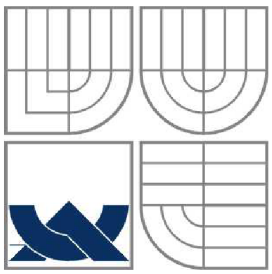

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FAKULTA STAVEBNÍ
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FACULTY OF CIVIL ENGINEERING
INSTITUTE OF BUILDING STRUCTURES

LOW ENERGY HOUSE
LOW ENERGY HOUSE

BAKALÁŘSKÁ PRÁCE
BACHELOR'S THESIS

AUTOR PRÁCE — MARIAN HLAVICA
AUTHOR

VEDOUCÍ PRÁCE — doc. Ing. JIŘÍ SEDLÁK, CSc.
SUPERVISOR

BRNO 2012

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Studijní program	B3607 Civil Engineering
Typ studijního programu	Bakalářský studijní program s výukou v anglickém jazyce a prezenční formou studia
Studijní obor	3608R001 Pozemní stavby
Pracoviště	Ústav pozemního stavitelství

ZADÁNÍ BAKALÁŘSKÉ PRÁCE

Student	Marian Hlavica
Název	Low energy house
Vedoucí bakalářské práce	doc. Ing. Jiří Sedlák, CSc.
Datum zadání bakalářské práce	30. 11. 2011
Datum odevzdání bakalářské práce	25. 5. 2012

V Brně dne 30. 11. 2011

.....	.....
doc. Ing. Miloslav Novotný, CSc.	prof. Ing. Rostislav Drochytka, CSc.
Vedoucí ústavu	Děkan Fakulty stavební VUT

Podklady a literatura

- Directives of the Dean No. 9/2009
- Building Programme defined by the text-based description
- Architectural study or sketches of the building, site conditions and requirements
- Technical Specifications, Eurocodes and National/European standards for building design and civil engineering
- Building Code No 183/2006 Sb., Public Notice No. 499/2006 Sb., Public Notice No. 268/2009 Sb. for the Czech students or keep to the terms of national Building Codes and building legislation valid in own country of international students.

Zásady pro vypracování

Architectural and structural design of the building as required by building codes in the documentation for building permit.
Graphic requirements and design documentation of the project:
- Drawings will be graphically elaborated on a white paper with the PC graphic editor
- Drawings will be equipped by unified description field (label) for each drawing unit. For the project defence and examination committee drawings will be folded and
fix up into specific paper coverings and put into fixed cover table with required lettering for Bachelor project (BP)
- Supplements of text and calculation sheets will be put in writing by technical lettering, typed print or PC text editors
- Editing and form of the main cover table in the format A4 (see sample for the BP at the Institute ÚPST). Cover tables for BP will be from the hard paper and covered by black fabric and head plate will be described and printed with gilded writing (letters)
- BP will be completed into three parts A, B and C and put into the cover tables
- Individual parts of BP will be equipped by description field (label) in the front page and with the table of contents inside.

Předepsané přílohy

Licenční smlouva o zveřejňování vysokoškolských kvalifikačních prací
A/ Basic documents
1. Assignments of Bachelor Project
2. Documents from the supervisor of Bachelor Project
B/ Studies
C/ Project drawings and technical documents (project in the level for realization)
1. Technical report
2. Technical situation and site plan
3. Foundations
4. Ground floor plans
5. Roof constructions, roofing and drainage system
6. Vertical cross sections
7. Front and side views
8. Building details and technical specifications of building components, external constructions and floor compositions
9. Assembly plan of precast structures or formwork drawings of cast in situ concrete
10. Report of fire safety and protection of building structures

11. Thermal assessment of external constructions of the building

.....

doc. Ing. Jiří Sedlák, CSc.
Vedoucí bakalářské práce

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FOLDER A – BASIC DOCUMENTS

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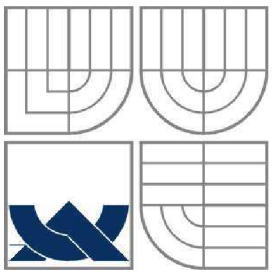
SUPERVISOR

BRNO 2012

FOLDER A: BASIC DOCUMENTS

1. TASK OF BACHELOR'S THESIS
2. DECLARATION
3. THANKS
4. ANOTATION, KEY WORDS, BIBLIOGRAPHY
5. LICENCES AGREEMENT
6. LIST OF SOURCES
7. CONTENT OF FOLDERS



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SUPERVISOR

BRNO 2012

Thanks:

I would like to thank my supervisor of the bachelor's thesis doc. Jiří Sedlák, CSc. for proper leading and supervision; patience and helpful advices during consultation.

Poděkování:

Tímto bych rád poděkoval vedoucímu bakalářské práce doc. Jiřímu Sedlákovi, CSc. za patřičné vedení, trpělivost a užitečné rady během konzultací.

Declaration

I declare, that I created the bachelor's thesis alone and that I statated all used information sources.

Prohlášení:

Prohlašuji, že jsem diplomovou práci zpracoval(a) samostatně, a že jsem uvedl(a) všechny použité, informační zdroje.

V Brně dne (In Brno, date) 25.5.2012

……
podpis autora (signature)

Abstrakt

Předmětem mé bakalářské práce je zpracování dokumentace novostavby nízkoenergetického rodinného domu. Objekt je dvoupodlažní, nepodsklepený. Půdorys domu je obdélníkového tvaru. Celý objekt je ukončen asymetrickou sedlovou střechou.

Klíčová slova

Bakalářská práce, nízkoenergetický dům, nízkoenergetický rodinný dům, rodinný dům, sedlová střecha

Abstract

The subject of my bachelor's thesis is creation of project documentation of a new low-energy family house. The building is a two-storey building with no basement. It is of a rectangular shape. The whole structure is enclosed with double-pitched non-symmetrical roof.

Keywords

Bachelor's thesis, low-energy house, low-energy family house, family house, double-pitched roof

Bibliografická citace VŠKP

HLAVICA, Marian. *Low energy house.* Brno, 2012. 54 s., 28 s. příl. Bakalářská práce. Vysoké učení technické v Brně, Fakulta stavební, Ústav pozemního stavitelství. Vedoucí práce doc. Ing. Jiří Sedlák, CSc..

PROHLÁŠENÍ O SHODĚ LISTINNÉ A ELEKTRONICKÉ FORMY VŠKP

Prohlášení:

Prohlašuji, že elektronická forma odevzdané práce je shodná s odevzdanou listinnou formou.

V Brně dne 25.5.2012

……

podpis autora

Marian Hlavica

Used legislation (požité právní předpisy):

- Law no. 183/2006 Sb., o územním plánování a stavebním řádu.

- Vyhláška MV č. 246/2001 Sb., o stanovení podmínek požární bezpečnosti a výkonu státního požárního dozoru.

- Vyhláška č. 137/1996 Sb., o obecných technických požadavcích na výstavbu

- Vyhláška č. 499/2006 Sb., o dokumentaci staveb

Použité ČSN (used standards):

- ČSN 73 4301 – Obytné budovy

- ČSN 01 3420 – Výkresy pozemních staveb

- ČSN 73 0540 – Tepelná ochrana budov

- ČSN 73 0802 – Požární bezpečnost staveb – Nevýrobní objekty

- ČSN EN 1992-1-1 – Eurokód 2: Navrhování betonových konstrukcí

Webové stránky výrobců a dodavatelů (web sites of manufacturers and suppliers)

www.katalog.betonserver.cz

www.vapis-sh.cz

www.ytong.cz

www.isover.cz

www.borga.cz

www.cemix.cz

www.porextherm.com

www.gutmann.de

CONTENT OF FOLDERS

FOLDER A: BASIC DOCUMENTS

FOLDER B: STUDY

FOLDER C1: REPORTS

FOLDER C2: CALCULATIONS

FOLDER C3: DRAWINGS

19. FLOOR COMPOSITIONS 1, 2, 5
20. FLOOR COMPOSITIONS 3, 4
21. LIST OF ELEMENTS - WINDOWS
22. LIST OF ELEMENTS - DOORS AND LINTELS

FOLDER C4: FIRE PROTECTION

1. FIRE PROTECTION REPORT
2. SITUATION

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FOLDER B – STUDY

BAKALÁŘSKÁ PRÁCE
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AUTHOR

VEDOUCÍ PRÁCE — doc. Ing. JIŘÍ SEDLÁK, CSc.
SUPERVISOR

BRNO 2012

FOLDER B: STUDY

1. SITUATION OF FURTHER RELATIONS
2. SITUATION
3. GROUNDPLAN 1.NP
4. GROUNDPLAN 2.NP
5. ELEVATION
6. SOUTH AND EAST VIEWS
7. NORTH AND WEST VIEWS

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FOLDER C1 – REPORTS

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SUPERVISOR

BRNO 2012

FOLDER C1: REPORTS

1. ATTACHEMENT A - ACCOMPANYING REPORT
2. ATTACHEMENT B - SUMMARY TECHNICAL REPORT
3. ATTACHEMENT F - TECHNICAL REPORT
4. THERMAL ASSASSEMENT OF BUILDING STRUCTURES
5. GEOLOGIC SURVEY

Content

a) Identification

Structure: Low energy family house, Rýmařov, N.P. 342/28

Investor: Jan Novák, Bartákova 28, Rýmařov 795 01

Designer: Marian Hlavica, Bartákova 38, Rýmařov, Student, Bachelor's thesis

Local building authorities: Rýmařov

b) Building parcel information

The building parcel is situated in the area defined for the residential buildings development. The area is unprocessed plane with a mild grass cover which has been until recently considered an arable land. The patch is in the ownership of the investor.

c) Initial surveying, measurements and technical and traffic network connections

There has been a geological investigation realized previously. There have also been performed several geological probes in the area. The overall parcel has been inspected by the designer.

