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Climate change effect on the income of medium and large-sized farms in an irrigated area located in the Lower Valley of Medjerda in Tunisia

Mlaouhi S., Boujelben A. and Elloumi M.

Abstract: **In this work we have simulated the climate change effects on crops yields for 3 typical farms in the irrigated area of Borj Touil located in the lower valley of Medjerda-Tunisia. We used a bio-economic approach based on coupling an agronomic model "CropSyst" at an economic model "GAMS" to simulate crop yields and calculate gross margins over 30 years for typical farms.**

With a rising temperature of 1° and 2°C, crop yields will be negatively affected regardless of farm sizes. These yields will accuse decreases that could reaching about 30%. Gross margins will also be decreased that could reach 69%. However, supplementation of water irrigation will reduce margins losses and gross margins could reach 107% for certain farms.

Keywords- Simulation, bio-economic, climate change, irrigation and gross margin,

1. INTRODUCTION

Last twenty years, many studies have been devoted to predict global warming impact on the worldwide agriculture [20]-[21]. Result process show that climate change will raise arid and desert areas especially in the Maghreb region.

Studies predict a decline in agricultural yields in North Africa due to the land degradation acceleration and land productive loss. Algeria is anticipating substantial reductions. Climate change will also affect the vegetables production. Their yields would decline between 10 to 30% and wheat yield loss will be about 40%. So, if no measures are adopted to combat and adapt to climate change, some authors [15] note that the domestic product gross (DPG) expected declines will be between 0.4% and

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1.3% in the 2020 year. These declines will be even up to 14% in North Africa countries and the Middle East. Furthermore, according to studies of [9], farmers should expect revenue losses with climate change. So, the present work is to evaluate the gross margins of 2 medium-sized farms and 1 large-sized farms to predict the effects of temperature rise of 1° and 2°C over 30 years and irrigation water supplementation effects and draw possible lessons.

2. EXPERIMENT DESCRIPTION

The work was done in the irrigated area of Borj Touil in the Lower Valley of Medjerda in Tunisia. The area covering approximately 3200 ha was created to intensify irrigated cereal and fodder crops with treated wastewater. First, we surveyed 83 farms ranging from 1 to 170 hectares in this area. Using typology [13], we selected 3 representative farms. Too farms having medium sizes and one having a large size. Then, we chose a preventive bio-economic methodological approach [11]. It is based on coupling a biophysical model "CropSyst" [2]-[10] at an economic model "GAMS" (General Algebraic Modeling System) based on mathematical programming [8].

We chose “Cropsyst” model that was used to evaluate different farming systems. It is able to simulate crops, for several consecutive years and to establish relationship between input-output for crop production.

Indeed, crop growth goes through several phases of development being dependent of genetic cycle, environment and soil factors. During each phase limiting factors are involved as reducing functions under the law of minimum established by Justus Von Liebig in 1840 [4], [5], [12], [19]. For exemple, the production function is represented for nitrogen and water as follows:

$$Y_i = \min\left[Y^*, \left(\beta_1 + \beta_2 E_i + u_{E_i}\right), \left(\beta_3 + \beta_4 N_i + u_{N_i}\right)\right] \quad (1)$$

With E: water, N: nitrogen and β and µ constants to be determined.

This function implies that the plant responds linearly to the most limiting factor. After a certain level of water supply (E*) and nitrogen (N*), culture does not respond to additional contributions and the maximum yield (Y*) is reached [1]-[3]. Some agronomists, believing in a certain level of substitutability between the inputs at low application rates, have developed other functional forms such as:

VON LIEBIG NON-LINEARE:

$$Y_i = \min\left[Y^*\left(1 - k_E e^{-\beta_E E_i}\right), Y^*\left(1 - k_N e^{-\beta_N N_i}\right)\right] + u_i \quad (2)$$

MITSCHERLICH BAULE:

$$Y_i = \min\left[Y^* \left(1 - k_E e^{-\beta_E E_i} \right) x \left(1 - k_N e^{-\beta_N N_i} \right) \right] + u_i \qquad (3)$$

So, econometric approach limits [7]-[11] have led us to adopt another original approach using engineer production functions obtained by simulations through a biophysical or agronomic model. However, "Cropsyst" was used to determine the appropriate crop response functions form, taking account their environmental conditions. This model operates with a daily time and the law limiting factor intervenes to determine biomass (yield).

We conducted surveys and collected data for crops and environmental conditions for the typical farms retained to study.

We established in a first step a culture model for each farm. Simulation as methods [2]-[10] were made initially for 4 years. This period was chosen for availability of real data relating to climate, plantings and yields. Those data were considered as a baseline to calibrate the model.

Based on the actual location and climate data of the area for 26 years from 1983 to 2008, we used "Climgen" a sub-program in "Cropsyst" and we generated climate data for 30 years from 2011 to 2040 to study crop response functions.

We also took account that climate change combined with other environmental factors could change crop conditions in the future.

So, we generated other climate data using the same sub- program for the same period adopting 2 increasing temperature scenarios.

We have assumed respectively 1° and 2°C increasing temperature. This supposition is based on the work done on climate change, that includes the increases in Mediterranean region and especially in Tunisia to the year 2050 [[17].

Once we calibrated the basic models and we used them for long-term simulations [2]-[10]. We kept the same cultivation techniques adopted by farmers and used generated climate data from 2011 to 2040 and generated data for the same period considering climate change.

We studied in a long-term, climate change impact and irrigation effects on culture yields.

Initially, we considered three scenarios defined as follows:

- Scenario 1 (SC1): we kept all the cultivation techniques, the same water irrigation doses initially applied by each farmer. We used for simulations the generated climate data. This scenario is considered as baseline reference (SC1);
- Scenario 2 (SC2): This is the baseline (SC1) using generated climate data taking account 1° C increasing temperature;
- Scenario 3 (SC3): This is the baseline (SC1) using the generated climate data taking account 2° C increasing temperature.

Secondly, we adopted 4 increasing water irrigation doses scenarios which are:

- Scenario 4 (SC4): This is the baseline (SC1) with 20% supplementation water irrigation doses initially applied;
- Scenario 5 (SC5): This is the baseline (SC1) with 40% supplementation water irrigation doses initially applied;

- Scenario 6 (SC6): This is the baseline (SC1) with 60% supplementation water irrigation doses initially applied;
- Scenario 7 (SC7): This is the baseline (SC1) with 100% supplementation water irrigation doses initially applied.

Simulations were performed first on 30 years to study the long-term effects on typical farms production. Second, we studied the predictable impact of temperature increases respectively to 1° and 2°C.

Those values are based on forecasts for Mediterranean region. Then, we simulated four scenarios effects providing irrigation for all farms studied.

The technical coefficients issued from the simulations have made the matrix inputs for the economic model “GAMS”. Positive Mathematical Programming (PMP) was used through this model to simulate and calculate the "objective function" formulated to optimize the production systems choice, taking account the climatic conditions and the amount of water irrigation.

The "objective function" represented by the gross margin to maximize in this work is written as follows:

$$
\begin{aligned}
MBG_{(\exp,s,a)} = {} & \sum_{(c,t)} X_{(\exp,c,t,s,a)} Rd_{(\exp,c,t,s,a)} pprodc_{(c)} \\
& - \sum_{(c,t)} \alpha_{(\exp,c,t,s,a)} X_{(\exp,c,t,s,a)} \\
& + \frac{\beta}{Z_{(\exp,c,t,s,a)}} X^{Z}_{(\exp,c,t,s,a)}
\end{aligned}
\tag{4}
$$

With,

MBG $_{(\exp,\ s,\ a)}$: Annual overall gross margin per farm per scenario and per year.

Margin is calculated per hectare for each crop. It represents the total proceeds realized by sales of cereals and fodder after amputation of direct expenses such as supply fertilizer, water irrigation, labor and product treatment costs.

X $_{(\exp,\ c,\ t)}$: Cultivated area per farm per crop and per technique
Exp: Typical farm
c: Culture
t: Technique (crop management: Dry or irrigated crop)
s: Scenario
a: Year
Rd $_{(\exp,\ c,\ t,s,a)}$: Yield per crop per farm, per technique, per scenario and per year
pprodc $_{(c)}$: Crop products Prices,
alpha $_{(\exp,\ c,\ t,\ s,\ a)}$ (α) and
beta $_{(\exp,\ c,\ t,\ s,\ a)}$ (β): They are non-linear terms of cost function. They are added in the "objective function” using dual values generated by calibration phase expressed as follows:

$VD(\exp, c, t) = calib.m(\exp, c, t)$; Dual values

These terms are calculated as follows:

$$\text{beta}(\text{exp},c,t) = 2VD(\text{exp},c,t)/\text{occ}(\text{exp},c,t);$$ For $occ_{(exp,c,t)} > 0$;

$$\text{alpha}(\text{exp},c,t) = \text{cpr}(\text{exp},c,t) - \text{vd}(\text{exp},c,t);$$

with

$occ_{(exp, c, t)}$: Cultivated area per farm per crop and per technique

cpr (exp, c, t): Production cost per culture, per technique and per exploitation

3. RESULTS AND DISCUSSION

Considering the crops grown by typicals farms, simulation results show that for medium-sized farms the yields average declines will be between 2.1 and 7.6 tons per ha for summer forages (corn and forage sorghum) in long-term. Decreases are ranging from 5.2 to 12.2%.

For cereals (soft wheat, durum wheat, barley and maize) and winter forage (oats and T. alexandrinum), declines are between 0.1 and 0.6 tons per hectare. Decreases are ranging from 4.2 to 13.8%.

These averages will be affected by the temperature rise of 1°C and will decrease between 0.7 and 5 tons per ha for summer fodder crops. Decreases are from 1.9 to 12.6%.

For cereal and winter forage crops decreases will be etween 0.13 and 0.83 tons per ha. So, they are between 5.8 to 23.1%.

Yields will be even more affected by the temperature rise of 2°C, and low will be between 0.6 and 3.7 tons per ha for summer fodder crops. Decreases are from 2.5 to 8.3%. For cereal and winter fodder crops decreases will be between 0.13 and 1.23 tons per ha. They are between 11.8 and 29.7%.

For large-sized farms which has a cropping system based on cereal (durum and soft wheat) and hay (oat), declines of crop yields average will be between 0.1 and 0.7 tons per ha in long-term.

Decreases will be between 1.6 and 24.5%. For a temperature increase of 1°C, declines will be between 0.1 and 0.55 tons per ha.

Decreases will be between 3.7 and 16.3%. for a temperature rise of 2°C, decreases will be between 0.1 and 0.6 tons per ha. Decreases are between 4.9 and 29.5%. For this typical farms the level of used areas plays an important role in keeping the gross margin average more or less acceptable.

We deduce from this simulation that yields decrease during years is inevitable with and without climate change.

These results are confirmed by other studies made by [17].

So, Yields decline translate into declines of gross margins average for all typical farms studied. Simulation results for thirty (30) years are shown in Figure 1.

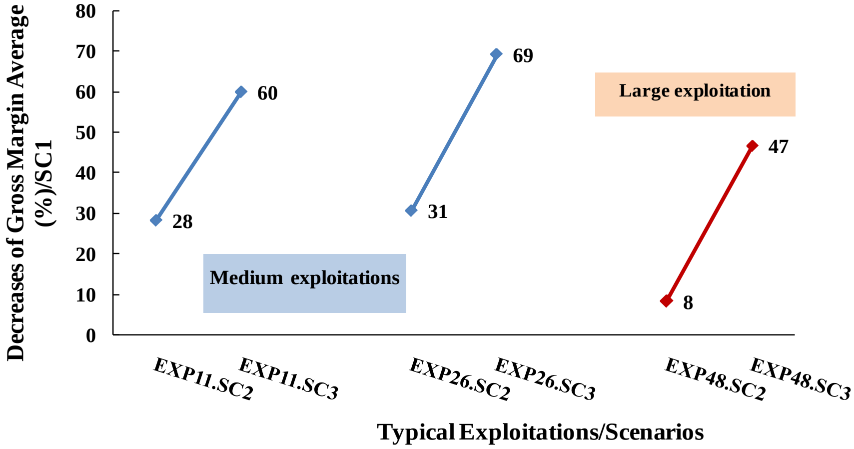

Fig. 1. Decrease in % of the average of the simulated gross margin per farm per scenario

It is consequently noted decreases in average simulated farm gross margins. Considering the scenarios of climate change (SC2 and SC3), these decreases are between 8 and 69% compared to the initial situation (SC1). Evolution of simulated average gross margin per farm per stratum scenario is shown in Figure 2.

