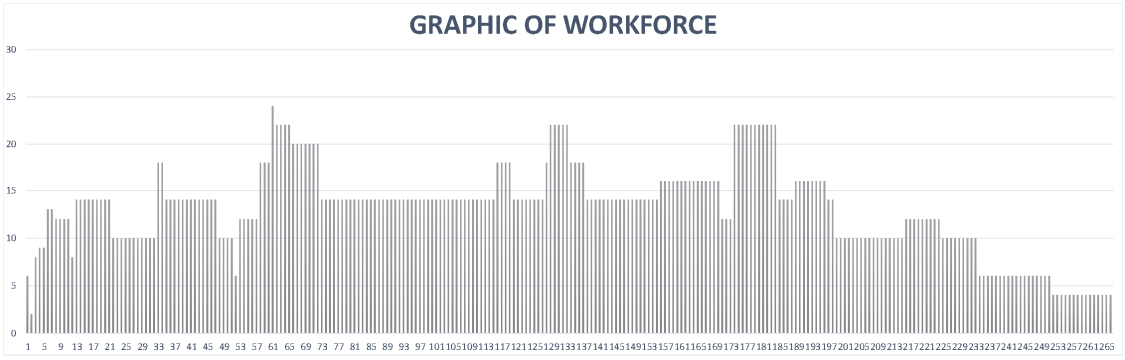


Figure 97. Graphic of Workforce

4.2.2 COSTS

The next graphic (Figure 98) shows the costs/day taking in account all the works planned to be done at the same time, and the line of the total increase of the costs from the origin. All the activities are placed in the first days of their available time. So is possible to modify the schedule taking in account this available time to do the activity making a better scheduling.

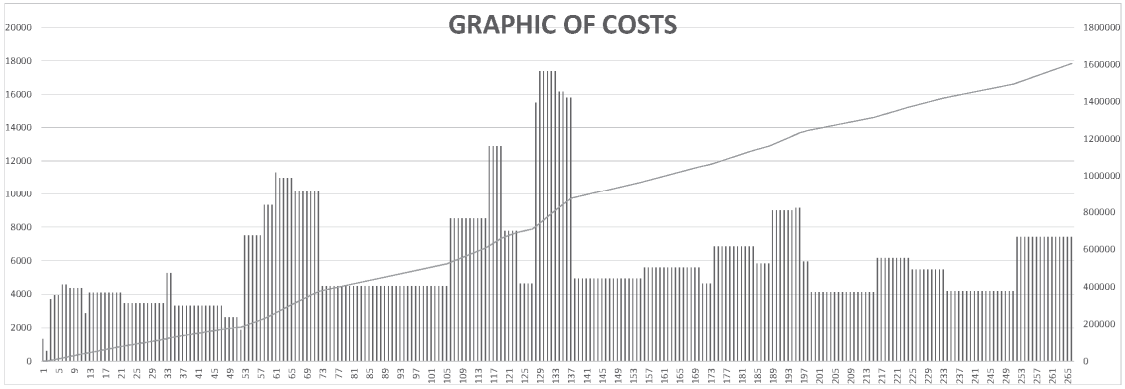


Figure 98. Graphic of costs

4.2.3 MACHINERY

The next graphic (**¡Error! No se encuentra el origen de la referencia.**) shows the costs/day taking in account all the works planned to be done at the same time, and the line of the total increase of the costs from the origin. All the activities are placed in the first days of their available time. So is possible to modify the schedule taking in account this available time to do the activity making a better scheduling.

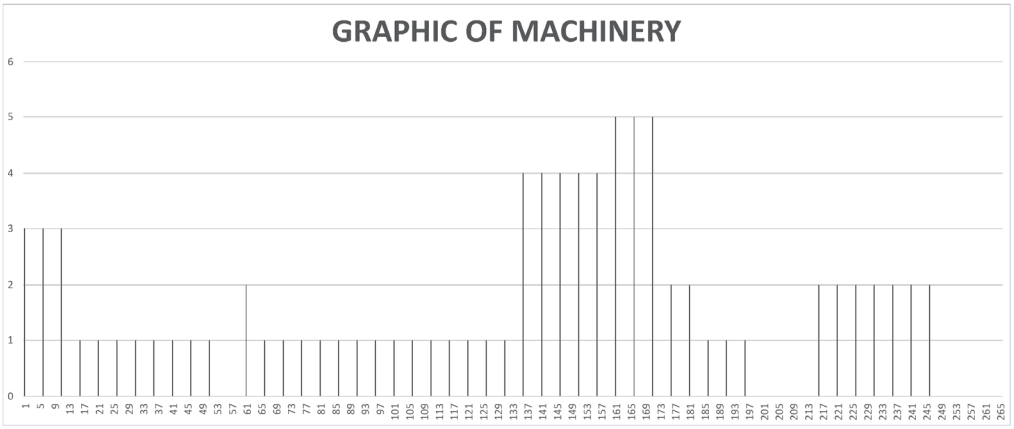


Figure 99. Graphic of machinery

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