There is a public road containing gas, electricity, water and sewerage network in the close neighborhood with the parcel.

d) Information of abiding of local authorities requests

All requests of affected entities have been fulfilled.

e) Information of following of building requests

All requests for common building procedure have been fulfilled. The latest CSN-EN and CSN have been followed.

f) Information of abiding legal commands of building law

All request of the local authorities has been fulfilled.

g) Time and item bonds of the construction towards surroundings

The construction has no effect (neither item nor time) on the possible present or future constructions.

h) Estimated duration of construction

Estimated construction start: 6/2012

Estimated construction completing: 3/2014

i) Estimated evaluation of the future construction expenses and floor area

The construction cost is estimated to 2800 tsd. CZK

Total floor area is 212.7 m^2.

Content

1. Urban, architectonic and technical (building) solution

a) Site evaluation

The building parcel is situated in the area defined for the residential buildings development. The area is an unprocessed plane with a mild grass cover which has been until recently considered an arable land. The nearest building in the south direction is over 30 m for which is suitable to avoid solar gains interruption The parcel is in the ownership of the investor.

b) The urban and architectonic solution of the construction

The building is a two-story building with no basement; The main entrance to the parcel will be situated in the eastern part of the northern face of the parcel. The main entrance of the building is situated in the left part of the northern façade; there is also side entrance situated on the eastern façade considered for easier garage and garden access as well as an service access to the technology equipment of the house. Both entrances are provided with a small polyuretan roof.

The house is oriented mostly in the north-to-south direction.

The structure is of a rectangular ground-plan suitable for low-energy systems to avoid excess heat losses. It has a white façade finished with 300 mm deep foot and with non-symmetrically pitched gable roof provided with metal tile shaped cover in black color penetrated with chimney and vent pipe as well as partially covered with solar collectors and photo-voltaic panels on the southern side.

The overlap of the roof varies according to the documentation. The gable walls will be covered with a wooden planking (larch wood).

The pitches of the roof are designed as 10° to the north and 45° to the south direction to create optimal position for sun energy using systems (collectors, PV panels).

The floor of the first floor is situated 250 mm above the formation ground level. The final construction of the access road will be adjusted in-situ according to the level of the main communication.

A garage will be solved as a single standing building at the eastern top part of the parcel.

The layout of the building is adjusted for an active family with two children in varying age.

The main window area is situated on the southern façade formed by windows ending roughly parallelly to floor finishes. There will also be constructed a wooden terrace in contact with the ground on the south side of the building.

The inner part is divided into one technical room, six habitable rooms and four non-habitable rooms; one water closet and two separate bathrooms.

The connection between both floors is achieved with a monolithic reinforced concrete staircase (exposed finish, stairs provided with wooden boards, railing from smoky glass)

All windows are formed with aluminum/wooden frames and triple glazing and all except from the ones on the northern façade are provided with adjustable motorized sunblinds in an exposed case.

c) Technical solution and networks; solution of outer land

1.) Foundations

Foundations are solved as foundation strips with a thin foundation slab at the top.

The external strips are formed with permanent formwork from concrete blocks mm) added with reinforcement bars filled with plain concrete. These strips are laid on a base layer of plain concrete – there will be 4 rows of the formwork as specified in the project documentation (further on referenced as PD).

Their external face will be provided with thermal insulation starting at the top of the house foot and ending below formation ground level. The face of the permanent foundation formwork must be flat – possible roughness on the surface of the slab (mentioned below) must be flattened and cleaned in-situ. The insulation will be formed with XPS glued with appropriate adhesive as specified in PD. The insulation will be separated from the drip pavement and other infill with geo-textile as referenced in PD.

There will be a drainage pipe laid in a sand bed covered with gravel infill installed at the bottom of the external foundation strip excavation acc. to PD.

The internal strips will be made from plain concrete in dimensions specified in PD.

The slab will be all over the ground plan projection of the house acc. to PD and will be made from concrete reinforced with steel grids.

Under the slab there will be compacted gravel bed and under it flattened compacted soil layer

The top surface of the slab will be provided with water-proof layer and then other layer of separation

The water-proof layer will be extended on the external masonry to the height of 280 mm. The top border of the water-proof layer will be connected with foundation profile supplied by the manufacturer of the foil.

There will be made two installation paths in the north-eastern part of the external strip acc. to PD.

2.) Vertical structures

The base layer of the load-bearing masonry preventing thermal bridges from the foundation strip will be formed with aerated concrete block YTONG P4 laid in a bed of acc. to PD.

Following load-bearing masonry of the external and main internal wall (extending to the top of the second floor wall) will be formed with lime-sand blocks VAPIS QUADRO E connected with construction adhesive VAPIS acc. to PD.

The internal load-bearing wall surrounding the staircase (extending to the top of the first floor) will be formed with aerated concrete blocks YTONG P4 connected with construction adhesive YTONG. These load-bearing walls will bear only the staircase and staircase landing slab (ceiling over hall as defined in PD) loads.

The openings in the load-bearing walls will be overcame with prefabricated lintels VAPIS as well as in-situ formed rc lintels as defined in PD and static calculation.

As thermal insulation of the external wall is used mineral wool ISOVER TF PROFI which will be connected to the masonry with aluminum anchors as specified by the manufacturer.

There will be plaster on both sides of all walls.

The whole façade insulation system is in the ETICS system as described in detail in PD.

The openings in the external walls will be filled with windows with aluminum / wooden frames and triple glazing with exposed external sunblinds cases (windows on the northern façade will have no external sunblinds) as well as with wooden doors prepared for the desired dimensions as defined in PD.

Each floor load-bearing walls will be finished with RC ring of varying height according to PD.

The internal partitions will be formed with aerated concrete blocks YTONG acc. to PD. The openings in the internal partitions will be overcame with prefabricated lightweight lintels YTONG.

3.) Horizontal structures

There will be two ceiling structures in the building – one above first floor, second above second floor.

Both will by formed with monolithic reinforced concrete slabs fixed into the RC rings of varying height acc. to PD.

The construction of the slabs and the composition of the single floors is described in detail in PD. (ceiling drawings, floor compositions)

For both slabs will be used concrete 20/25 and reinforcing steel B 500 B.

There will be used system formwork PERI for the ceilings creation..

The first slab has mainly a load bearing function (second floor load) while the second slab is more of a space separation, air tightness, temperature damping, noise protection, thermal accumulation, maintenance and load bearing function.

4.) Floors connection

The connection of the floors is realized through a monolithic reinforced concrete staircase which overcomes the cant of 3000 mm which separates the single floors. It is designed in accordance with the latest CSN-EN and CSN.

It is of a partly helical shape with U ground plan situated in the northern part of the central hall.

The bottom part of the staircase is laid on the layer of foam-glass to eliminate thermal bridges from the foundation strip situated below the stair connection. The top part is connected with the RC slab of the ceiling. There will be several hidden stringers formed around the load-bearing wall surrounding the staircase to transfer the loads from the staircase to the walls and thus to the foundations.

The height h of the single stair is 176.47 mm; the width of a single stair is 282.35 mm.

The top surface of the stairs is provided with wooden boards according to the shape defined in the ground plan of the staircase and building detail. Rest of the staircase is from an exposed concrete.

The hand-railing is designed in accordance with latest CSN-EN and CSN.

It is formed with metal frame and smoky glass infill. It is shaped acc. to PD.

The space below the staircase should be used as a storage space.

5.) Roof

The roof is laid on a reinforced concrete which is laid on a layer of foam-glass connected with construction adhesive VAPIS to eliminate thermal bridges from the roof construction.

There is a wall plate situated on the RC ring mentioned above, connected with threaded rods which are put into pre-drilled holes in the ring and sealed with special adhesive. The situation of the wall plate is defined in the PD.

The roof itself is consist of single trusses, lathing, cover, gable walls and bracing.