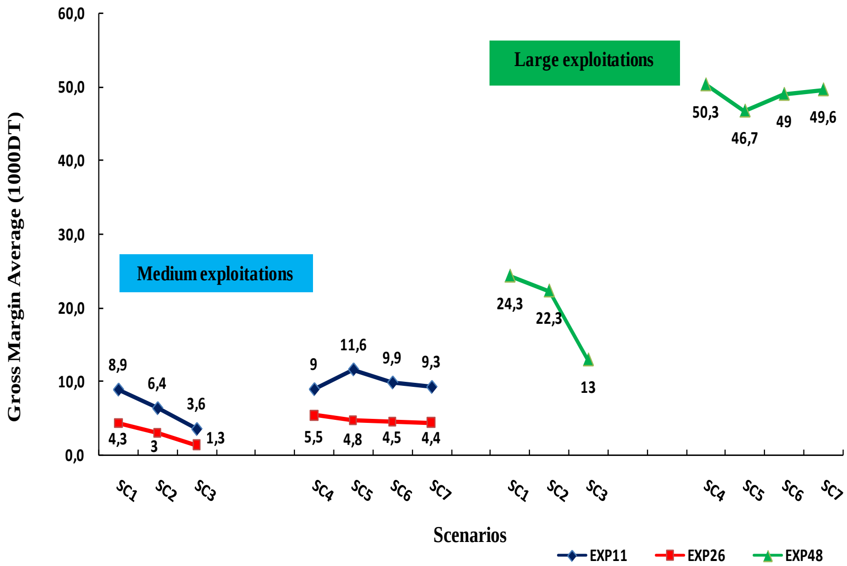

Fig. 2. Average of simulated gross margin per farm per scenario (1000TD) (2.2TD ≈1€)

Analysis of figures 2 and 3, shows that irrigation effect on gross margin is significantly positive for all investigated farms. Figure 3 illustrates the gross margins change of 3 typical farms studied per scenarios in%.

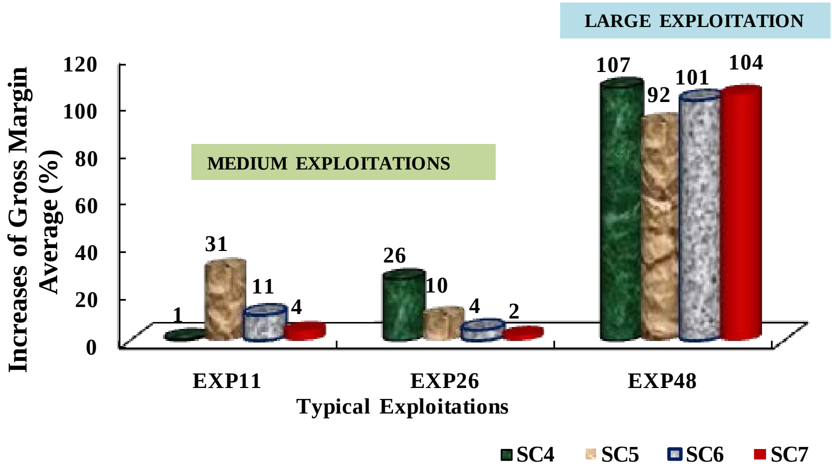

Fig. 3. Evolution of simulated gross margin with additional irrigation per scenario (%)

Simulation results for thirty years show that crop yields will suffer declines in a long-term for all typical farms. These results were confirmed by previous studies[14].

These results are also consistent with those obtained by other authors in studies made for holdings with similar cultures [9], [15], [17].

Gross margin averages simulated during thirty years for medium-sized farms will be between 1.3 and 50.3 miles TD. For EXP11 farm which produces irrigated cereal, winter green fodder and summer fodder, gross margin which was about 8.9 miles TD will increase to an average of 6.4 miles TD for a temperature increase of 1°C and 3.6 milesTD for increase of 2°C. The EXP26 farm has a culture system consisting of irrigated winter fodder hay and summer forage. Their gross margin averages will be affected by the temperature increase of 1°C and more affected with increase of 2°C.

This average which was about 4.3 miles TD will pass for respectively increases to 3 and 1.3 miles TD. For EXP48 farm that produces irrigated and dry cereals and irrigated hay fodder, the gross margin average will increase from 24.3 to 22.3 miles TD for a temperature increase of 1°C. It will be reduced to 13miles TD for a temperature rise of 2°C. The climate change effect is more felt by medium farms studied [18]. Indeed, for a temperature increases of 1°C (SC2), simulated gross margins average will tend to decline between 28 and 31% for medium farms (EXP11 and EXP26), while for large farms (EXP48) decline is only about 8%. So, decreases will be aggravated by a temperature increases of 2°C (SC3) and could reach 69% for medium farms and 47% for large farms (Fig.1).

With additional irrigation doses, simulated gross margins average for medium-sized farms will accuse increases between 1 and 31%. For large-sized farms, these increases will be between 92 and 107% (Fig. 3). For EXP11 farm, the most profitable scenario is (SC5) in which the quantities of water irrigation will be increased by 40%.

Simulated gross margin will show an increase about 31%.

For EXP26 farm, gross margin will accuse an increase about 26% by 20% of quantities water irrigation increase (SC4). For EXP48 farm, the amount of water should also be increased by 20% (SC4) to improve simulated gross margin of 107%.

Simulations results for all farms have shown that yields will tend to decline [6] with and without climate change [18]. Yield declines will generate gross margins declines.

However, additional irrigation doses initially applied [2]-[10] will increase crop yields and thus improve gross margin for all farms.

4. CONCLUSION

At the end of this work and following simulations gross margins for all farmers (medium and large-sized farms) located in the irrigated area of Borj Touil-Tunisia, we would predict that farms revenue will be negatively affected following the yield cultures declines in a long- term. They will be again affected by temperature increases of 1° and 2°C.

However, additional water doses irrigation could improve crop yields and consequently increase the farmers' income. Thus, the significant potential valuation of treated wastewater in the region will allow farmers to adapt to climate change.

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Climate change effects on barley behaviour in an irrigated area by treated wastewater in Tunisia

Mlaouhi Saida, Boujelben Abdelhamid and Elloumi Mohamed

***Abstract*: We used a biophysical approach based on simulation with an agronomic model "Cropsyst". It was used to simulate yields of barley led irrigated with treated wastewater and to study climate changes impacts for over 30 years. The main results show that barley yields are adversely affected by temperature rise to 1 and 2°C. They accuse decreases reaching 31%. So, Supplementation water irrigation could increase yields about 58% and reduce negative climate change impacts.**

***Keywords:* Barley, biophysical simulation, climate change, environment, irrigation, treated wastewater, yield.**

1. INTRODUCTION

Climate change poses a serious threat to the growth and sustainable development in Africa. It also threatens the progress made to reduce poverty and achieving the objectives of decision makers. Rural and small-scale farmer communities likely to be the most affected. They are unlikely to react to direct and indirect climate change effects because their human, institutional and financial capacities are limited. The expected effects cover water resources decrease, land degradation, rising sea levels and salt water intrusion in land. Such impacts are likely to affect economic activities with a significant negative impact on crop yields, ecosystems and tourism [11]-[16].

Thus, higher temperatures and fewer precipitations expected could increase the frequency of droughts, which will expose thousands of people in water shortage areas to year 2030. According to previous studies rising temperatures to 1 and 2°C could affect crop yields generating a negative impact on farmers' incomes in Mediterranean region including Tunisia [9]-[18].

Face to water shortage, unconventional resources such as treated wastewater and

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brackish water are an alternative to conventional water. Tunisia has invested heavily for the reuse of treated waste water into a target to achieving an utilization rate of 60% [19].

Reuse treated wastewater is an exploitation form of an important potential water. However, the waste water is rich in nutrients but it also contains a residual amount of suspended solids. In Tunisia, according to current methods of treatment, it is only used to irrigate feed crops, tree crops and industrial crops. There is a reluctance of farmers for their health risk and their salinity.

This work fits into the overall framework of sustainable agriculture and environment preservation [23]. It is based on an approach using a biophysical model "CropSyst" [22] which allows simulation yields. Our goal is to establish long-term simulations to study the climate change effects on barley yields in Tunisian conditions in order to predict their impact on the area studied. Also, it is an introduction to study this crop response in the short and long-term to climate change and irrigation supplementation of treated wastewater.

2. EXPERIMENT DESCRIPTION

Modelling was conducted using data collected through a survey in an irrigated area located in Borj Touil in the north east of Tunisia. The area perimeter is about 3180 hectares. It is irrigated with treated wastewater. We study the behaviour of barley given its importance for livestock sector development. We constructed the basic crop model. So, we entered location data, region climate data, soil granulometry data and barley physiological parameters. We conserve crop rotation, amounts of water irrigation and fertilizer applied by farmers.

For this work, we chose “Cropsyst” model that was used to evaluate different farming systems. It is able to simulate crops, for several consecutive years and to establish relationship between input-output for crop production.

Indeed, crop growth goes through several phases of development being dependent of genetic cycle, environment and soil factors. During each phase limiting factors are involved as reducing functions under the law of minimum established by Justus Von Liebig in 1840 [2], [5], [6], [13], [20]. The production function is represented for nitrogen and water as follows:

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With E: water, N: nitrogen and β and μ constants to be determined.

This function implies that the plant responds linearly to the most limiting factor. After a certain level of water supply (E*) and nitrogen (N*), culture does not respond to additional contributions and the maximum yield (Y*) is reached [1]-[4]. Some agronomists, believing in a certain level of substitutability between the inputs at low application rates, have developed other functional forms such as:

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MITSCHERLICH BAULE:

$$Y_i = \min\left[Y^* \left(1 - k_E e^{-\beta_E E_i} \right) x \left(1 - k_N e^{-\beta_N N_i} \right) \right] + u_i \qquad (3)$$

Econometric approach limits [7]-[12] have led us to adopt another original approach using engineer production functions obtained by simulations through a biophysical or agronomic model. So "Cropsyst" was used to determine the appropriate crop response functions form, taking account their environmental conditions. This model operates with a daily time and the law limiting factor intervenes to determine biomass (yield).

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So, we generated other climate data using the same sub- program for the same period adopting 2 increasing temperature scenarios.

We have assumed respectively 1 and 2°C increasing temperature. This supposition is based on the work done on climate change that includes this increasing to the year 2050 [14] in Mediterranean region and especially in Tunisia [18].

Once we calibrated the basic models and we used them for long-term simulations. We keptt the same cultivation techniques adopted by farmers and used generated climate data from 2011 to 2040 and generated data considering climate change.

We studied the barley growing response in a long-term, climate change impact on yields and irrigation effects on these yields. Initially, we considered three scenarios defined as follows:

- Scenario 1 (SC1): we kept all the cultivation techniques, the same water irrigation doses initially applied by each farmer. We used for simulations the generated climate data. This scenario is considered as baseline reference (SC1);
- Scenario 2 (SC2): This is the baseline (SC1) using generated climate data taking account 1° C increasing temperature;
- Scenario 3 (SC3): This is the baseline (SC1) using the generated climate data taking account 2° C increasing temperature.

Secondly, we adopted 4 increasing water irrigation doses scenarios which are:

➢ Scenario 4 (SC4): This is the baseline (SC1) with 20% supplementation water irrigation doses initially applied;

➢ Scenario 5 (SC5): This is the baseline (SC1) with 40% supplementation water irrigation doses initially applied;

➢ Scenario 6 (SC6): This is the baseline (SC1) with 60% supplementation water irrigation doses initially applied;

➢ Scenario 7 (SC7): This is the baseline (SC1) with 100% supplementation water irrigation doses initially applied.

3. RESULTS AND SIGNIFICANCES

Figure 1 shows overall results from all simulations of barley yields for 2 surveyed farms (EXP11 and EXP20) and for all scenarios during 30 years (2011-2040). It shows that barley yields will suffer a long-term decline (SC1) for both farms. This decline is enhanced by 1°C increasing temperature (SC2). It is more affected by 2°C increasing temperature (SC3).

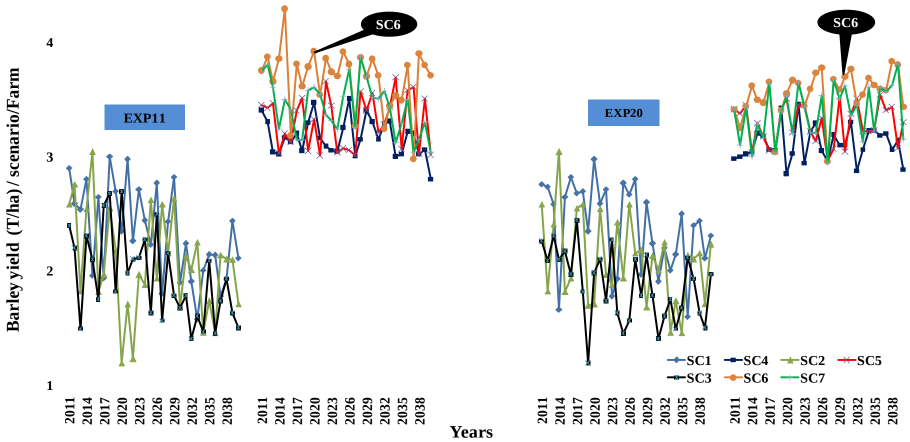

Figure 1. Barley simulated yields evolution per farm and scenarios (T/ha)

Furthermore, we analyzed the barley yields simulated averages for 3 decades to study the long-term effects and climate change impacts. Table 1 illustrates the average of simulated barley yields for both farms per decade and scenarios (SC1 to SC3).

Table 1. Simulated barley yields averages (T/ha) per farm, decade and scenarios

Yield /SC/farm/decade	EXP11			EXP20		
Scenarios	SC1	SC2	SC3	SC1	SC2	SC3
1 st decade	2.5	2.2	2.2	2.6	2.2	2
2 nd decade	2.4	2	2	2.4	2.2	1.9
3 rd decade	2	1.9	1.7	2.2	1.9	1.7

From this table it appears, in the first decade for both farms, that the averages of simulated barley yields are respectively around 2.5 and 2.6 tons per hectare. They will decrease respectively in the second decade by 0.1 and 0.2 tons per hectare. So, their percentages are about 4% and 7% compared to the first decade.