The trusses are designed in the special static software (Truss 4, demo) which defines their overall shape and dimensioning according to given permanent, climatic and variable load. They will be laid on the wall plate and fixed acc. to manufacturer's recommendation. The detailed definition of the trusses is prescribed in PD.

The trusses which define the overall shape of the roof are designed as double inclined with varying slope – the northern part is of 10° inclination while the southern part is of 45° inclination to secure suitable positioning of the solar collectors.

The lathing is formed by wooden beams situated acc. to PD. Its function is to support cover layer as well as secure certain amount of transversal stability.

The cover of the roof is formed with OSB boars covered with metal tile-shaped sheeting (BORGA ELEGANT, black color). Under the OSB boards there is a securing water-proof layer situated as defined in PD.

The gable walls are formed with OSB boards installed on the last truss to secure final attic space separation. Over the boards there are connected on which are connected external wooden boards which create external gable wall façade. The bottom of the boards will be provided with over-drip profile. The construction will be realized as defined in PD.

There are several types of bracing in the roof construction. The main spatial rigidity is achieved through the OSB boards cover as well as transversal vertical bracing among all of the trusses and horizontal bracing. All bracing is defined in PD. The bracing will be connected to the trusses with nails.

The composition of the roof cover as well as drainage and roof ventilation is prescribed in PD.

Used gutter system is BORGA, black color. Design of the system will be processed according to manufacturer's instructions. There will be two vertical pipes on the northern façade and one on the southern façade. The gutter system will be connected to the building

6.) Installation systems

The electricity systems will be situated in special grooves prefabricated in the load-bearing walls as well as in partitions (need of cutting the grooves). The net will be held in floor gaps.

The heating pipes will be held in floor gaps using double pipe. The heating system will be formed with radiators as well as convectors underneath floor-leveled windows.

The installations (water supply, sewerage, ventilation) will be held in the offset installation walls formed with gypsum boards systems (this solution affect mainly bathrooms and water closet) as defined in PD.

All the installations exceeding first floor (water supply, hot domestic water supply, sewerage, ventilation, electricity, heat piping) will be held in a shafts prescribed in PD.

The fumes from the gas burning in boiler will be ventilated through an over-pressure chimney held in the chimney space defined in PD.

7.) Heat loss elimination – thermal insulation and thermal bridges removal

The heat losses will be eliminated through overall thermal insulation surrounding the building envelope. This mainly consists of: Floor on the ground insulation, external wall insulation, second ceiling insulation and thermal bridges reduction.

The insulation of the floor on the ground is formed with EPS. The detailed composition is prescribed in PD.

The insulation of external walls is formed with ETICS system whose main thermal insulation consists of mineral wool considering the durability of the material exposed to a certain amount of UV rays. The detailed composition of the ETICS is defined in PD.

The insulation of the attic space is situated on the second ceiling (monolithic RC slab). The main part of this insulation system is formed with 150 mm of EPS. Detailed composition of attic thermal insulation is described in PD.

The thermal bridges throughout the construction are mostly solved with foam-glass layers as well as aerated concrete in the masonry base layer. These secure the overall contiuity of the thermal insulation around the whole building envelope. More detailed solutions of the thermal bridges are described in the PD.

8.) External façade

The external façade is mostly formed with the ETICS system top layer as well as windows with aluminum/wood frames and triple glazing and exposed cases of adjustable motorized sunblinds (except the north-sided windows) and wooden doors with triple glazing in the external walls openings. The gable walls on the eastern and western façades are covered with wooden boards as mentioned above.

Above main and side entrances are situated small polyuretan roofs connected with the external walls as visible in PD. The connestion will be realized eiliminating thermal bridges using anchors Thermax.

A gutter system BORGA will be used and realized according to manufacturer’s information.

9.) Internal finishes

The internal walls and ceilings will be covered with layer of plaster and varying finishes according to the room purpose (painting in habitable rooms, tiles in sanitary areas, etc.)

The staircase surface concrete will be left as exposed one.

The floors will be of different compositions as defined in PD.

10.) Doors and windows

The external windows will be composed from aluminum/wood frames and triple glazing.

The external door will be composed from wood and triple glazing. The doors will be manufactured for the certain dimensions of the opening in external wall.

The internal door will be of standard height dimensions and varying widths and composed from wood. All the metal frames and door components will be parts of the supplier's delivery.

All the doors and windows will be prescribed in the PD (list of elements)

The internal and external sills will be a part of the supplier's delivery.

The French windows in the second floor will be provided with railing consisting of tempered clear glass and stainless steel connections. Anchoring to the vertical masonry will be ensured with anchors Thermax while eliminating thermal bridges.

11.) Other

There will be a wooden framed terrace formed on the southern side of the building. For its installation there will be a compacted gravel bed created on the desired area.

There will be a monolithic concrete entrance staircase created for both the main and the side entrances to the building overcoming the height from the formation ground level to the bottom of the door openings. The staircase will be bedded on the layer of compacted gravel. Both staircases will be formed with two stairs and a 100 mm overlap into the ground.

The access road and sidewalk will be formed with lock paving according to situation.

The drain sidewalk around the house will be formed with concrete tile laid on a sand bed secured with side pavement in a concrete pad both bedded in a layer of compacted gravel.

d) Line-up of the construction to the traffic and the technical infrastructure.

The parcel is in a close neighborhood of an existing public road. New access road will be created to connect garage and parking spot to the above mentioned. An existing sidewalk will be connected with house entrance.

New gas, water, electricity and sewerage connections to the public nets will be created as well as according shafts, regulatory and measuring equipment.

The appropriate connections (water supply, electricity, middle pressure gas) will be situated in the post next to the main entrance to the parcel.

e) Solution of technical and traffic infrastructure including the traffic in quiet.

The garage and parking spot will be situated on the previously defined place according to the project documentation.

A gas, water, electricity supply and sewerage with appropriate equipment will be created according to the building needs.

f) Environmental impact of the building

The allowed noise limits are defined in the § 11 part 4 of the government instruction no. 502/2000 Sb. The construction works in the outside area will endure since 7:00 till 19:00 and the noise limits defined in the § 12 part 5 of the government instruction which means 60 dB will be abided. The owners of the neighborhood parcels will be acknowledged with the construction process. During the construction the dust elimination will be prior. The public communications will not be contaminated during the realization process. The constant communication cleaning will be held in front of the building during construction.

The excess soil from the excavations will be taken out to the storage areas.

g) Solution of the access to the building for disabled persons

The parking spot, garage and the access road are fully accessible for the disabled persons. The first floor is accessible over two low stairs. The second floor is not accessible without assistance.

h) Surveys, measurements – their integration into project documents

There has been a geological investigation realized previously. There have also been performed several geological probes in the area. The overall parcel has been inspected by the designer.

There have been several documents included in PD:

the geologic survey, the cadastral map, networks scheme without dimensions and project solution ordered by the investor, situation in paper

i) Data for alignment of construction, geodetic referential positioning and elevation system

Several documents included in PD:

situation in paper (the measuring points in the corners of the building has been defined in the situation and their height and location has been set in a relationship with the border of the patch and nearby contour line) , networks without dimensions, the cadastral map

j) Division of construction

The building objects: low energy family house, garage

The engineering objects: water supply connection, gas supply connection, electricity network connection, sewerage connection

k) Impact of the construction onto neighbouring lands and buildings

The construction has no negative impacts on the neighboring area; the private land is utilized for its realization; a possible building company will ensure constant cleaning of the entrance and the local communication during construction.

l) Ways of ensuring of safety and security of work on site

While realizing the project it is necessary to keep the statement ČÚBP a ČBU č. 324/1990 Sb. about the work and the technical equipment safety during construction works.

2. Mechanical endurance and stability

The materials for the construction realization have certificates which are considering their properties in the accordance with the ČSN for resident dwellings. All the design and

calculations as well as construction works must be processed in accordance with current ČSN and ČSN-EN.

3. Fire security

The fire security is analysed in a separate report where there is protection of the load bearing construction projected so that the stability for the necessary evacuation would be kept.

The request for the fire resistance of the load bearing part is 30 min. for the first floor and 15 min. for the second floor. There are also hold-off distances calculated which will satisfy the evaluation according to CSN and whose defined borders will not be crossed.

The building is two-story build and during evacuation it can be left through the main door, side door or rear terrace door.

The building will be provided with two fire detectors and one extinguisher.

The parcel is available from the public communication and the fire brigade intervention is possible through the main entrance.

4. Hygiene, health and environment protection

Ventilation of kitchen hood, WC and bathrooms is through the ventilation under-pressure system. Other ventilation is natural.

The sanitary sewerage and the rain sewerage is connected to the public sewerage network. The sanitary sewerage is provided with vent pipe.

5. Security of usage

The security of using is ensured with the grounded electricity which is designed in accordance with CSN and will be revised.

The surfaces in the areas of the hygiene importance are cleanable and covered with anti-slip pavements.

The staircase is provided with hand-railing in accordance with CSN.