During the third decade, these decreases will be around 0.5 and 0.4 tons per hectare and their percentages are about 20% and 27% compared to the first decade. Compared to the second decade they will be about 0.4 and 0.2 tons per hectare whose percentages are about 17% and 10%.

With a 1°C rising temperature, the averages of simulated barley yields will increase in the first decade. They will undergo decrease during the second decade. Their reduction will reach 0.2 tons and 0.1 tons per hectare. So, their percentages are about 9% and 3% compared to the first decade. In the third decade, decreases will be around 0.3 and 0.1 tons per hectare. Indeed, they are respectively around 15% and 13% compared to the first decade. Compared to the second decade, they are about 0.1 and 0.2 tons per hectare. Their percentages are about 10% and 6%.

With a possible 2°C increasing temperature, the averages of simulated barley yields will further undergoing declines during the second decade. These reductions will be around 0.2 tons per hectare for both farms. Their percentages are about 10% and 9% compared to the first decade. During the third decade average simulated yields declines will be about 0.5 and 0.3 tons per hectare. Their percentages are around 5% and 16% compared to the first decade. These declines will be around 0.3 and 0.1 tons per hectare and their percentages are respectively about 16% and 8% compared to the second decade.

Figure 2 shows the evolution of simulated barley yields averages for both farms (EXP11 and EXP20) per climate change and irrigation scenarios during 30 years. These averages for all scenarios and for both farms are between 1.9 and 3.7 tons per hectare.

Regardless of climate change, the averages of simulated barley yields are between 2.3 and 2.4 tons per hectare (SC1). The averages will be between 2 and 2.1 tons per hectare with 1°C increasing temperature (SC2). These averages will reach 1.9 tons per hectare for 2° C increasing temperature (SC3).

With increasing water irrigation doses (SC4 to SC7), the averages of simulated barley yields will be adjusted between 3.1 and 3.7 tons for both farms. So, the farms EXP11 and EXP20 should increase including 60% (Fig.1) water irrigation doses applied initially (SC6)

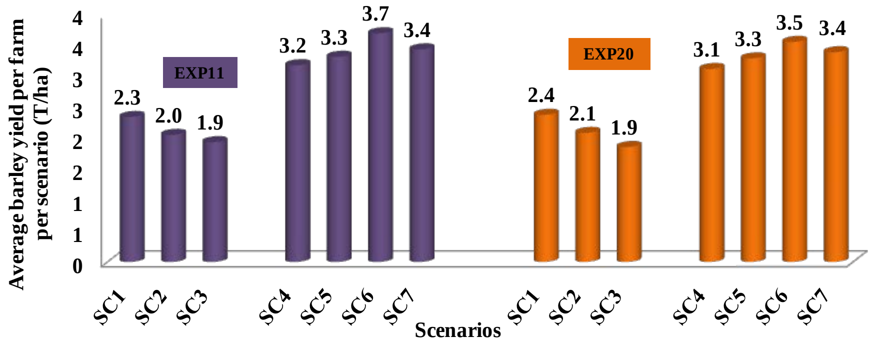

Fig. 2. Evolution of simulated barley yields averages (T/ha) per farm and scenario

The simulated barley yields averages for 30 years are about 2.3 tons for the farm EXP11 and 2.4 tons for the farm EXP20 (Fig.2). These averages will be reduced by about 0.3 tons with 1°C increasing temperature. With 2°C increasing temperature, reductions for both farms will pass respectively to 0.4 and 0.5 tons per hectare.

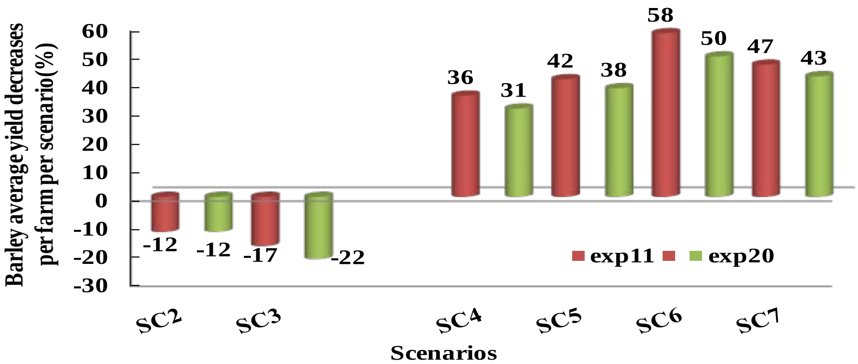

Fig. 3. Evolution of simulated barley yields averages (%) per farm and scenarios

The simulation results for 30 years for both farms surveyed show that barley yields will generally suffer declines. These results are confirmed by previous studies [15]. Reductions for both farms are around 12% for 1°C increasing temperature and respectively about 29% and 31% for 2°C increasing temperature (Fig.3). This is consistent with the work done by [9]-[21]. Yields variability and crop losses will decline over time [17]. So, we observe yields variability between farms. This variability is related to cultivation techniques adopted, soil types and crop behaviour depending on each farm environment.

With supplementary irrigation adoption scenarios, the barley averages yields are improved respectively with 1.4 and 1.1 tons per hectare (Fig.2). These improvements are respectively 58% and 50% including 60% increasing water irrigation doses initially applied by both farms. The supplementary water irrigation will reduce negative climate change impacts on barley yields.

4. 4. CONCLUSION

This work aims to simulate barley yield irrigated with treated wastewater to predict climate change impacts. It has been inferred that the yields will be reduced in the long-term. These yields will be adversely affected by 1°C rising temperature and more affected by 2°C increasing temperature. Supplementation wastewater treated irrigation doses are beneficial for crop yields. These non-conventional waters are enhanced by increasing yields and consequently they would have benefits on farmers' incomes. Simulations established for 30 years would predict that supplemental water irrigation adoption will allow Tunisian farmers to adapt foreseeable climate change. The model used in our work proves efficient and could be exploited for other applications.

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Building of dynamic capabilities in new, innovative firm. A study of Bulgarian construction market

Aneta Marichova

***Abstract* - The development opportunities and improve the firm positions of contemporary markets is mainly associated with the ability of each company to adapt to changes in the environment, as build and develop its dynamic capabilities. In studies of dynamic capabilities is given relatively little space and attention to the way they create, develop, and their role in the work of new, starting his business firm (most authors focus on the problems in big, established companies). This is a serious shortcoming in theoretical research because the new firm especially needs the creation and development of unique capabilities that allow it to adapt successfully to the dynamics of the external environment in order to survive and/or to realize growth, taking advantage of their innovation. In the study author aims to: 1) Development of a practicable model of building dynamic capabilities in new, innovative firm that includes recognizable, understandable and measurable components for managers, 2) Empirical research of the developed model of the dynamic capabilities in the work of two innovative companies operating in the market of building construction.**

***Keywords* - Construction market, Dynamic capabilities, Entrepreneurial capabilities (adaptive, absorbing, innovative), Innovative construction firm, Model "4P", Performance**

1. INTRODUCTION

The development opportunities and improve the firm positions of contemporary markets is mainly associated with the ability of each company to adapt to changes in the environment, building and developing its dynamic capabilities. In studies of dynamic capabilities is given relatively little space and attention to the way they create, develop, and their role in the work of new, starting his business firm

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(most authors focus on the problems in big, established companies). Each newly emerged firm has an idea for the realization of innovation. The innovation process in the company is associated with the development and introduction of new products/processes as a result of monitoring of marketing and technological changes, assessment of opportunities and threats, and primarily the acquisition of new knowledge, integration with internal knowledge to find the right way and direction for development. The innovation change demand, create new markets and transform relationships between customers and suppliers, but at the same time the process has been accompanied by difficulties, uncertainty, high risk and increasing costs. Since its creation, the theory of dynamic capabilities of the firm is associated with the development of innovation as a key factor to reduce uncertainty and increase opportunities for realizing competitive advantages and performance. Since its creation, the theory of dynamic capabilities of the firm is associated with the development of innovation as a key factor to reduce uncertainty and increase opportunities for realizing competitive advantages and performance. The management team of newly established firm must solve several key issues[1]: 1) what capabilities to develop, what elements to include in the system of dynamic capabilities, 2) what specific decisions and methods, approaches to apply taking into account the specificities of the firm, 3) how dynamic capabilities can change the company resources and to develop innovation. Therefore the aim of the study is:

1) Development of a practicable model of building dynamic capabilities in innovative firms that includes recognizable, understandable and measurable components for managers 2) Empirical research of the developed model of the dynamic capabilities in the work of two innovative companies operating on the market of building construction.

2. 2. THEORETICAL FRAMEWORK OF THE STUDY

In this chapter we will develop the theoretical basis and will deduce: 1) practicable model of building dynamic capabilities in innovative firm that includes recognizable, understandable and measurable components of managers, 2) based on the model will define working hypotheses that will be empirically tested the market of building construction.

2.1. Dynamic capabilities of second order

Dynamic capabilities are the "ability of each company to identify need of changes, evaluate alternatives and to take appropriate decisions to adapt to external changes, which include strategic and organizational internal changes" [2]. They are related to the company's ability to use its tangible and intangible resources and to develop, expand and change its resource base in order to get the desired result. Starting point in the creation of dynamic capabilities is the "entrepreneurial activity"[3], which includes solutions for production, choice of resources, appropriate skills development, training, organizational knowledge to develop the resource base and which allow quick adaptation to dynamic external environment and constantly changing conditions work. Material resources of the firm predate the dynamic capabilities, but over time the links between them are becoming more complex and intricate. At the center of this complex process stand entrepreneurial capabilities and activities of managers who focus on [4]:

1) Adaptive capacity. This is the ability to monitor changes in the environment and assess the possible development alternatives. It is associated with the collection of information, data on changes in tastes, preferences, consumer demand, competitive actions and reactions and the emergence and development of new technologies. The collected information identifies opportunities for the development of innovation (product and/or process) and development of the firm.

2) Absorbing capacity. This is the ability of the firm to recognize and evaluate external information, to assimilate new knowledge and apply it in practice. The development of the training system, creating capacity for acquisition, utilization and sharing of knowledge and creating a new way of thinking is the most significant factor for the development of new initiatives and programs and the renovation of existing resources and functional competencies (market, technology, management).

3) Innovative capacity is the ability to change the way in which the problem is solved. It defines the required reconfiguration of existing opportunities in order to increase the efficiency, speed and value of the innovation activity. Basis for the development of innovation capacity is risk appetite on the part of managers and their desire to find, develop new solutions, new, different combinations.

Monitoring, evaluation of alternatives and learning are directly related to the dynamics of the external environment and are a function of the adaptive, absorbing and innovative capacity of the senior management team. They can be defined as dynamic capabilities of higher second order (or second level), which reconfigured the company competencies in response to changes in the external environment.

These conclusions make it possible to put the first hypothesis: Building of dynamic capabilities of second order in new, innovative firm is a function of entrepreneurial capabilities (adaptive, absorbing, innovative capacity).

2.2. Dynamic capabilities of first order

Adaptive, absorbing and innovation capacity of managers in new, innovative firm are the main factors, components that provide constant possibility of the firm to "integrate, reconfigure, update, develop and change its resources in accordance with changes in the external environment"[5]. Although common to all firms these factors are developing differently, unique in each firm. Building dynamic capabilities depend heavily on the managers and their evaluation of changes in the external and internal environment and on this basis the development of corporate strategy, which includes specific solutions and actions based on known best practices, general knowledge and skills. Therefore, dynamic capabilities are specific organizational process related to the selection and creation of new synergistic combinations (reconfiguration) of the resources and assets of the firm. The processes of integration, coordination, and reconfiguration are related to internal organization and can be defined as the dynamic capabilities of the lower first order (or first level) that develop through the expansion and improvement of management capabilities.

The most complex problem for the firm associated with the extremely high risk, is the decision to change and reconfiguration functional competencies/resources, which means searching for entirely new capabilities for technological development, entering new markets, developing new product or in short innovation. These activities are the basis of dynamic capabilities and functional abilities which in innovative firms must be developed in the following four areas (model "4P" - Product, Process, Position, Paradigm) [6]:

1) Product development (Product) directs the company to the development of specific business competencies that create conditions for the establishment of a new or change, modification, improvement of an existing product, in accordance with customer needs.

2) The development process (Process), as the second element of the model includes a series of horizontal technical work. The realization of this innovative direction in new firms associated with the demand for information, knowledge for the development of new technologies, choice of suppliers, external partners or a decision to participate in the development of open innovation.

3) The third element of the model "4P" - Position - is associated with the process of successfully positioning the company product

4) Especially important is the last fourth element - Paradigm - definition of strategic goals and strategic development. Strategic development should include activities related to the protection and expansion of market position and improve the organization and management of human resources.

Therefore, the second hypothesis can be formulated: Building dynamic capabilities of first order in new, innovative firm is a function of the managerial activities and innovation.

The analysis and conclusions allow us to define dynamic capabilities as intellectual inputs in the firm that improves its main business, through a process of reconfiguration of internal and external resources and capabilities (or newly acquired), which in its turn have a back impact by developing and create new dynamic opportunities. The components of the dynamic capabilities in this complex, multidimensional structure are:

1) Monitoring, 2) Evaluation of alternatives and 3) Learning. These three activities are a function of the entrepreneurial ability of managers and defined as *dynamic capabilities of second order,*

4) Integration 5) Coordination, 6) Reconfiguration, which are a function of the internal organization and innovative activity of the firm and are defined as *dynamic capabilities of first order.*

They can not claim to be exhaustive, but recognizable, understandable for the firm and managers and can provide realization of final goal - reconfiguration of functional competencies (marketing, technology, management). Each component of the dynamic capabilities is different, unique to each firm and offers a specific way for reconfiguration of functional competencies and creating new ones. This is the basis to develop a **model of the dynamic capabilities, which includes understandable and measurable components into account the specificities of the new, innovative firm** (Fig.1).

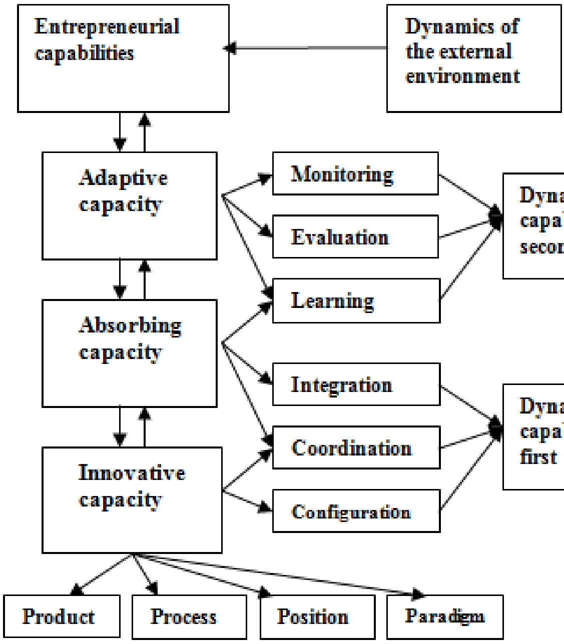

Fig. 1. Model of building dynamic capabilities in new, innovative firm

3. 3. APPLICATION THE THEORETICAL MODEL OF THE DYNAMIC CAPABILITIES IN INNOVATIVE FIRM AND TESTING OF THE HYPOTHESES

In this chapter of the study, the developed model is applied to the analysis and evaluation of the process of building dynamic capabilities in two new, innovative construction firms working in the market of building construction and working hypotheses are tested. The survey is exploratory, searching for evidence about the potential of innovative construction company to build dynamic capabilities in order to create competitive advantage and performance, taking into account their specific characteristics.

3.1. Method and restrictive conditions in the study

The surveyed firms participate actively in the construction market in Bulgaria from 2008-2010 years. One of them operates in the market of public and residential buildings. It is created by a young entrepreneur who has so far worked in a large, well-established construction company, which allows make a comparative characteristic of the process of building dynamic capabilities in innovative and the large, established company in the market. The aim of the firm is to offer only innovative products with high specialization, high quality, focused on the client's wishes and for flexible solutions to each individual problem. It is focused on principles: Quality control and customer feedback. Employed in the company (about

10 people) are trained and ready to implement new, efficient, innovative technologies and solutions in harmony with the environment.

The other company is created in 2009-2010 years by changing its corporate identity and marks a new stage in its development. The company is specialized in the design and creation of specific structures applicable in non-residential construction, especially in the design and construction of logistics centers, with which she fills a market niche in which demand is greater than supply. The company works with a staff of 20 people and uses technological equipment that meets the highest modern requirements, especially in the production of building materials. The aim is to modernize, improve and enhance the quality of products and services in order to adequately respond to market trends and optimal satisfaction of investors through innovation and innovative approach.

First hypothesis: Building of dynamic capabilities of second order in new, innovative firm is a function of entrepreneurial capabilities (adaptive, absorbing, innovative capacity) was tested through interviews with managers at different levels in the company (business unit), in which they answer questions and describe the frequency with which they carry out the monitoring and scanning the external environment, the frequency with which is implemented the introduction of new products in a given market and the necessary change in its marketing practices, technologies and others.

The second hypothesis: Building dynamic capabilities of first order in new, innovative firm is a function of the managerial activities and innovation was tested by an analysis and assessment of the systems that improve business organization, allow effective integration of individual and collective knowledge in coordinating the process of efficient allocation of scarce resources. Were assessed management skills for effective administration, coordination and control of all activities at all levels. Reconfiguration of existing resources and functional competencies and creation of new ones was evaluated by developing and implementing long-term strategies and flexible solutions in the short term.

3.2. Methods used to build the dynamic capabilities in the company

In a changing external environment, managers in the new firms can not build a complex system of dynamic possibilities suddenly and fully. The first problem for any manager is to determine the scope of dynamic capabilities and connections between components. In emerging firms he is limited and focused on several components of their overall structure (such as monitoring, learning). In contrast, in established companies on the market scope of dynamic capabilities and focus on them is big enough and wide.

Next is particularly important to clarify the methods and mechanisms that can use the new firm to create and/or develop their dynamic capabilities and change the resource base. These firms are more inclined to *improvise* in their activity because do not have rich resources and experience, time for reflection and planning of any decision [7]. This requires as a basic mode of action application of the principle *"trial and error"*, which allows the accumulation of experiences, information about the actions and the corresponding reactions that can be used without any effort at a later stage of development of the company for similar solutions in similar situations.

Young firms due to lack of time, resources and experience are more likely to learn on the go, but over time the accumulated information and knowledge will allow them to more accurately predict the outcome and plan various experiments, unlike the "old "firms with the experience and knowledge that often apply the method of experiment and take a final decision based on comparing different results. Another important source for construction and development of dynamic capabilities for all firms and the "young" and "old" is *imitation*. Every new company can use it in a short period as a means to acquire new knowledge due to their relative inexperience and/or lack of knowledge. In fact, most young firms started business with imitation known, best practices, with change some routines. Incumbent firms also often used the process of imitation through the application of knowledge, which for various reasons have failed in other companies or due to institutional constraints imposed before.

Overall comparing different ways approaches that firms use to build the complex and multidimensional construct dynamic capabilities can conclude that the *experiment* presupposes and requires a higher level of organization and control compared to improvisation and principle "trial and error". The decisions that take new firms are unsystematic, unplanned, impulsively and often dramatic. This suggests that the speed and depth of change are greater in less structured knowledge and less experience in new, young firm. Big, radical unexpected change is more likely to happen in firms that are not well organized structure and who now learn and change under the influence of external stimuli [8]. The main factor for building dynamic capabilities has the manager and his own skills, knowledge and abilities to see the prospects for development of their own company.

3.3. Main results of the study

Testing the first hypothesis: Building of dynamic capabilities of the second order in new, innovative firm is a function of entrepreneurial capabilities (adaptive, absorbing, innovative capacity) indicates that the management team of both firm carry out continuous monitoring, scanning the dynamics of the environment and processing large amounts of information. Adaptive ability allows identification new opportunities for development of the company, depth study of the impact of macro factors - the market and technological development of the local and global level. The construction market this process involves analysis and detection of latent demand, technological developments, and analysis of government and regulatory mechanisms the impact of general economic and social factors, the requirements for environmental protection and others. At the micro level, the monitoring process includes analysis of the market structure and the level of competition, possible actions and reactions of competitive behavior, relationships with suppliers, opportunities construction of vertical integrated systems, investments in research, etc. The managers believe that only monitor the external environment is not enough because is possible, the need for change is induced and/or internal reasons of dissatisfaction with the company's position, the current state of resources and others. The simultaneous monitoring and evaluation of external and internal environment allows to make and assessment of the company's capability to respond to the dynamic changes with the existing potential, or its development, expansion or creation of new configurations. Adaptive and absorbing capacity allow managers using the information gathered to develop different scenarios for the development, evaluation of technological change, learning from partners, customers and competitors.

Testing the second hypothesis: Building dynamic capabilities of first order in new, innovative firm is a function of the managerial activities and innovation proves:

1) Product. Both firms develop specific firm competencies as a condition for creating a new or modification, improvement of already existing product, in accordance with the needs of customers and business partners. The first company focuses on the requirements of sustainable construction and preservation of the national cultural and historical heritage, and the second focuses on offering unique, flexible solutions, covering the full construction process and tailored to individual wishes of each client.

Creating and offering new product requires integrating, coordinating the activities of all units and employees in the company and search for new the most appropriate configuration of the resource. Its implementation is carried out with the active participation of many actors (both inside and outside the company), with complex relationships and interrelated processes in the vertical chain to create value. Product development is closely linked with the development of market competencies - market segmentation, target market selection, advertising, flexible pricing, and after sales service. The main objective of the company is constantly improving the quality of the offered product, effective use of available material, human and financial resources, growing image in society, increasingly recognizable brand on principles - quality, reliability and efficiency.

2) Process. Any change and development in the process can lead to the creation and development of new technological competence of the firm, which provides increasing its productivity and efficiency and enables it to create and offer greater value to customers compared with its competitors. In recent years, firms are oriented towards expanding its activities in guidance related to less investment in physical equipment, but requiring more intangible assets, which means implementing effective, innovative technologies and development of sustainable construction. They shall endeavor to apply the latest materials and technologies in construction practice based on the constant transformation of knowledge, exchange of information, which provides short deadlines and quality execution of projects and optimization of processes in the company.

Guideline for the successful development of both studied construction firms is the development of complementary innovations and strategy of integration and cooperation. The ability of managers to identify, develop and utilize their specific assets in combination with other specific assets of other firms participating in the vertical chain of value created is unique and often very difficult to realize.

Building an effective vertical chain is an important factor in stimulating innovation, particularly "open innovation", increased specialization and technological development inside and outside the firm.

3) Position. The process of successful positioning requires attracting potential customers and turning them into real, innovative orientation, to find new partners for development or improvement of the product, organizational changes in distribution, advertising, additional services and facilities which meet the needs of customers. For this purpose, the surveyed companies build long-term partnerships with its customers - large investors and households on the basis of honesty, loyalty and customer feedback. Every company strives to find the optimum solution for clients and works so that they will feel the engagement of employees at all their individual projects and the possibility of flexible solutions for each individual problem.

4) Paradigm. The innovation process in the surveyed companies includes not only investment and development of new products/processes, but also investing in the development of intangible assets and the development and implementation of a new business model. Both functions are effectively integrated within the corporate organization. Each company develops new processes management, organization of production that stimulate and support the process of development and implementation of new technologies and new products. Each firm strives to create his, own, unique model, through the analysis of multiple alternatives and informed assumptions about the behavior of competitors, customers, revenues and expenses, mechanism of adaptation to the external environment and the relevant decisions.

Primary means of realizing corporate purpose are organizational and management changes that include construction of a decentralized corporate structure, coordination of internal resources of the "bottom-up", training of personnel, assimilation and integration the external and internal knowledge, create strong loyalty among customers and maintaining the company's reputation, effective management of innovation and investment process.

4. Conclusion

In the study, the author seeks answers to questions: how the new firm, which started its activity can build a system of dynamic possibilities, what is their scope, what methods to use managers and how they can influence and develop innovation and its resources. In the new, innovative firm, building a system of dynamic capabilities depend primarily on entrepreneurial skills and management activities that focus on the development of adaptive, absorbing and innovation capacity. The author defines the company's ability to monitor changes in the external environment assessment of opportunities for development and learning (assimilation, use of new knowledge) as the dynamic capabilities of second order function of entrepreneurial ability. Their development allows the use of new information and knowledge, which is the basis of successful innovation process in the company. The company's ability to carry out the process of integration, coordination, and reconfiguration of resources determines the dynamic capabilities of first order. They are specific to each firm related to its internal organization and grow through the expansion and improvement of managerial skills. The dynamic capabilities of first and second order help the company to expand, modify and reconfigure existing resources and functional competencies into new, which respond well to changes in the environment and ensure the realization of corporate goals.

The developed model for building dynamic capabilities in new, innovative firm includes understandable and recognizable for managers components, taking into account its specificity and is applicable in companies that have long-term rather than short-term orientation of development. The main specific the model of the new company, which now starts its activity relates to the identification of the management processes and activities - model "4P", that encourage and stimulate innovation and thus the dynamic capabilities. Basis for analysis, testing the model and defined hypotheses and conclusions relevant information is collected from the copyright studies and interviews with managers at different levels in the company (business unit). The empirical analysis proves that new firm is learning on the move, using methods of "trial and error", improvisation and imitation. Spontaneous, unplanned decisions of managers, lack of experience and routine, however, may allow them to realize the great radical changes that provide competitive advantages. Such behavior implies less chance of failure and loss, compared with companies that do not experiment, do not improvise, for fear of failure or due to greater confidence. The first firm focuses its innovative work to continuously improve the characteristics and quality of the product, according to the needs of customers, and the second firm, covering the full cycle of construction and investment process aims to create develop and improve the process, creating and additional facilities to their customers.

A major factor in the success of the innovative firm is the development of knowledge is that the right combination and integration with internal knowledge, skill and experience allows: 1) establishing a long-term vision for development (against the short one), 2) the creation of multidisciplinary teams (not functional), 3) use of complementary innovation, introducing new technologies and creating a unique product (opposite strategy imitation). In each specific company manager has to create its own rhythm and habit for building a system of dynamic capabilities taking into account the specifics of the organization, which manages.