6. Noise protection

Due to analysis of the designer the partitions fulfil the request for acoustic behaviour between separate rooms according to their usage.

The outer wall and ceiling as well as windows and doors according to the information of the supplier secure the inner area from the point of view of the noise penetration from the external environment. The area is meant for dwelling buildings.

Disturbing elements in the close area are not known.

7. Thermal protection and energy savings

The whole building is designed in the low-energy standard.

The energy savings are achieved through the architectonical disposition as well as used quality envelope materials and design of the thermal bridges elimination.

The building corresponds with the top border of the building efficiency chart class B.

The further detailing on the energy data is defined in the energy label of the building.

8. Solution of access and usage of the building by disabled people

The parking spot, garage and the access road are fully accessible for the disabled persons. The first floor is accessible over two low stairs. The second floor is not accessible without assistance.

The construction is not designed for disabled people usage.

9. Protection of the building against negative effects of the external environment

Due to information from the investor there is low radon index connected with this area (no special requirements for insulation) – has to be declared with radon analysis.

There are no other possible negative effects of the external environment.

10. Public protection

The building meets the requirements according to the standards.

11. Engineering structures

a) The sanitary and rain waste water is drained through the sewerage connection to the public sewerage network.

b) The water supply will be realized through connection to the public water supply network

c) Electricity will be gained from the public electricity network;

Thermal energy for heating, hot domestic water preparation and cooking will be gained from gas burning (stove, boiler);

Additional energy for hot domestic water preparation will be gained from the solar collectors.

d) the traffic is realized through the main entrance and access road connected to the public road.

e) The neighbor areas of the building will falttened with slight declination in the south part of the parcel.

The drain sidewalk around the house will be realized with concrete tiles with concrete pavement.

The entrance area in front of the north façade as well as parking spot next to the garage and the area in the front of the garage will be provided with lock paving. The area under future terrace on the south side of the house will be provided with compacted gravel layer.

The rest of the parcel be planted with grass

f) Electronic communications are realized through satellite systems

12. Production and non-production services of buildings

There is a heating system based on gas burning (condensation boiler) added with solar collectors in the building. All its features and equipment is designed according to standards (CSN-EN, CSN).

There is a simple over-pressure ventilation system (several air pumps) in the building. All its features and equipment is designed according to standards (CSN-EN, CSN).

There is a water supply system in the building. All its features and equipment is designed according to standards (CSN-EN, CSN).

There is a sewerage system in the building. All its features and equipment is designed according to standards (CSN-EN, CSN).

The area is designated as a residential area, interferences from the outside sources are not known.

Content

1.2 Building and constructional part

1.2.1 Technical report

1.) Foundations

Foundations are solved as foundation strips with a thin foundation slab at the top.

The external strips are formed with permanent formwork from concrete blocks (500x500x250 mm) added with reinforcement bars (d=12mm) filled with plain concrete. These strips are laid on a base layer of plain concrete (th. 100 mm) – there will be 4 rows of the formwork as specified in the project documentation (further on referenced as PD).

Their external face will be provided with thermal insulation starting at the top of the house foot and ending in the depth 1000 mm below formation ground level. The face of the permanent foundation formwork must be flat – possible roughness on the surface of the slab (mentioned below) must be flattened and cleaned in-situ. The insulation will be formed with XPS (th. 80 mm) glued with appropriate adhesive as specified in PD. The insulation will be separated from the drip pavement and other infill with geo-textile as referenced in PD.

There will be a drainage pipe laid in a sand bed covered with gravel infill installed at the bottom of the external foundation strip excavation acc. to PD.

The internal strips will be made from plain concrete in dimensions specified in PD.

The slab will be all over the ground plan projection of the house (th. 120 mm) acc. to PD and will be made from concrete reinforced with steel grids (d=6mm).

Under the slab there will be compacted gravel bed (th. 200 mm) and under it flattened compacted soil layer (th.150 mm).

The top surface of the slab will be provided with water-proof layer (Bitumen strip, 3 mm) and then other layer of separation (Fatratex-h, 200g/m2).

The water-proof layer will be extended on the external masonry to the height of 280 mm (which means 300 mm above formation ground level). The top border of the water-proof layer will be connected with foundation profile supplied by the manufacturer of the foil.

There will be made two installation paths in the north-eastern part of the external strip acc. to PD.

2.) Vertical structures

The base layer of the load-bearing masonry preventing thermal bridges from the foundation strip will be formed with aerated concrete block YTONG P4 of height 230 mm, width 250 mm and thickness 200 mm laid in a bed of mortar (th. 20 mm) acc. to PD.

The foot-brick must be during whole construction protected against moisture as well as possible to avoid losing of compressive strength.

Following load-bearing masonry of the external and main internal wall (extending to the top of the second floor wall) will be formed with lime-sand blocks VAPIS QUADRO E (th. 200 mm) connected with 2 mm of construction adhesive VAPIS acc. to PD.

The internal load-bearing wall surrounding the staircase (extending to the top of the first floor) will be formed with aerated concrete blocks YTONG P4 connected with construction adhesive YTONG. These load-bearing walls will bear only the staircase and staircase landing slab (ceiling over hall as defined in PD) loads.

The openings in the load-bearing walls will be overcame with prefabricated lintels VAPIS as well as in-situ formed rc lintels as defined in PD and static calculation.

As thermal insulation of the external wall is used mineral wool (th. 150 mm) ISOVER TF PROFI which will be connected to the masonry with aluminum anchors as specified by the manufacturer.

There will be 15 mm of plaster on both sides of all walls.

The whole façade insulation system is in the ETICS system as described in detail in PD.

The openings in the external walls will be filled with windows with aluminum / wooden frames and triple glazing with exposed external sunblinds cases (windows on the northern façade will have no external sunblinds) as well as with wooden doors prepared for the desired dimensions as defined in PD.

Each floor load-bearing walls will be finished with RC ring (200x150 mm, 4xd=12 mm, stirrup 10 mm, stirrup distance 250 mm, cover =20 mm) of varying height according to PD.

The internal partitions will be formed with aerated concrete blocks YTONG (th. 125, 150 mm) of varying thicknesses acc. to PD. The openings in the internal partitions will be overcame with prefabricated lightweight lintels YTONG.

3.) Horizontal structures

There will be two ceiling structures in the building – one above first floor, second above second floor.

Both will by formed with monolithic reinforced concrete slabs (th. 180 mm) fixed into the RC rings (200x150 mm, 4xd=12 mm, stirrup 10 mm, stirrup distance 250 mm, cover =20 mm) of varying height acc. to PD.

The construction of the slabs and the composition of the single floors is described in detail in PD. (ceiling drawings, floor compositions)

For both slabs will be used concrete 20/25 and reinforcing steel B 500 B.

There will be used system formwork PERI for the ceilings creation as prescribed in PD (formwork drawing).

The first slab has mainly a load bearing function (second floor load) while the second slab is more of a space separation, air tightness, noise protection, thermal accumulation, maintenance and load bearing function.

4.) Floors connection

The connection of the floors is realized through a monolithic reinforced concrete staircase which overcomes the cant of 3000 mm which separates the single floors. It is designed in accordance with the latest CSN-EN and CSN.

It is of a partly helical shape with U ground plan situated in the northern part of the central hall.

The bottom part of the staircase is laid on the layer of foam-glass (FOAM GLASS PERINSUL) to eliminate thermal bridges from the foundation strip situated below the stair connection. The top part is connected with the RC slab of the ceiling. There will be several hidden stringers formed around the load-bearing wall surrounding the staircase to transfer the loads from the staircase to the walls and thus to the foundations.

The height h of the single stair is 176.47 mm; the width of a single stair is 282.35 mm.

The top surface of the stairs is provided with wooden boards (th. 60 mm, overlap 30 mm) according to the shape defined in the ground plan of the staircase and building detail. Rest of the staircase is from an exposed concrete.

The hand-railing is designed in accordance with latest CSN-EN and CSN.

It is formed with metal frame and smoky glass infill. It is shaped acc. to PD.

The space below the staircase should be used as a storage space.

5.) Roof

The roof is laid on a reinforced concrete ring (200x150 mm, 4xd=12 mm, stirrup 10 mm, stirrup distance 250 mm, cover =20 mm) which is laid on a layer of foam-glass (FOAM GLASS PERINSUL, height 150, th. 200 mm) connected with construction adhesive VAPIS (th. 2 mm) to eliminate thermal bridges from the roof construction.

While preparing formwork of the above mentioned RC ring, the foam-glass must not be penetrated, (e.g. the formwork must be anchored to the ceiling and RC ring of the second floor).

There is a wall plate (75x100 mm) situated on the RC ring mentioned above, connected with threaded rods (d=16 mm) which are put into pre-drilled holes in the ring and sealed with special adhesive (PATTEX CF850). The situation of the wall plate is defined in the PD.