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Building of dynamic capabilities in a small firm
A study of Bulgarian construction market

Aneta Marichova

***Abstract* - One of the essential characteristics of the European economy is the large number of small and medium-sized firms - SMEs. According to Eurostat data they are about 95% of all operating companies, which employ over 70% of the active population. One of the most complex and relatively poorly developed problem is the analysis of the strategy that should be applied in their operations these companies and how it can be adapted to their characteristics, in order to stabilize their market position and to realize its objectives in terms of constant technological and market changes. The study aims: 1) to analyze the prospects of small firm, which according to the author are mainly related to the establishment of strategic alliances with other firms, 2) to develop a model for building dynamic capabilities of small firm participating in strategic alliance, which create potential for competitive advantages in terms of the constant dynamics of the environment.**

***Keywords* - Construction market, Dynamic capabilities, Evaluation of the results, Management practices, Small and medium-sized firms - SMEs, Strategic alliance**

1. INTRODUCTION

One of the essential characteristics of the European economy is the large number of small and medium-sized firms - SMEs. According to Eurostat data they are about 95% of all operating companies, which employ over 70% of the active population. In the construction market is also dominated by a large number of relatively small firms (90% of all construction firms are classified as small to employment to 50 people), which are facing serious new and unknown challenges. In modern conditions, the prospects for their development are associated mainly with the development of intangible assets - knowledge, technological know-how, innovation. They must be combined effectively with other material resources/assets that can be

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defined as complementary in the firm and that through effective management and control create new resources and opportunities for company growth and development. To respond to constant changes in the external environment, the company must develop these new resources and build a system of dynamic capabilities.

The author defines dynamic capabilities as a complex, multidimensional structure of interconnected and complementary specific activities in the company, including its ability to identify and analyze the need for changes, to develop own system of solutions for reconfiguration of resources and functional competences in response to changes in external and internal environment, and implement the necessary actions to adapt to them [1]. Starting point in the whole process, common to all firms in different dynamics of the external environment is the analysis of changes in the environment, assessment of development opportunities, training needs and absorption of new knowledge (dynamic capabilities of the second order), the integration and coordination in the company, which will ensure reaching the end point of this chain - reconfiguration of resources (dynamic capabilities of the first order) and evaluation of the final results.

The aim of managers must be not just building the structure of the dynamic capabilities of their common features but their incorporation in a different, specific way in particular, overall corporate structure and organization. This is a condition for maintaining a competitive advantage in terms of the constant dynamics of the environment in which the firm operates. From this point of view the study has two objectives: 1) to analyze the prospects of small firm, which according to the author are mainly related with the creation of strategic alliances with other firms, 2) to develop a model for building dynamic capacity of small businesses participating in a strategic alliance that includes not only the common features but also take account of its specifics.

2. THEORETICAL FRAMEWORK OF THE STUDY

In this chapter will analyze the prospects for development and will develop a model to build dynamic capabilities of small firm.

2.1. Creating a strategic alliance - a major factor for the development of small firm

The practice shows that the development of dynamic capabilities on the basis only of its own, internal resources is ineffective due to limited resources, the risk of duplication of solutions in the development of which has been invested considerable cost. For these reasons, is a growing feeling that small and medium-sized (SMEs) firms have an important opportunity to develop, by combining with other large firms and creating a strategic alliance. They are defined as voluntary alliances between companies based on contractual relations that allow development and change through cooperation in production and development of creating a final product, through the transfer of technology, knowledge and services [2]. Participating firms typically have a long history before the establishment of the union and preserve their relative independence in the time of its existence, i.e. practically excluded and no observed processes of mergers and acquisitions. Merger between the companies can provide more efficient allocation and use of scarce resources and the realization of synergic effect in one or more firms, and successfully adapt to external changes, integration of external resources through know-how, exchange of knowledge, information, technology and products that increases the overall productivity. These processes allow managers to more efficient use of existing physical, human (experience, knowledge) and organizational (managerial knowledge, vertical relations, etc.) resources which are the foundation for higher added value. Building of specific, unique relations between firms participants in such alliances, allows the development of their own resources, access to different markets, including territorial, creating new business models for management, which is a factor of competitive advantages, higher reputation and stabilization and/or expand market positions[3]. The policy of such unions restricts access of new firms to information, resources and markets and their opportunities for development, which stabilizes the realized advantage.

The creation of any strategic alliance and the development of dynamic capabilities of the participating companies raises several basic questions:

1) What firms to participate in them (equivalent to small firms or small firms and a leading company in a market) and how to make a selection of participants?

2) What is the structure of the company union?

3) How to evaluate the results achieved total alliance and each firm?

2.2. Selection of firms participating in the strategic alliance

The decision to participate in a corporate alliance should be the result of a thorough analysis, consideration of the the pros and cons and evaluate development perspectives. The created strategic alliances have different organization, management, degree of control and coordination of activities. They can be realized between both companies equal participants and between firms with different market position and potential[4]. If a small firm involved in alliance with the big established company in the market, the question is how it can cooperate with it in a different resource base and different organizational structure in a way that would provide its development. It is clear that such a union provides access small firms to experience major to "best practice" opportunity to improve internal organization, improvement of its operations, expansion of knowledge and creation of new, that allows initiation of necessary changes. Establishment of the union involving small, medium equivalent firms limited potential, reduces flexibility to the dynamics of the environment and their future development. A small firm has its chance of success if it participates in a strategic alliance in which other participants have adaptive, absorbing and innovation capability and the potential for technological and market change. Building strategic alliances between small and large companies raises the question: what is the interest of the largest company to participate in it, is there a way it can develop its dynamic capabilities in conditions of limited resources and opportunities for small firms. The answer to this question gives the idea of M. Iansiti and R. Levin [5]. According to them, the economic system should be seen as a biological ecosystem, involving different but related entities with different fates, some better, some worse, but everyone is better together than separately. External shocks and problems in the system are absorbed by the participants, they are a source of opportunities for the firm (not an external threat), which is a condition for the development of new thinking and behavior, factor for greater stability, improve specialization and creation of a heterogeneous structure - business eco-system with different firms that adopt different roles and that affect different aspects of the stability and performance. In these structures develops collective organization, apply collective strategy whose choice depends on the participating firms, the complexity of connections and relationships with others in the system, but also the overall level of turbulence in the external environment.

Basis for the success of any such business eco-system are: 1) innovation, 2) competition between the participants and 3) intelligence of the participating firms. Within a business ecosystem firms can play three specific roles:

1) Firms identified as key players and their potential can improve the condition of eco-business system and thus increase and its operational performance.

2) The dominant firm that build their relations with others (mainly smaller) firms based on the principles of vertical integration.

3) A large number of small firms specialized in a particular activity, the creation of certain specific product and have their niche market.

Therefore, the choice and the decision for the participation of each individual firm in a business system is the result of an assessment of the opportunities, its resource provision (a key player, a dominant or a small company with niche market), goals which placed, and also the dynamics of the market in which work and relationships with other firms-participants.

2.3. Structure and relationships in strategic alliance

Outlining the structure and relationships in a business eco-system allow each firm to determine its technological and operational strategies that create competitive advantage. A major factor for the success of the strategic alliance is a clear definition of the external environment (market, technology, etc.), the development of specific assets and competencies of each company in the creation of a common final product/service and on that basis determine the tasks and competences of each participant [6]. This requires building effective internal structure, system of knowledge transfer information from one company to another and successfully business behaviour, which develops adaptive capacity of each company and the union as a whole. The correct integration of internal and external resources ensures the development of effective collective strategies and it maintained in terms of competition between participating firms and flexible reconfiguration of resources in response to the dynamics in the external environment, which provides the desired result.

Each union means dependency, but also gives you the opportunity for the development, opening of new opportunities more easily to overcome and eliminate the threats. The participation of small firm in unions facilitates access to new technologies, to specialized knowledge to new equipment and the conversion of own production an integral part of the overall multi-product production. Development of managerial skills to analyze changes in the external environment and adapt to them, absorbing the news, information and their inclusion as a component of accumulated internal, corporate knowledge, create potential for development of innovative capabilities. The competitive advantages the firm are the result of integration, unification and specialization. Each small firm, under these conditions can realize their personal success through learning and development of dynamic capabilities on the experience and skills that observed in large companies, key players.

If small firms, players in such a system, the result is better business and adoption of "best practices" for the major, key players in building these relationships is an opportunity for economies of scale and/or economies of scope, reduce the switching costs associated with the selection of suppliers and other contractors, which stimulates the development of innovation in product technology and allows the creation of higher added value to customers and therefore realize a higher profit. An important factor for realizing the desired success, greater than the success that can be implemented separately in each firm or taken etc. synergistic effect is the necessary controls and coordination of common action [7]. The development of relations between small firms and key players in each strategic alliance, process of integration of the main competences of key player with internal resources of small businesses is key to building a new dynamic capabilities different from those which the company began its participation and stabilizing market positions and increase profits.

2.4. Criteria and mechanisms for assessing the competitive advantages and business results for the total union and each company

The question of the criteria and mechanisms should be developed and implemented to evaluate the realized competitive advantages and business objectives established company union is extremely complex. Such an assessment of the activities of the union as a whole is relatively easy to be done, but it is much more difficult to be made for individual companies. The realization of individual company aims is usually asymmetrical insofar as the success achieved by one firm can mean failure for at least another mismatch with set expectations and goals. Each participant with their activity provides the realization of the desired general final result, but it is difficult to prove the individual contribution of each. It is difficult to assess objectively such processes in the union, resulting from the created better organization and which provide effective exchange and development of knowledge, technology, management skills, more effective links between participants, but may be an indirect assessment to use the reaction of competitors, improving the overall performance of a market assessment of consumers and society as a whole [8]. Results and assessments of the strategic alliance by all means should be bilateral. Therefore, besides quantitative financial indicators characterizing the overall activity should be used and qualitative indicators such as: flexibility of management decisions, management and resolution of conflicts, increasing the responsibility of individual actors and staff, efficiency of the existing connections in and outside the union, system of information exchange and others. At the same time must take into account the fact that the assessment of the realized final result is not directly dependent on the amount of just above estimates.

In conclusion from the analysis of the relationships between the companies involved in a strategic alliance may be developed model of building dynamic capabilities of the small firm-participant in strategic alliance with a firm a key player and other firms (Fig.1) and define the following key research issues:

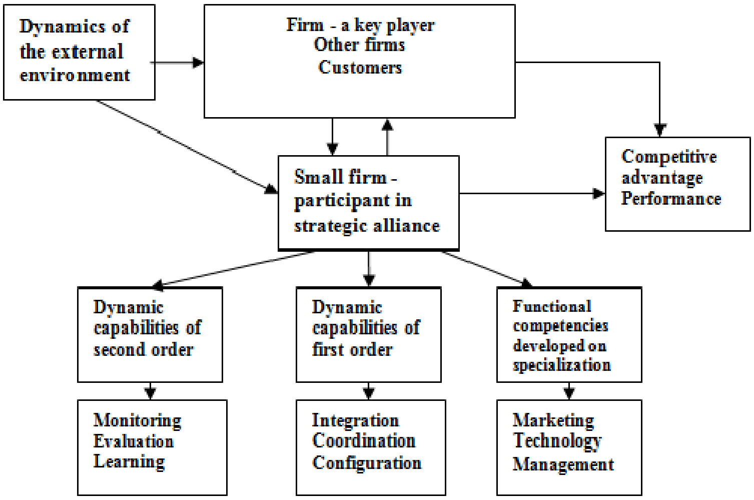

Fig. 1. Model of building dynamic capabilities of small firm - participant in strategic alliance with a firm a key player and other firms

1) What strategy should apply small firm in order to realize competitive advantages in terms of constant technological and market changes?

2) What management practices should apply small firm to monitor the external environment and the assessment of alternatives for development?

3) What management practices should apply small firm in order to successfully integrating the internal and external competencies and reconfiguration of resources?

4) What management practices should apply small firm, to implement the most effective process of specialization and differentiation of its activities?

5) What criteria and mechanisms should be used to make a realistic assessment of the results?

3. APPLICATION OF THE MODEL OF BUILDING DYNAMIC CAPABILITIES IN SMALL FIRM PARTICIPATES IN THE STRATEGIC ALLIANCE OF THE CONSTRUCTION MARKET

In this part of the study, developed a model of building dynamic capabilities of small firm participating in strategic alliance with the firm key player and other firms was applied to analyze and evaluate the activities of three small construction companies working in the market of civil engineering and which are included in the broader work of the great leading company in the construction market.

3.1. Method and restrictive conditions survey

Studied three small construction firms working as contractors and subcontractors that specialize in specific tasks in the realization of large infrastructure projects implemented by the company, which can be identified as a key player. The co-operation between different companies and activities carried out by them, so created a strategic alliance opens new possibilities for new combinations of resources, development of new competences, organizational structures, creating new products, entering new markets, which can be implemented in different ways. Realizing a common objective requires maintenance of formal and informal links between individual firms and personalities based on established common resource through the acquisition of various assets. A key success factor is the access to information and exchange experience in order to solve current problems. Building effective relationships at all levels, formal and informal, trust between all subjects is critical for any association. The empirical study was carried out on the basis of information collected and processed by workshops, shared posts, ratings, experience of managers, employees in the surveyed companies (as in the firm a key player , and small firms). This study is exploratory, searching for evidence of opportunities for development of small construction firms and realization of competitive advantage and business objectives within the established strategic alliance. Information collected and processed allows to give answer to the research questions and to summarize these survey results.