The roof itself is consist of single trusses (12), lathing, cover, gable walls and bracing.

The trusses are designed in the special static software (Truss 4, demo) which defines their overall shape and dimensioning according to given permanent, climatic and variable load. They will be laid on the wall plate and fixed acc. to manufacturer's recommendation. The detailed definition of the trusses is prescribed in PD.

The trusses which define the overall shape of the roof are designed as double inclined with varying slope – the northern part is of 10° inclination while the southern part is of 45° inclination to secure suitable positioning of the solar collectors.

The lathing is formed by wooden beams (60x60 mm) situated acc. to PD. Its function is to support cover layer as well as secure certain amount of transversal stability.

The cover of the roof is formed with OSB boars (th. 25 mm) covered with metal tile-shaped sheeting (BORGA ELEGANT, black color). Under the OSB boards there is a securing water-proof layer situated as defined in PD.

The gable walls are formed with OSB boards (th. 25 mm) installed on the last truss to secure final attic space separation. Over the boards there are connected lamellas (wooden beams 30x30 mm) on which are connected external wooden boards (larch wood, 129x15 mm) which create external gable wall façade. The bottom of the boards will be provided with over-drip profile. The construction will be realized as defined in PD.

There are several types of bracing in the roof construction. The main spatial rigidity is achieved through the OSB boards cover as well as transversal vertical bracing among all of the trusses (wooden planks 20x80 mm) and horizontal bracing (wooden planks 20x80 mm). All bracing is defined in PD. The bracing will be connected to the trusses with nails (4x50).

The composition of the roof cover as well as drainage and roof ventilation is prescribed in PD.

Used gutter system is BORGA, black color. Design of the system will be processed according to manufacturer's instructions. There will be two vertical pipes on the northern façade and one on the

southern façade. The gutter system will be connected to the building using anchors Thermax M16-12/170 while eliminating thermal bridges.

All wooden parts are from wood C22 if not stipulated otherwise. All steel parts are from steel S 235 if not stipulated otherwise.

The roof ventilation design must be abided.

6.) Installation systems

The electricity systems will be situated in special grooves prefabricated in the load-bearing walls as well as in partitions (need of cutting the grooves). The net will be held in floor gaps.

The heating pipes will be held in floor gaps using double pipe. The heating system will be formed with radiators as well as convectors underneath floor-leveled windows.

The installations (water supply, sewerage, ventilation) will be held in the offset installation walls formed with gypsum boards systems (this solution affect mainly bathrooms and water closet) as defined in PD.

All the installations exceeding first floor (water supply, hot domestic water supply, sewerage, ventilation, electricity, heat piping) will be held in a shafts prescribed in PD.

The fumes from the gas burning in boiler will be ventilated through an over-pressure chimney (110/80 pipe) held in the chimney space (250x250 mm) defined in PD.

7.) Heat loss elimination – thermal insulation and thermal bridges removal

The heat losses will be eliminated through overall thermal insulation surrounding the building envelope. This mainly consists of: Floor on the ground insulation, external wall insulation, second ceiling insulation and thermal bridges reduction.

The insulation of the floor on the ground is formed with 150 mm of EPS. The detailed composition is prescribed in PD.

The insulation of external walls is formed with ETICS system whose main thermal insulation consists of 150 mm of mineral wool (ISOVER PROFI TF) considering the durability of the material exposed to a certain amount of UV rays. The detailed composition of the ETICS is defined in PD.

The insulation of the attic space is situated on the second ceiling (monolithic RC slab). The main part of this insulation system is formed with 150 mm of EPS. Detailed composition of attic thermal insulation is described in PD.

The thermal bridges throughout the construction are mostly solved with foam-glass layers as well as aerated concrete in the masonry base layer. These secure the overall contiuity of the thermal insulation around the whole building envelope. More detailed solutions of the thermal bridges are described in the PD.

8.) External façade

The external façade is mostly formed with the ETICS system top layer as well as windows with aluminum/wood frames and triple glazing and exposed cases of adjustable motorized sunblinds (SUNSYSTEM C-65) (except the north-sided windows) and wooden doors with triple glazing in the external walls openings. The gable walls on the eastern and western façades are covered with wooden boards as mentioned above.

Above main and side entrances are situated small polyuretan roofs connected with the external walls as visible in PD. The connection will be realized eliminating thermal bridges using anchors Thermax M16-12/170.

A gutter system BORGA will be used and realized according to manufacturer's information. The gutter system will be anchored with Thermax M16-12/170 anchors to avoid thermal bridges.

9.) Internal finishes

The internal walls and ceilings will be covered with layer of plaster (th. 15 mm) and varying finishes according to the room purpose (painting in habitable rooms, tiles in sanitary areas, etc.)

The staircase surface concrete will be left as exposed one.

The floors will be of different compositions as defined in PD.

10.) Doors and windows

The external windows will be composed from aluminum/wood frames and triple glazing (GUTMANN MIRA CONTOUR SYSTEM).

The external door will be composed from wood and triple glazing. The doors will be manufactured for the certain dimensions of the opening in external wall.

The internal door will be of standard height dimensions (1970 mm) and varying widths and composed from wood. All the metal frames and door components will be parts of the supplier's delivery.

All the doors and windows will be prescribed in the PD (list of elements)

The internal and external sills will be a part of the supplier's delivery.

The French windows in the second floor will be provided with railing consisting of tempered clear glass and stainless steel connections. Anchoring to the vertical masonry will be ensured with anchors Thermax M16-12/170 while eliminating thermal bridges.

11.) Other

There will be a wooden framed terrace formed on the southern side of the building. For its installation there will be a compacted gravel bed created on the desired area.

There will be a monolithic concrete entrance staircase created for both the main and the side entrances to the building overcoming the height from the formation ground level to the bottom of the door openings (250 mm). The staircase will be bedded on the layer of compacted gravel. Both staircases will be formed with two stairs (250x125 mm) and a 100 mm overlap into the ground.

The access road and sidewalk will be formed with lock paving according to situation.

The drain sidewalk around the house will be formed with concrete tile (400x400x50 mm) laid on a sand bed secured with side pavement (100x50 mm) in a concrete pad both bedded in a layer of compacted gravel (100mm).

Protocol of the energy label of a building

Identification data

Type of construction Address (city, street, postal code) Cadastral territory and cadastral place The operator, or future operator	Low energy family house Rýmařov, Karla Schinzela 10, 795 01 Edrovice 744573, 342/28 Jan Novák
The owner or owners Address Phone / email	Jan Novák Bartákova 28 +420609112777 / jan.novak@email.cz

Characteristics of building

The building volume - the volume of external heated zone does not include balcony, cornices, attics and foundations	**741.88 m^3**
The total area A - the sum of the inner surfaces of the cooled structures defining the volume of the building	**450.12 m^2**
Volume factor of the building A / V	**0.61**
The prevailing internal temperature in the heating period The external design temperature in winter	+ 20 °C - 18 °C

Characteristics of energy-relevant data of the cooled structures

Cooled structure	**A_i area (m^2)**	**Heat transfer coefficient U ($W.m^{-2}K^{-1}$)**	**Required (recommended) heat transfer coefficient U_i ($Wm^{-2}.K^{-1}$)**	**Temperature reduction factor b_i (-)**	**Specific loss through heat transfer $HT_I = A_i.U_i.b_i$ ($W.K^{-1}$)**
External wall	200.61	0.22	0.25	-	44.13
Floor on the ground	106.35	0.20	0.3	0,395	8.40
Ceiling towards attic space	106.35	0.21	0.4	-	22.33
Widnows	33.28	0.75	1.2	-	24.96
Doors	4.43	0.75	1.2	-	3.32
Thermal bridges between structures	**(ΣA_i)**	**($\Sigma\psi_i$. l $+\Sigma\chi_i$)/A_i**		**A. U_{tbm} =**	9.0
Total	450.12	0,02		**Q_{ti} =**	**4261.38 W**

Construction meets the heat transfer coefficients according to CSN 73 0540-2

Determination of the heat envelope.

Specific loss through heat transfer HT	**$W.K^{-1}$**	**112.14**
Average heat transfer coefficient U_{em} = HT/A	**$W . m^{-2}.K^{-1}$**	**0.25**
Recommended heat transfer coefficient $U_{em,rc}$	**$W . m^{-2}.K^{-1}$**	**0.375**
Required heat transfer coefficient $U_{emn,20}$	**$W . m^{-2}.K^{-1}$**	**0.5**

Construction meets the requirements on the envelope according to CSN 73 0540-2

Classification classes of the heat transfer through the rated building envelope.

boundaries of the classification classes	Classification indicator CI for boundaries of the classification classes	$U_{EMN,20}$ ($W.m^{-2}.K^{-1}$) for classification classes boundaries	
		Generally	For the rated building
A - B	0.5	0.5. $U_{emn,20}$	0,25
B - C	0.75	0.75. $U_{emn,20}$	0,375
C - D	1	$U_{emn,20}$	0,5
D - E	1,5	1.5 $U_{emn,20}$	0,75
E - F	2,0	2 . $U_{emn,20}$	1
F - G	2,5	2.5 . $U_{emn,20}$	1,25

Classification: **B - Energy saving**

Date of issue of the energy label: 11. 5. 2012

Processor of the energy label of the building envelope: Marian Hlavica
Address of the manufacturer: N/A
ICO: N/A
Created by: Marian Hlavica, Student, bachelor's thesis Signature:.....