3.2. Main results of the study

Strategic behavior of small firm in strategic alliance

The survey shows that the firm a key player developing its own strategy, which sets the rules of the game, the requirements for product development, entering new markets and more. Development and implementation of a common strategy to solve the various problems in the strategic alliance creates significant opportunities for the development of small firms-participants. The firm a key player in takes decisions on future action and directions of development, based on analysis and evaluation of existing capacity in the alliance, develops requirements for standards and rules of procedure and defines the different tasks of the participants within a common system, acting as a single mechanism. Moreover, considering the influence of different variables that can create opportunities or threats to increase business value. According to the managers of small firms, participation and behavior of the company, which as a key player creates stability and predictability and stimulate their development in the following areas:

1) Increased productivity in general business eco-system by creating effective links between all participants, providing for improved outcome.

2) Increase the stability of the system through the development and implementation of technical novelties and innovation.

3) Encouraging the introduction of innovation in small firms and deepening their specialization within the overall framework by creating an effective system of complementary and interrelated production and activities. Under the so general "rules of the game" any small firm from a niche market to develop its own strategy, which allows the realization of competitive advantages and performance in a dynamic market. It includes three main elements: 1) identification the needs of key players, and the identification of other smaller firms-participants and their production and links in the union, 2) identification of opportunities for the integration of external resources with internal ones and 3) identification and development of activities who develop specialization of the firm within the general activity. Developing its own strategy

determines the necessary management practices (actions and decisions) that must apply a small firm within a strategic alliance to realize its goals.

- **Management practices that apply surveyed firms in the market of civil engineering with purpose to monitor (incl. the firm key player and other firms-participants), assessing the external environment and learning include activities related to:**

1) Collection and analysis of information about other participants, their role and strategy in the union and assessment of opportunities for development in the general conditions of the alliance and the benefits of cooperation.

2) Analysis of the strategy of key players and taken strategic decisions that determine the development trends of the union.

3) Assess the opportunities and threats for the development of the market which determined the general conditions for development of small businesses.

4) Determine the type of product they create and offer other firms-participants, the market that offer or plan to go and strategic behaviour.

5) Decision on participation and investment in markets that can ensure development of the company's product.

6) Development of actions to protect the market positions of other firms-participants (incl. and the key player) who might be tempted to attack the positions gained.

- **Management practices that apply surveyed firms with purpose successful integration of internal and external competencies and reconfiguration of resources**

Integration of external resources for development and change internal is the main goal and task of each small firm. The main factor for its success within the built strategic alliance is the presence of internal distinctive competencies provided with the necessary physical assets and growing specialization in some stage of total production [9], in accordance with the established standards and product requirements of the company - key player. Under these conditions surveyed firms develop their competences and capabilities within the specified limits and the following management actions:

1) Ensuring access to new technologies and their implementation, their use in real time.

2) Encouraging the exchange of information, knowledge and technologies in the union, which stimulates innovation.

3) Development of complementary innovations and create complementary products as an integral part of the overall innovation activity in order to improve quality of the final product and providing better customer service.

4) Conclusion of contracts for long-term cooperation with other firms in order to reduce or neutralization the impact of changes in the environment.

5) Concentration on the activities that require a joint effort by the participating firms and for which no developed effective solutions.

6) Support of own production through integration of complementary activities or other key players and firms development of new strategic solutions that meet the specific capabilities of the company and ensured its stability and neutralize threats from other participants.

- **Management actions that develop the company's distinctive competences and deepen the specialization of a small firm a participating in strategic alliance**

In the context of limited resources, the main direction for the successful development of the small firm's participants is specialization and product differentiation. In strategic alliance creation of the final product is the result of innovative activities and the creation of separate parts of this product in the participating firms. The common organization of this process can provide the desired success for each one of them with the best combination of changes in the production of changes in the external environment and managerial experience [10]. The creation of a specific, differentiated product as the basis for the realization of the positive performance and strong market positions against current and potential competitors, i.e. realization of advantages, which requires managers take the following decisions:

1) Evaluation of its resource base, especially technical and its possibilities for improvement, improvement through cooperation in the union.

2) Development of specific professional solutions, using technical innovations which satisfy customer/investor.

3) Establishment of an effective system of relationships with suppliers, customers, other companies in and outside the union on the principles of honesty, perseverance, permanence, exchange of technical knowledge and experience, which is a guarantee for the success of the company.

4) Development of joint programs with the leading company for learning, exchange of experts, knowledge, technology transfer that create new dynamic capabilities in the company.

5) Creating a better organization,, a proper allocation of tasks and selection of the right people to solve them. Improving relations between people in the team and general organizational climate and establishing an effective system of incentives and motivation of staff.

6) Expanding of the firm through the development of marketing, technological and managerial skills resulting from the successful integration of external resources with its distinctive competencies increases the desire and the possibilities for greater autonomy in the development of the principle of open innovation model.

- **Evaluation of realized results from the participation of small firms in a strategic alliance with the firm - a key player**

The surveyed firms reported stabilization of financial results, a tendency to cover the obligations good opportunities to cover current operations and greater financial stability. The realization of corporate goals measured by the costs, revenues, used technological innovations and human knowledge and skills embodied in the product creation, evaluation of positions in the market against competitors is proof of the ability of the manager to develop dynamic capabilities and adapt the strategy of a small firm in a way that allows implementation competitive advantages. The success of a manager in no case should not be associated only with the development and implementation in practice of a large project, but must be seen as composed of permanent small organizational and management changes that enable efficient allocation and use of human, technological, physical and financial resources and quickly resolve emerging problems. The final result of participation in a strategic alliance can be summarized as follows:

1) Growing reputation in society trust among current and future customers.

2) Development of marketing skills and opportunities for entering new markets and expanding positions
by specialization, cooperation.

3) Development of technological competencies, which allow increasing the quality offered and additional services.

4) Improve financial performance, occupying a dominant position on a market niche and becoming a product leader not only of the given segment, but also in the global market.

The overall assessment of the results of the company is an assessment of the built dynamic capabilities and its ability to apply their common characteristics specific way that combines a management, marketing and technical internal capabilities with external ones. For small businesses participating in the strategic alliance, they are a function of its ability to analyze the external environment and adapt to changes in it through managerial abilities and flair for creating an effective organization and use of market opportunities.

4. CONCLUSION

The study analyzes the prospects for development of small construction firms, offers a model for building of dynamic capabilities that create potential for competitive advantages in terms of the constant dynamics of the environment. The author argues that in a dynamic environment, the building of dynamic capabilities in the small firms, which have limited capacity and resources is mainly associated with the creation of strategic alliances with other big companies and it identified as a key player. The effectiveness of the functioning of such unions can be compared with the functioning of a biological system where everyone is better with others than alone. Basis for the success of any such "business eco-system" are: 1) innovation, 2) competition between the participants and 3) intelligence of the participating firms.

The creation of a strategic alliance for the big firms - key players is an opportunity for economies of scale and/or economies of scope, reduce the switching costs associated with the selection of suppliers and other counterparties, which stimulates the development of innovation in product technology and allows the creation of higher added value to customers and thus realizing higher profits. The aim of any small, specialized firm is the integration of external to internal resources, transfer of technology, information, knowledge and other specific resources in the union and fast, aggressively adapting to the requirements of key player and a external changes. Absolutization and fully copying foreign experience significantly limits its chances of success. It's not enough participation in the union in order to reach a level of development of the resources and capabilities of other firms but necessary participation which ensure the establishment and development capabilities and a new resource base as a source of competitive advantage. In strategic alliance integrating the resources of all participants is a factor stimulating development of dynamic capabilities of each company and the building of closer ties with other actors within the union and outside it, which in turn prevents a competitive advantage. The competitive advantages of the firm are the result of integration, consolidation and specialization.

A major factor in the success of small firms in within the established strategic alliance is the presence of distinctive competencies provided with the necessary physical assets that allow specialization and differentiation of product creation. The creation of a specific, differentiated product from small businesses a participating in the strategic alliance is the basis for the realization of positive performance and strong market positions. On this basis, most firms have good opportunities for self-development in the future or continued participation and cooperation within the same or other strategic alliance. Of course remains one part of small businesses that just work, implement the decisions of key players, based on existing knowledge and opportunities. However growing requirements to create products imposed by the leading firm established system of relations between the companies involved in the union and those outside impose seeking new directions for improvement, improvement of operations and expansion positions.

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Considerations upon adapting the pumps to variable network regimes by controlling the pumped flows through the delivery pipe valve

Nicolae Marcoie

***Abstract* – The pumping installations that operate on water distribution networks are major energy consumers. Therefore, their operating regimes have to be adapted to the users' variable demands, in order to minimize the average total annual costs and to ensure a high efficiency of supplied services. However, there are many situations in which the adapting to the variable functioning of pumps is carried out by means of pumps delivery valves. The presented case study demonstrates that the use of this method involves significant increases of energy losses, fact that implies an increasing of the specific energy consumption.**

***Keywords* – energy specific consumption, parametric control, pumping stations, water supply systems**

1. INTRODUCTION

Pumps installed in water supply systems are serving networks of which demands may vary in time, between the minimum flow and the designed flow. Therefore there is need to adjust pumps in a manner that ables the conveying of the various flows demanded by users, in conditions of maximum energy and economical efficiency [1].

The variation of a pumped flow can be provided by means of two methods [2]:

- by modifying the system's load characteristic, reduced at delivery's origin by:
  - modifying of head loss characteristic (h_{rcp}~Q) on pumps communications;
  - modifying of pumps' own head loss characteristics $(H\sim Q)_P^R$;
  - modifying of the resulting characteristic of a pumping group equipped with parallel coupled pumps;

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- by an intermittent pumping and flow compensation, by providing the head demanded by network.

2. THEORETICAL ASPECTS

The control technique by modifying the head loss on pumps communication lines is known as *parametric control*. An adaptation to variable regimes can be provided by modifying the head loss (h_{rcp}~Q) on pumps delivery mains, an by keeping unchanged the pumps characteristics $(H\sim Q)_P^R$.

This can be achieved with very simple means, but which, however, shall generate energy losses, and, therefore, a decreasing of the pump's global efficiency and an increasing of its specific energy consumption.

The adaptation to variable regimes performed by modifying the characteristics of delivery communication line is achieved [2]:

- by varying the fluid flow via the valve mounted on the pump delivery main;
- by by-passing the pumped flow stream through a by-pass pipe.

2.1. THE CONTROL TECHNIQUE BASED ON THE MODIFICATION OF FLOW VIA THE DELIVERY PIPE VALVE

Such a control is carried out by varying the head loss on the pump communication lines (h_{rcp}~Q), by means of the valve mounted on its delivery main.

The pump's head loss can be analytically expressed through an equation of type $H=A_0+A_1Q+A_2Q^2$ (where A_0, A_1 and A_2 are coefficients).

If the valve is opened at various degrees this shall modify the local head loss coefficient ζ_v and, implicitly, the local head loss on the valve h_{rvalve}. Therefore, the head loss on the pump communication lines shall vary, from the form $(h_{rcp}\sim Q)_P^0$ that corresponds to a fully opened valve, to the form $(h_{rcp}\sim Q)_P^\mu$, associated to the closing degree μ (see **Fig. 1**), according to equation conform (1):

$$h_{rcp}^{\mu} = \left(M_{rcp}^{0} + M_{rvalve}^{\mu}\right)Q^2 \tag{1}$$

where: M^0_{rcp} – the equivalent hydraulic resistance module of pump lines, with a full opened delivery valve; M^μ_{rvalve} – the local hydraulic resistance module corresponding to a valve set at a closing degree μ.

The modifying of head loss on the pump communication lines has a direct effect upon the pump head loss, reduced at the intake section on the pump's delivery pipe. Therefore, a translation shall take place, from the form $(H\sim Q)_P^{O,0}$, when the delivery valve is fully opened, to the form $(H\sim Q)_P^{O,\mu}$, that corresponds to various closing degrees μ, and expressed as form (2):

$$H_P^{O,\mu} = A_0 + A_1Q + \left(A_2 - M_{rcp}^{0} - M_{rvalve}^{\mu}\right)Q^2 \tag{2}$$

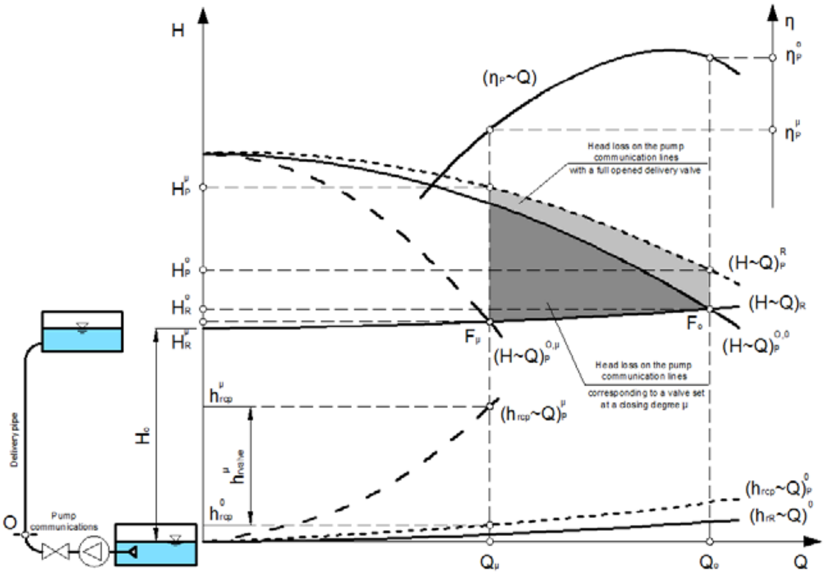

Fig. 1. Adaptation to pumping variable regimes by means of delivery valve adjustments

The system's operating regime corresponds to a balance status of the pump network system, the common section (O), and the resulting solution of system (3) made out of the network's characteristic and equation (2):

$$\begin{cases} H_R = H_o + M_{rR} Q^2 \\ H_P^{O,\mu} = A_0 + A_1 Q + \left(A_2 - M_{rcp}^{0} - M_{rvalve}^{\mu}\right) \end{cases} \tag{3}$$

where: H_R - the head demanded by the network; H_o - the network's static pumping head; M_{rR} - the hydraulic resistance module of the pump delivery pipe; $H_P{}^o$ - the head delivered by pump.

By solving the system (3) it results that the flow conveyed by pump is given by equation (4):

$$Q_\mu = \frac{-A_1 + \sqrt{A_1^2 - 4\left(A_2 - M_{rcp}^{0} - M_{rvalve}^{\mu} - M_{rR}\right)\left(A_0 - H_o\right)}}{2\left(A_2 - M_{rcp}^{0} - M_{rvalve}^{\mu} - M_{rR}\right)} \tag{4}$$

The head of pumped flow in the common section (O), results by replacing the value Q_μ obtained in any of the equations (3):

$$H_R\left(Q_\mu\right) = H_o + M_{rR} Q_\mu^2 = A_0 + A_1 Q_\mu + \left(A_2 - M_{rcp}^{0} - M_{rvalve}^{\mu}\right) Q_\mu^2 \tag{5}$$

The head on the pump delivery main results by replacing the same value of Q_μ in the pump head equation:

$$H_P^R(Q_\mu) = A_0 + A_1 Q_\mu + A_2 Q_\mu^2 \tag{6}$$

The operational regimes F_o and F_μ, that correspond to various flows requested by the network, are obtained by varying the valve closing degree (see **Fig. 1**).

With a fully opened valve the pump delivers the designed flow Q_o, and is efficiently running under a head that equates the head demanded by the network at which adds only the specific energy strictly needed for the conveying of water via the pump communication lines $h^0_{rcp}(Q_o)$.

By maneuvering the valve up to a closing degree μ, it is possible to achieve a balance between the network requested flow and the pump conveyed flow Q_μ, but this, only if the pump works under a head $H_P^R(Q_\mu)$, given by equation (7):

$$H_P^R(Q_\mu) = H_R(Q_\mu) + h^\mu_{rcp}(Q_\mu) \tag{7}$$

This is obviously superior to the effective head (demanded by the network) and given by $H_R(Q_\mu) + h^0_{rcp}(Q_\mu)$. The difference between the two heads, given by (8):

$$h^\mu_{rvalve}(Q_\mu) = h^\mu_{rcp}(Q_\mu) - h^0_{rcp}(Q_\mu) \tag{8}$$

represents the specific energy dissipated on the delivery pipe valve.

Although the varying of flow via the delivery pipe valve allows the establishing of a balance between the network head and the pump effective flow, this also means to accept an imbalance between the network demanded head and the head which is effectively delivered by the pump, on the delivery pipe.

The energy losses generated by a flow control carried out via the delivery valve are shown by the hatched area located between the reduced characteristic of the pump with an open valve, and the network's characteristic.

In textbooks, the pumping energy and economical efficiency can be described using the energy specific consumption – the energy amount used for conveying, under head H, the volume unit of pumped fluid (expressed in Wh/m^3), and given by equation (9):

$$e = 2{,}725 \frac{H}{\eta_P \eta_m} \tag{9}$$

this being defined as an estimation of pumping efficiency within the particular conditions of the studied pumping plant.

3. STUDY: THE BOLDESTI RE-PUMPING STATION

The Cotnari commune (Iasi County) is located in an area that features a difficult relief, and where stable water resources are scarce (for its inhabitants and also for its developed wine industry). Hence, the community had to be supplied from relatively remote sources, located around the Siret River. Nowadays, by means of the Blagesti main water pipeline (that was once serving a catchment abandoned since 1990) the

Boldesti water source is exploited (a creek that supplies a high quality water, at a relatively stable flowrate that reaches cca. 18...25 l/s (see **Fig. 2**).

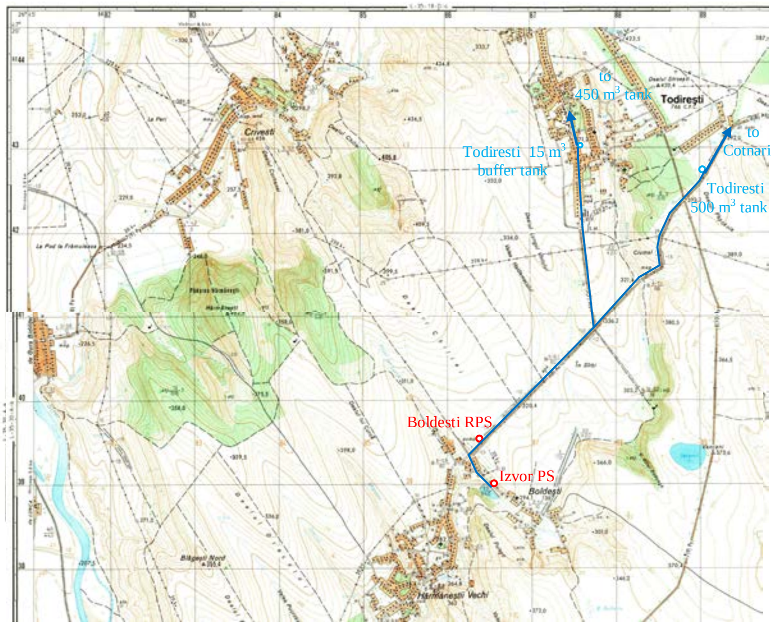

Fig. 2. The „PS Izvor – RPS Boldesti – Todiresti tank" main water pipeline system

The main water pipeline conveys water from a level of 280 mSL (meter Sea Level) – inside the suction basin at level of 200 mSL – in the Cotnari tanks level, after the crossing of the Pascania Hill, on which is located - at the route's highest spot (407 mSL) – the Todiresti 500 m^3 tank, and passing afterwards through the Stroesti slope breaking and distribution system, located at level 360 mSL. Water is conveyed all along this route by means of two pumping plants: the Izvor-Boldesti pumping station and the Boldesti re-pumping station (RPS). The Boldesti RPS –Todiresti tank water conveying system includes the Boldesti RPS and a Dn 300 pipeline, reaching a length of 4300 m, which supplies the 500 m^3 Todiresti tank. The Dn 300 steel pipeline supplies water to the Todiresti village via a branch connecting pipe. This connecting pipe is located at approximately 2000 m away from the Boldesti RPS and ensures the supply of a 15 m^3 buffer tank, belonging to the Todiresti pumping station. The Todiresti PS is pumping water towards a 450 m^3 water tank, located on a dominating hill, allowing the gravity water distribution towards the commune.

As it is shown in **Fig. 3**, for the two consumers C (the 15 m^3 buffer tank)and D (the Todiresti 500 m^3 buffer tank) it shall result $H_{g2} \neq H_{g3}$, and, as well, different factors $(H\sim Q)_{R2} \neq (H\sim Q)_{R3}$. Moreover, the consumer C is supplied from the network of consumer este D. The pump P (LOWARA) is transferred from point O towards point B. Once this transfer achieved, its head factor, $(H\sim Q)_P^{O,0}$ becomes $(H\sim Q)_P^{B,0}$. This occurs due to fact that the head values $(H\sim Q)_{R1}$ have been substracted from the basic head, this being in fact the head losses from the pipe sector from O to B [3].

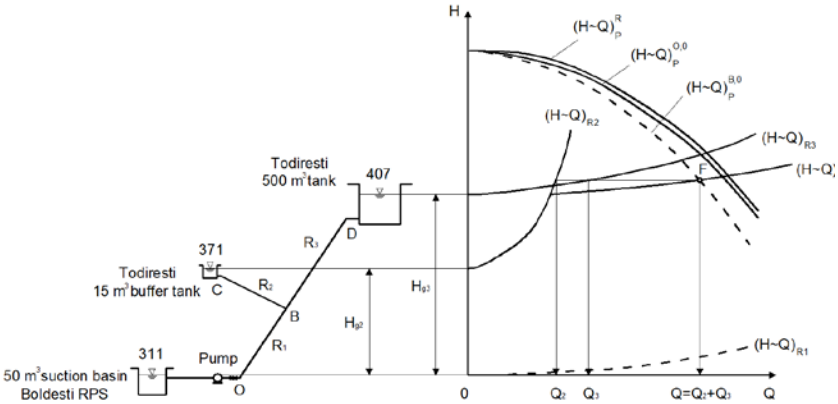

Fig. 3. Operation of pump P (LOWARA), with characteristic $(H\sim Q)_P{}^R$, which suplies two different consumers (C and D) of which one – C (15 m^3 buffer tank) is fed from the network of D (Todiresti 500 m^3 tank); $(H\sim Q)_P{}^{O,0}$ – head characteristic of pump P locared in O; $(H\sim Q)_P{}^{B,0}$ – head characteristic of pump P, located in B (reduced characteristic); $(H\sim Q)_{R1}$ – characteristic of the O-B network; $(H\sim Q)_{R2}$ – characteristic of the B-C network ; $(H\sim Q)_{R3}$ – characteristic of the B-D network; Q_2 and Q_3 – flows towards consumers C and D

Next to experimental measurements carried out in Boldesti RPS and after processing the gathered date the following characteristics have resulted [4], [5]:

- the head characteristic of the pump LOWARA 66 06/1:

$$H_P = 174{,}82 - 701{,}42Q - 104917{,}64Q^2 \tag{10}$$

- the efficiency characteristic of pump LOWARA 66 06/1:

$$\eta = 2{,}01 + 6949{,}45Q - 170367{,}87Q^2 \tag{11}$$

- the head characteristic on the pump communication lines:

$$h_{ro} = M_{ro}Q^2 = 6096{,}24Q^2 \tag{12}$$

The characteristic of network $(H\sim Q)_{R1}$ (between Boldesti SRP and the connecting manhole) has the equation:

$$H_1 = M_{r1}Q^2 = 1849{,}90Q^2 \tag{13}$$

The characteristic of the network $(H\sim Q)_{R2}$ (between the connecting manhole and the Todiresti 15 m^3 buffer tank) has the equation:

$$H_2 = H_{g2} + M_{r2}Q^2 \tag{14}$$

where: H_{g2} = 60 m and $M_{r2} = 2{,}00 \cdot 10^6$ s^2/m^5.

The characteristic of network $(H\sim Q)_{R3}$ (between the connecting manhole and the 500 m^3 Todiresti water tank) has the equation:

$$H_3 = H_{g3} + M_{r3}Q^2 \qquad (15)$$

where: H_{g3} = 96 m and M_{r3} = 2150 s^2/m^5.

In order to highlight the energy losses that occur when the flow is to be adjusted with the pump delivery valve two cases have been studied:

- the pump being run with the delivery valve set at various closing degrees μ_i (the operating personnel stated that for a long period of time the pump has provided a flowrate with 50 % lesser than the nominal flowrate);
- the pump being running with a fully opened delivery valve.

Figure 4 shows the diagram of the operational conditions that correspond to the studied cases.

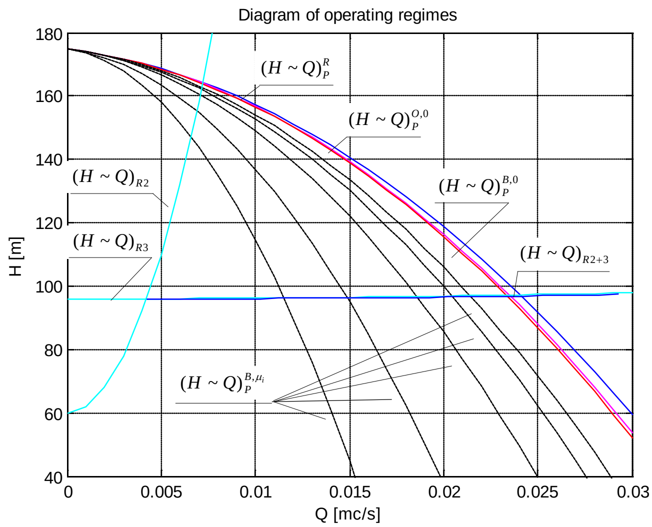

Fig. 4. Diagram of operating regimes

Table 1. Water pumping: Calculations for the specific energy consumption

No	Delivery configuration	Closing degree	Q (m^3/s)	H (m)	η (%)	e (Wh/m^3)
1	Fully opened valve	0	0,0234	100,96	71,34	416,90
2	Partially closed valve	μ_1	0,0215	111,24	72,67	450,95
3		μ_2	0,0205	116,35	72,88	470,33
4		μ_3	0,0186	125,48	72,33	511,06
5		μ_4	0,0149	141,08	67,73	613,59
6		μ_5	0,0115	152,88	59,40	758,23

The energy and economical characteristics of pumps, the efficiency of operational regimes and, as well, the specific energy consumption have been determined by taking into account the pump's analytical head and efficiency characteristics and the characteristics of the head losses on the pump's own communication lines (that is, suction and delivery) - according to the studied operational assumptions (see **Table 1**).