This protocol and energy label is created in accordance with RoHS European Parliament and Council No.2002/91/EC and EN 15217. It has been also created in accordance with CSN 73 0540 and the project documentation supplied by the investor.

Content

1. Used materials

- The geologic map of ČSSR, the map of pre-quaternary objects, scale 1 : 200 000, page M-33-XXIV, Olomouc

- The geologic map of Czech Republic, scale 1 : 50 000, no. 14-42 Rýmařov

2. Summary of geological and hydro-geological state

Pre-quaternary basis in the investigated area is formed with rocks of Devon – flyshoid rock (top devon) which is here presented with chloritic and muscovite-chloritic phyllites, the green slate. The mentioned rocks are ascend to the surface of the area.

The underground water is connected with the cleft system in the bigger depths.

The presumed geological profile:

	Acc. CSN 73 1001	Acc. CSN 73 3050
0,0 – 0,6 m – top soil, compacted	**F5MLY**	**3**
0,6 – 1,5 m – phyllite muscovite-chloritic, weathered to less weathered	**R4**	**5**
1,5 – x - DTTO less weathered	**R3**	**6**

The underground water is connected with the cleft system in the bigger depths (cca 10 m).

3. Geotechnical properties of rocks (CSN 73 1001)

3.1 phyllite muscovite-chloritic weathered to less weathered belongs to the R4 class:

Compressive strength σ_c = 15 MPa

Modulus of shape-ability E_{def} = 250 MPa

Poisson's number ϑ = 0,25

Design load carrying capacity R_{dt} = 0,4 MPa

3.2 phyllite muscovite-chloritic weathered belongs to the R3 class:

Compressive strength σ_c = 25 MPa

Modulus of shape-ability E_{def} = 600 MPa

Poisson's number ϑ = 0,2

4. Geological evaluation

These geological conditions can be classified as simple. The designed structure (low-energy family house) is not foundation - demanding. While designing foundations in simple geological conditions the first geo-technologic category is followed:

The tabled design load-bearing capacity is used:

R_{dt} = 0,4 Mpa

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FACULTY OF CIVIL ENGINEERING
INSTITUTE OF BUILDING STRUCTURES

FOLDER C2 – CALCULATIONS

BAKALÁŘSKÁ PRÁCE
BACHELOR'S THESIS

AUTOR PRÁCE — MARIAN HLAVICA
AUTHOR

VEDOUCÍ PRÁCE — doc. Ing. JIŘÍ SEDLÁK, CSc.
SUPERVISOR

BRNO 2012

FOLDER C2: CALCULATIONS

1. STAIRCASE DESIGN
2. CALCULATION OF FOUNDATIONS
3. PRELIMINARY DESIGN OF RC LINTEL L8
4. PRELIMINARY DESIGN OF RC LINTEL L9
5. PRELIMINARY DESIGN OF RC SLABS OVER 1st AND 2nd FLOOR
6. CALCULATION OF HEAT LOSS COEFFICIENTS

Content

1.) Stair height design

According to CSN 73 4230 – Staircases and inclined ramps:

2 x h + b = 600 - 650 mm

2 x **176.57** + **282.35** = **635.49 mm**

h = 176.57 mm

b = 282.35 mm

2.) Construction design of foundations and foundation calculation

STRIP UNDER INTERNAL LOADBEARING WALL

All constructions are calculated for 1 m width of the foundation strip

PERMANENT LOAD

1NP:

Load Bearing wall:

construction	thickness (m)	load (kN/m3)	loading breath (m)	total load (kN)
masonry	0,2	20	2,5	10
plaster	0,03	16	2,67	1,28
base layer	0,2	13	0,125	0,33

RC ring not considered in the RC slab:

construction	thickness (m)	load (kN/m3)	loading breath (m)	total load (kN)
RC ring	0,2	25	0,195	0,98

Ceiling construction:

construction	thickness (m)	load (kN/m3)	loading breath (m)	total load (kN)
plaster	0,01	16	4,5675	0,73
RC slab	0,18	25	4,5875	20,64
Noise	0,04	0,56	4,5675	0,102

protection				
vapour proofing (PE foil)	0,001	0,65	4,5875	0,003
Leveling layer (anhydrite)	0,05	22	4,5675	5,02
wooden finishing	0,011	12	4,5875	0,83

2.NP

Load bearing wall

masonry	0,2	20	2,625	10,5
plaster	0,03	16	2,705	1,3

RC ring not considered in the RC slab:

construction	thickness (m)	load (kN/m3)	loading breath (m)	total load (kN)
RC ring	0,2	25	0,18	0,9

Ceiling construction:

construction	thickness (m)	load (kN/m3)	loading breath (m)	total load (kN)
plaster	0,01	16	4,5675	0,73
RC slab	0,18	25	4,5875	20,64
thermal insulation (EPS)	0,15	0,56	4,5875	0,39
vapour proofing (PE foil)	0,001	0,65	4,5875	0,003
Leveling layer (anhydrite)	0,05	22	4,5875	5,05

Total SUM of Permanent loads: 79,45 kN on 1 m of the foundation strip.

+ Estimated self-weight of the strip: 0,5 x 1,2x 23 = 13,8 kN

79,45 + 15 = 93,25 kN

VARIABLE LOAD

Type of load:	
3 kN/m2 variable load on the 2nd floor on the area of 4,5675 m2	13,703
1 kN/m2 variable load on the attic floor on the area of 4,5675 m2	4, 568

Total SUM of variable loads: 18,27 kN on 1 m of the foundation strip.

Combination of loads: 1,35 x 93,25 + 1,5 x 18,27 = Gd = 153,29 kN

DESIGN OF THE STRIP

Soil class = R4 …… Rdt = 400 kPa

Demanded effective area: Aeff = Gd / Rdt = 153,29 / 400 = 0,383

width of strip: W = 0,5 m
height of strip: H = 1,2 m

0,5 x 1 = 0,5 > 0,383

Aeff = 0,5

REVIEW

Stress of the effective area: σde = Gd / Aeff = 153,29 / 0,5 = **306.58 kPa**

Final condition **σde<Rdt (306,58 kPa < 400 kPa) ... OK**

STRIP UNDER EXTERNAL LOADBEARING WALL

All constructions are calculated for 1 m width of the foundation strip

PERMANENT LOAD

1NP:

Load Bearing wall:

construction	thickness (m)	load (kN/m3)	loading breath (m)	total load (kN)
masonry	0,2	20	2,5	10
plaster	0,015	16	2,67	0,64
base layer	0,2	13	0,125	0,33

RC ring not considered in the RC slab:

construction	thickness (m)	load (kN/m3)	loading breath (m)	total load (kN)
RC ring	0,2	25	0,195	0,98

Ceiling construction:

construction	thickness (m)	load (kN/m3)	loading breath (m)	total load (kN)
plaster	0,01	16	2.5825	0,41
RC slab	0,18	25	2.7825	12.52
Noise protection	0,04	0,56	2.5825	0,06
vapour proofing (PE foil)	0,001	0,65	2.5825	0.002
Leveling layer (anhydrite)	0,05	22	2.5825	2.84
wooden finishing	0,011	12	2.5825	0,34

2.NP

Load bearing wall

masonry	0,2	20	2,625	10,5

plaster	0,015	16	2,705	0,65

RC ring not considered in the RC slab:

construction	thickness (m)	load (kN/m3)	loading breath (m)	total load (kN)
RC ring	0,2	25	0,18	0,9

Ceiling construction:

construction	thickness (m)	load (kN/m3)	loading breath (m)	total load (kN)
plaster	0,01	16	2.5825	0,41
RC slab	0,18	25	2.7825	12.52
thermal insulation (EPS)	0,15	0,56	2.5825	0.21
vapour proofing (PE foil)	0,001	0,65	2.5825	0,002
Leveling layer (anhydrite)	0,05	22	2.5825	2.84

RC ring:

construction	height (m)	load (kN/m3)	width (m)	total load (kN)
RC ring	0,15	25	0,2	0,75
foamglass	0,15	1,65	0,2	0,05

Roof construction:

construction	height (m)	load (kN/m3)	width (m)	total load (kN)
truss	0,05	4,5	3 (m2)	0,675
lathing	0,06	4,5	0,06	0,0162
sheating	0,025	4,5	12,164	1,367
vapour proofing (PE foil)	0,002	0,65	12,164	0,01
wall plate	0,075	4,5	0,1	0,034
cover	0,0005	48,3	12,164	0,294

Total SUM of Permanent loads: 59,35 kN on 1 m of the foundation strip.

+ Estimated self-weight of the strip: 0,5 x 1,2 x 23 = 13,8 kN

59,35 + 15 = 74,35 kN

..

VARIABLE LOAD

Type of load:	
3 kN/m2 variable load on the 2nd floor on the area of 1,6925m2	5,08
1 kN/m2 variable load on the attic floor on the area of 1,7125m2	1,71
1,5 kN/m2 snow load on the roof on area of 12,164 m2	18,25
0,8 kN/m2 variable load on the roof on area of 12,164 m2	9,73

Total SUM of variable loads: 34,77 kN on 1 m of the foundation strip.

Combination of loads: 1,35 x 74,55 + 1,5 x 34,77 = Gd = 152.8 kN

DESIGN OF THE STRIP

Soil class = R4 …… Rdt = 400 kPa

Demanded effective area: Aeff = Gd / Rdt = 152.8 / 400 = 0,382

width of strip: W = 0,5 m
height of strip: H = 1 m

0,5 x 1 = 0,5 > 0,382

Aeff = 0,5

REVIEW

Stress of the effective area: σde = Gd / Aeff = 152.8 / 0,5 = **305.6 kPa**

Final condition **σde<Rdt (305.6 kPa < 400 kPa) ... OK**

3.) Preliminary design of monolithic RC lintel L8

According to Eurocode 2 – Design of concrete structures:

Lintel L8: length above the opening: 3.75 m

LOAD on one meter of lintel:

Permanent load:

First floor

Masonry ….. 0.2 x 0.125 x 20 = 0,5 kN/m
RC ring ……0.195 x 0.2 x 25 = 0.975 kN/m
RC slab ……2.875 x 0.18 x 25 = 12.94 kN/m

Second flor

Masonry ……..2.625 x 0.2 x 20 = 10.5 kN/m
RC ring ……0.18 x 0.2 x 25 = 0.9 kN/m
RC slab ……2.875 x 0.18 x 25 = 12.94 kN/m

Third floor

Foam glass ……0.15 x 1.65 x 0.2 = 0.05kN/m
RC ring ……0.15 x 0.2 x 25 = 0. 75 kN/m
Roof ...from calculations of foundation strip… 1.198 kN/m

SW of the lintel ……..0.2 x 0.25 x 3.75 x 25 = 4.69 kN/m

Variable load:

Variable load on 2nd floor ……2.875 x 2 kN/m^2 = 5.57 kN/m
Variable load on 3rd floor ……2.875 x 0.5 kN/m^2 = 1.45 kN/m
Snow load ……...12.164 x 0.5 x 1.5 kN/m^2 = 9.12 kN/m
Variable load on roof …….12.164 x 0.5 x 0.5 kN/m^2 = 3 kN/m

Σ of permanent loads = 45.44 kN/m; Σ of variable loads = 19.14 kN/m

Acc. to combination 6.10:

q = 1.35 x 45.44 + 1.5 x 19.14 = 90.05 kN/m

M_{ed} = 1/8 x q x l^2 = 1/8 x 93.25 x 3.75^2 = **158.3 kNm**

CONCRETE 20/25; STEEL B500B

cover = 20 mm

d = 250 – 20 – 18 = 212 mm, z = 0.8 x d = 170 mm

$Ast_{,req} = M_{ed} / f_{yd} \times z = 147\ 970 / 434.78 \times 10^{6} \times 0.170 = 2.001 \times 10^{-3}\ m^2$

=> **2 x Ø 36**; $2.036 \times 10^{-3}\ m^2$

Review:

d = 250 – 20 – 18 = 212 mm

$\lambda x = f_{yd} \times A_{st} / fcd \times b = 434.78 \times 10^{6} \times 2.036 \times 10^{-3} / 16.67 \times 10^{6} \times 1 = 0.0531$ m

$z = d – \lambda x/2 = 212 – 53.1 / 2 = 185.45$

$M_{rd} = f_{yd} \times A_{st} \times z = 434.78 \times 10^{6} \times 2.036 \times 10^{-3} \times 0.18545 =$ **164,17 kNm**

$M_{rd} > M_{ed}$

The designed bottom reinforcement will endure the emitted bending moment the from upper building.

4.) Preliminary design of monolithic RC lintel L9

According to Eurocode 2 – Design of concrete structures:

Lintel L8: length above the opening: 2.55 m

LOAD on one meter of lintel:

Permanent load:

Second flor

RC ring ……0.18 x 0.2 x 25 = 0.9 kN/m
RC slab ……4.5875 x 0.18 x 25 = 20.64 kN/m

SW of the lintel ……..0.2 x 0.175 x 2.55 x 25 = 2.23 kN/m

Variable load:

Variable load on 3rd floor ……..4.5875 x 0.5 kN/m^2 = 2.29 kN/m

Σ of permanent loads = 23.77 kN/m; Σ of variable loads = 2.29 kN/m

Acc. to combination 6.10:

q = 1.35 x 23.77 + 1.5 x 2.29 = 35.52 kN/m

M_{ed} = 1/8 x q x l^2 = 1/8 x 93.25 x 3.75^2 = **28.87 kNm**

CONCRETE 20/25; STEEL B500B

cover = 20 mm

d = 175 – 20 – 8 = 147 mm, z = 0.8 x d = 117.6 mm

$Ast_{,req} = M_{ed} / f_{yd}$ x z = 28 870 / 434.78 x 10^6 x 0.1176 = 5.65 x 10^{-4} m^2

=> **3 x Ø 16**; 6.03 x 10^{-4} m^2

Review:

d = 175 – 20 – 8 = 147 mm

$\lambda x = f_{yd}$ x A_{st} / fcd x b = 434.78 x 10^6 x 6.03 x 10^{-4} / 16.67 x 10^6 x 1 = 0.0157 m

z = d – λx/2 = 147 – 15.7/ 2 = 139.15

$M_{rd} = f_{yd} \times A_{st} \times z = 434.78 \times 10^{6} \times 6.03 \times 10^{-4} \times 0.1392 =$ **36.39 kNm**

$M_{rd} > M_{ed}$

The designed bottom reinforcement will endure the emitted bending moment the from upper building.

5.) Preliminary design of monolithic slabs of ceiling 1 and ceiling 2

According to Eurocode 2 – Design of concrete structures:

The biggest span of the horizontal construction is 5350 mm (over living room)

For fixed slabs the height h_s is defined as <1/30 – 1/35> x span = 1/30 x 5350 = 178.33 mm

= > h_s = 180 mm

The height h_s will be the same for all slabs to avoid misinterpretations during construction.

The condition for the slab consideration as fixed is that the height of the ring or beam supporting this slab is: $h_{ring/beam} >= 2 \times h_s$ ($2 \times h_s = 2 \times 180 = 360$ mm)

Therefore: h_{ring1} = 375 mm >= 360 mm; h_{ring2} = 360 mm >= 360 mm

6.) Calculation of heat loss coefficients

U = 1 / (Rsi + R + Rse)

R = d / λ

External wall

Simplified composition:

Structure	**λ [kW/mK]**
Load-bearing masonry VAPIS 0.2 m	1.1
Plaster (internal + external) 0.028 m	0.99
Thermal insulation ISOVER TF PROFI 0.15 m	0.035

U = 1 / (0,13 + (0.2 / 1.1 + 0.028 / 0.99 + 0.15 / 0.035) + 0.04) = **0.22 W/m^{2}K**

Floor on ground

Simplified composition:

Structure	**λ [kW/mK]**
RC concrete foundation slab 0.12 m	1.74
Thermal insulation EPS 0.15 m	0.033
Leveling anhydrite layer 0.05 m	1.2
Wooden finish 0.021 m	0.45

U = 1 / (0,17 + (0.12 / 1.74 + 0.15 / 0.033 + 0.05 / 1.2 + 0.021 / 0.45) + 0.04) = **0.20 W/m^{2}K**

Ceiling towards attic space

Simplified composition:

Structure	**λ [kW/mK]**
RC concrete slab 0.18 m	1.74
Plaster 0.015 m	0.99
Thermal insulation EPS 0.15 m	0.033
Cement leveling layer 0.05 m	0.99

U = 1 / (0,1 + (0.18 / 1.74 + 0.15 / 0.033 + 0.015 / 0.99 + 0.05 / 0.99) + 0.04) = **0.21 W/m^{2}K**

Windows and doors

The values are given by manufacturer

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FOLDER C3 – DRAWINGS

BAKALÁŘSKÁ PRÁCE
BACHELOR'S THESIS

AUTOR PRÁCE — MARIAN HLAVICA
AUTHOR

VEDOUCÍ PRÁCE — doc. Ing. JIŘÍ SEDLÁK, CSc.
SUPERVISOR

BRNO 2012

FOLDER C3: DRAWINGS

1. SITUATION OF FURTHER RELATIONS
2. SITUATION
3. FOUNDATIONS
4. GROUND PLAN – FIRST FLOOR
5. GROUND PLAN – SECOND FLOOR
6. ROOF
7. ELEVATION A-A
8. ELEVATION B-B
9. SOUTH AND EAST VIEWS
10. NORTH AND WEST ELEVATIONS
11. CONSTRUCTION DETAIL A – EXTERNAL FOUNDATION STRIP
12. CONSTRUCTION DETAIL B – STAIR FINISHING
13. CONSTRUCTION DETAIL C – WINDOW OPENING LINTEL
14. CONSTRUCTION DETAIL D – WINDOW OPENING SILL
15. CONSTRUCTION DETAIL E – GUTTER CONNECTION
16. CONSTRUCTION DETAIL F – RIDGE
17. CEILING ABOVE FIRST FLOOR
18. CEILING ABOVE SECOND FLOOR
19. FLOOR COMPOSITIONS 1, 2, 5
20. FLOOR COMPOSITIONS 3, 4
21. LIST OF ELEMENTS - WINDOWS
22. LIST OF ELEMENTS - DOORS AND LINTELS

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FOLDER C4 – FIRE PROTECTION

BAKALÁŘSKÁ PRÁCE
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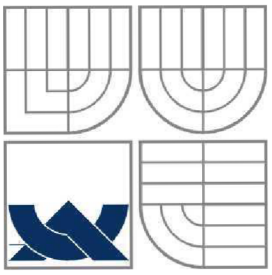
FOLDER C4: FIRE PROTECTION

1. FIRE PROTECTION REPORT
2. SITUATION



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FIRE SAFETY REPORT

BAKALÁŘSKÁ PRÁCE
BACHELOR'S THESIS

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BRNO 2012

Content

1.) Identification

Structure: Low energy family house, Rýmařov, N.P. 342/28

Investor: Jan Novák, Bartákova 28, Rýmařov 795 01

Designer: Marian Hlavica, Bartákova 38, Rýmařov, Student, Bachelor's thesis

Local building authorities: Rýmařov

2.) Background papers

- Project documentation
- CSN 73 0810 – Fire protection of building – General requirements
- CSN 73 0812 – Fire protection of building – Non-industrial buildings
- CSN 73 0833 – Fire protection of building – Buildings for dwelling and lodging
- CSN 73 0873 – Fire protection of building – Equipment for fire water supply
- Public notice 23/2008sb.
- Public notice 268/2011sb.
- Public notice 246/2001sb.

3.) Brief description of building

- GENERAL DESCRIBTION OF THE BUILDING

The project solves low energy family house suited for four member active family. It is designed as two-storey building with no basement and with non-symmetrically double pitched roof.

The build-up area covers 121.41 m^2

The sum of surface areas of both habitable floors is 212.72 m^2

- DESCRIBTION OF SOULUTION OF DISPOSITION

The object is of two storeys connected by internal self-supporting monolithic RC staircase. The main entrance to the object is in the northern façade of the first floor.

- DESCRIBTION OF CONSTRUCTION SOLUTION

Vertical load-bearing structures

- external and internal load-bearing wall formed with lime-sand blocks VAPIS QUADRO E (th. 200 mm)

- internal load-bearing wall formed with aerated concrete block YTONG P4 (th. 200 mm)

Vertical non-load-bearing structures

- internal partition YTONG (th. 125, 150 mm)

- internal offset installation wall from GYBSUM BOARDS – KNAUF

Horizontal load-bearing structures

- monolithic fixed RC slabs above first floor, th. 180 mm

- monolithic fixed RC slabs above second floor, th. 180 mm

Roof construction

- double non-symmetrically pitched roof formed with trusses, wall plates, cover, gable walls and bracing

Staircase

internal self-supporting monolithic RC staircase

Window openings infilling

The external windows will be composed from aluminum/wood frames and triple glazing (GUTMANN MIRA CONTOUR SYSTEM).

The external door will be composed from wood and triple glazing. The doors will be manufactured for the certain dimensions of the opening in external wall.

4.) Division into fire sectors

The building is one single fire sector of area 212.72 m^2.

5.) Fire risk, degree of fire safety, size of fire sectors

According to the appendix B of CSN 730822 it has been defined fire load: $p_v = 40$ kg.m^2

Degree of fire safety: II

Size of fire sectors is up to 600m2, so it satisfies section 3.5 a) CSN 730833 for classification into class OB1.

6.) Evaluation of construction fire resistance

Material	Demand – ČSN 730802	Actual value
External load-bearing wall VAPIS QUADRO E (th. 200 mm)		
1st floor	REW 30	REW 180 DP1
2nd floor	REW 15	REW 180 DP1
Internal load-bearing wall VAPIS QUADRO E (th. 200 mm)		
1st floor	R 30	R 180 DP1
2nd floor	R 15	R 180 DP1
Internal load-bearing YTONG P4 (th. 200 mm) 1st floor	R 30	R 180 DP1
monolithic fixed RC slabs above first floor	RE 30	*cover designed according to* RE 30 DP1
fixed RC slabs above second floor	REI 15	*cover designed according to* REI 30 DP1
Roof – wooden system with aluminum cover	-	-

7.) Evaluation of material properties

- external and internal load-bearing wall formed with lime-sand blocks VAPIS QUADRO E (th. 200 mm)

– reaction to fire A1

- internal load-bearing wall formed with aerated concrete block YTONG P4 (th. 200 mm)

– reaction to fire A1

- monolithic fixed RC slabs above first floor, th. 180 mm

– cover designed according to reaction to fire A1

- monolithic fixed RC slabs above second floor, th. 180 mm

– cover designed according to reaction to fire A1

- roof construction – wooden system with aluminum cover

– reaction to fire A3 – the roof is not part of load-bearing construction and is separated from the construction with monolithic RC slab

8.) Evacuation

Escape ways – according to 4.3 ČSN 730833, family house – length of escape ways is not considered. There are three entrances to the building. All of them are at least 900 mm of clear width with doors of minimal width 800 mm.

9.) Fire hazardous area

Southern façade:

Total fire-open area S_{po} = 20.67 m^2

Sp = 40.96 m^2

Po = S_{po} / S_p .100 = 20.67 / 40.96 .100 = 50.46 %

d_1 = 5.2 m according to annex F of CSN 730822

Northern façade:

Total fire-open area S_{po} = 5.1 m^2

Sp = 26.85 m^2

Po = S_{po} / S_p .100 = 5.1 / 26.85 .100 = 18.99 %

d_2 = 1.1 m according to annex F of CSN 730822

Eastern façade:

Total fire-open area S_{po} = 5.94 m^2

Sp = 22.72 m^2

Po = S_{po} / S_p .100 = 5.94 / 22.72 .100 = 26.14 %

d_3 = 1.5 m according to annex F of CSN 730822

Western façade:

Total fire-open area S_{po} = 6 m^2

Sp = 20.9 m^2

Po = S_{po} / S_p .100 = 6 / 20.9 .100 = 28.71 %

d_4 = 1.5 m according to annex F of CSN 730822

10.) Water for extinguishing

Internal hydrants are not demanded for family houses according to 4.4 b) CSN 730873. There is no internal hydrant in the building.

External hydrants – built-up area of the building is bigger than 200 m^2, therefore it is necessary to have an external hydrant of dimension of DN100 in distance from the object maximally 150 m. The distance to the closest hydrant is 47 m.

11.) Emergency routes

According to 4.4.1 CSN 730833, there is an access road going along the northern border of the parcel. The distance from the object is 9.75 m. It is asphalt road of width 5.5 m, it fulfils the requirements.

12.) Fire extinguishers

According to the regulation 23/2008 Coll. there is one 6 kg powder extinguisher (113B) placed in the hall of the each building unit. The extinguishers are useable for categories A, B and C.

According to the regulation 23/2008 Coll. a free access to the fire extinguisher must be kept.

13.) Technical equipment

The building uses common condensing boiler. It is used for heating and domestic hot water preparation. Inside the building there is a chimney, which is connected to the condensing boiler. There is no fireplace in the building. Ventilation is semi-natural.

14.) Special requirements for contructions

There are no special requirements.

15.) Fire safety devices

According to the regulation 23/2008 Coll., every family house has to have fire or smoke detector.

There are 2 detectors in each building unit. There is one fire detector in the stairwell, another one is in the kitchen. Both of them have to be checked periodically as is stated in the manual from the producer.

16.) Safety signs

The extinguisher has to be marked according to the valid regulation. There is main power switch (“total stop”) in the technical room. It is marked according to CSN ISO 3864, CSN 0810813 and NV 11/2002 Coll.

17.) Conclusions

The structure will satisfy all needs for fire safety of buildings.