4. CONCLUSIONS

The current capacity of the water pumping Boldesti – Todiresti system is estimated at Q = 64 m^3/h, value that is slightly limited by the rated capacity of the pumps that operate at the Izvor PS. It is to be noted that if the LOWARA pump is running at flowrates representing 60 % of the maximum flowrate pumped of Izvor PS (about 50 % lower than the pump rated flow), the efficiency is lower by 16,74 % compared to the case when the pump is running with a fully opened valve and the specific energy consumption is 81,88 % higher. Therefore there is need to operate the LOWARA pump with a fully opened delivery valve (possible to do only if the Boldesti catchment flowrate would be increased) or by replacing this pump with a lower sized pump able to ensure an optimal energy consumption.

Moreover, it appears necessary to implement a monitoring and control system in the Boldesti PRS, this intention being supported by the current large amounts of consumed power and the important value of the equipment.

The positive effects of implementing a monitoring system in the pumping station will be: the optimizing of operational manoeuvers, reducing the frequency and severity of failures, reducing the time needed for repairs and the possibility to adopt a preventive maintenance program [6].

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Problem of non-conformity of computational model and results of vibration tests of multistory buildings with girderless construction

O. Murashko, V. Dorofeev, O.Mihailov, V. Yegupov, N. Mihailova

***Abstract* - The work is dedicated to solution of the problem of non-conformity of computational model of multistory reinforced concrete buildings to results of vibration tests by means of consideration in calculation scheme of nonstructural elements.**

***Keywords* – computational model, girderles floor, nonstructural elements, vibration tests.**

1. INTRODUCTION

Reinforced concrete buildings with girderless floor with diaphragms and cores are widespread in seismic regions of many countries, including Ukraine. In spite of a set of drawbacks typical for this structural diagram such as absence of beams, concentration of stresses in the zone of abutment of the slab to bearing walls and columns, these buildings are very simple in assembling and have a low material consumption compared to the girder construction. For these reasons they have become widespread.

Nowadays a seismic stability assessment of these buildings shall be urgently made. For this purpose the seismic stability assessment system is being developed, which consists of three levels and covers seismic stability assessment methods from visual examination to nonlinear analysis in combination with vibration tests [1]. When developing this system the problem has been revealed, to which this work is dedicated.

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The problem that one often comes across during examination of buildings and dynamical tests, consists in non-conformity of their results and data obtained as a result of the building calculation.

2. EXPERIMENT DESCRIPTION

The results of the dynamic test of 24-story residential building in the city of Odesa, on which example the abovementioned problem is being solved, are given below.

The building is made in reinforced concrete girderless frame with diaphragms and cores with a storey of 3.3 m high. The plan of a typical storey and a sectional view of the building are in Fig.1.

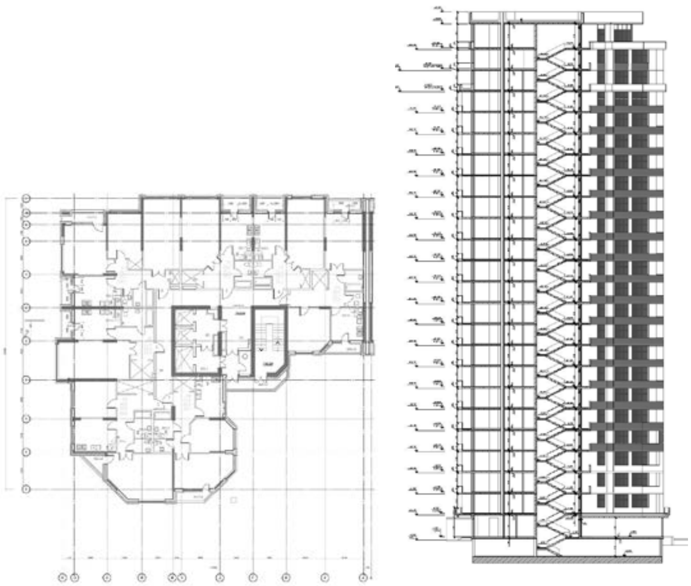

Fig. 1. Plan of typical storey and sectional view of the building.

At the moment of the examination in the building there was a fully erected reinforced concrete frame (except for a slab of a lift room) and the wall infil was up to the level of 19th storey.

Tests were conducted in two stages using two measuring instrumentation sets:

1. A set of sensors S5S and spectrum analyzer SM3KV
2. A set of sensors VEGIK and S5S and spectrum analyzer developed espetially for State Project Development & Research Institute of Marine Transport

Vibrations were generated using three methods by means of impacts:

1. load made of reinforced concrete, in a permanent formwork made of auto tyres
2. formwork beams 2 meters long, which acts as a tamper (Fig.2 right)
3. ambient vibrations from wind effect and seismic noise.

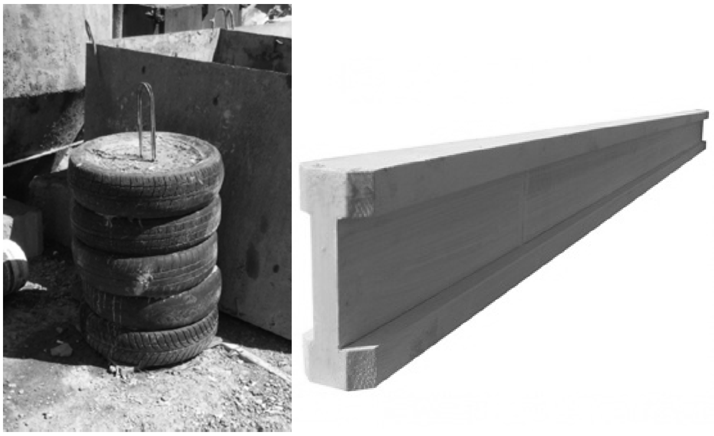

Fig 2. Load (from the left) and tamper (from the right), by means of which vibrations were generated

Impacts were delivered over reinforced concrete cores walls at the level of the upper storey slab. Recording instruments were located by different variants: both on the slab (to reveal vibrations in plan view) and on different storeys (to reveal distribution of vibrations along the building height). Due to the restricted scope this article contains only data on frequency-response characteristics of the building, although shapes of the building vibrations have been analyzed.

In Fig. 3 shown records that were made on the first equipment set. Three areas were clearly distinguished: from the left – vibrations were generated by impacts of the load along the recording direction, in the middle – in perpendicular direction by the load as well, from the right – vibrations that were generated by the tamper.

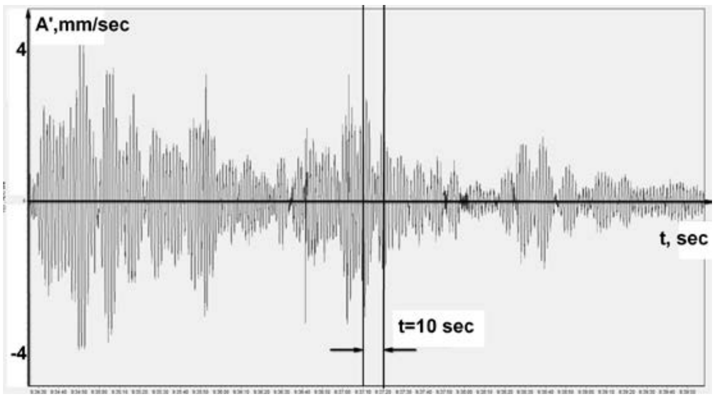

Fig. 3. Data were registered with sensors S5S and spectrum analyzer SM3 KV (the left part of vibrations was generated by impacts of the load, the right part – by impacts of the tamper)

Fig.4 and Fig.5 contains an enlarged capture of the record shown in Fig.3 and the results recorded by means of the second recording instrumentation set.

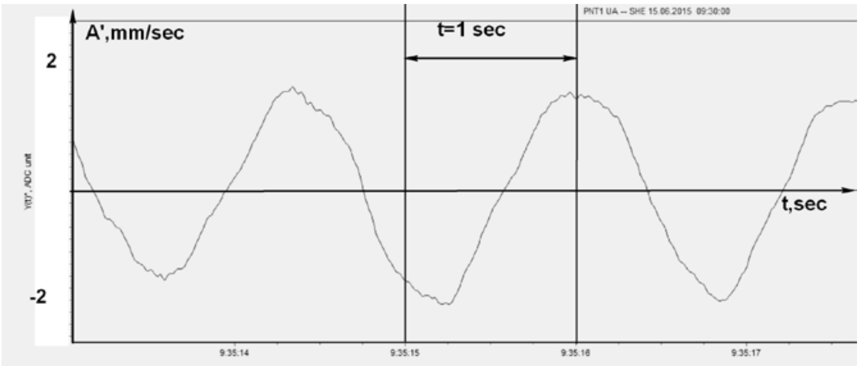

Fig. 4 Enlarged capture of the record shown in Fig. 3

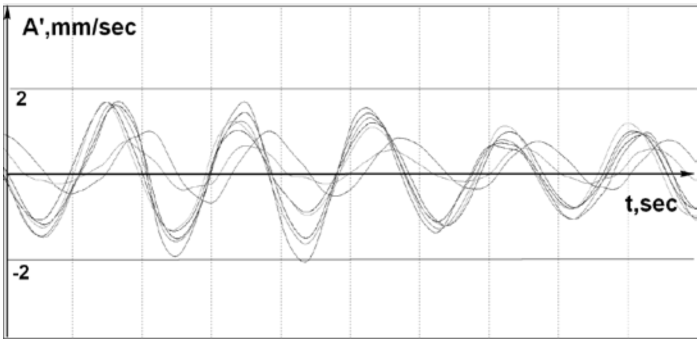

Fig. 5 Results were registered by a set of sensors S5S and VEGIK on specially developed spectrum analyzer (distance between vertical lines conforms to 1 second)

As a result of conducted field tests the fundamental natural period of the structure was 1.68 sec, notwithstanding the vibration generation method (load, tamper, wind or seismic load).

3. COMPUTATION DESCRIPTION

The next stage of this investigation was calculation of the building. The computational model, on which basis the building had been designed, was modified: effective and long-term loads were removed, loads from partitions and outer railing on storeys, on which it had not been constructed yet, were removed.

The initial computational model shown in Fig. was made in the program complex LIRA-SAPR. Period of the first shape of free vibrations was 2.54 sec. Thus, the difference between the computed and experimentally obtained was 34%. For other buildings the difference is up to 100%.

There is an analogous deviation of the computed results and results of natural tests. The obtained results are being harmonized with data obtained by other authors [5]. .

Such non-conformity is cause by suppositions, proceeding from which the calculation model of the building is being developed.

If earlier according to building codes nonstructural elements were recommended to be considered as load, presently a tendency to consider nonstructural elementsas bearing elements has been established [2,3,4].

Taking into account abovementioned suppositions the modified computational model of the building has been developed. On the figure there is a picture of the building and its calculation scheme with consideration of wall infill (fig.6). As a result of the calculation the period of vibrations is 1.6556 sec., the difference with the results obtained during tests is 1.5%.

Consequently, it is possible not only to consider the structure at the limit state, when only structural elements are involved in load distribution, but to track the life cycle of the building. Vibrodynamical tests of the building allow estimating its current state by integral characteristics such as periods of vibrations, damping decrements. A variation of these parameters may imply serious violations of the building load-bearing ability. Calculation schemes of buildings with taking into account of nonstructural wall filling should be developed exactly for these purposes.

Fig. 6. Picture of the building and general view of the modified calculation scheme

This scheme in the represented form cannot be used for determination of stress and strain state at the final stage under action of intensity of VII-VIII. Therefore authors of this work conduct investigations on analysis of building behavior with consideration of wall filling in non-linear formulation. Only in such a way one can determine at which moment and under which effect nonstructural elements shall be excluded from work of the buildings and how it shall influence on the work of structural elements.

4. CONCLUSIONS

Recommendations on development of buildings calculation schemes suggested in the work permit to get data conforming to the results of dynamic tests and a scheme developed according to them can be the basis for further calculation tracking of the building life cycle.

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Water analysis of the treatment plant Calafat

Omer Ichinur, Miserelicu Zoe

***Abstract* – The EU Water Framework Directive define the water a heritage which must be protected. Without water the humanity could not exist. So, this paper presents the variations of some water quality parameters (physical and chemical parameters) of treated water from the water treatment plant Calafat, in 2010. The obtained values of parameters were compared with the allowable maximum limits permitted by the Law no. 458/2002. For the treated water quality, the turbidity and the residual chlorine concentration exceed the allowable limits.**

***Keywords* – treatment plant, physical and chemical parameters, water analyses.**

1. INTRODUCTION

The water is a heritage which must be protected (The EU Water Framework Directive); it is exhaustible, vulnerable and essential in maintaining ecological balance and economic activities resource.
The pure water (H_2O) is the chemical combination of hydrogen and oxygen and it can be described as a colorless, transparent, inodorous and tasteless liquid, at a 760 mm Hg pressure and a temperature between 0°C and 100°C.

In nature, the water is not pure, but it has certain physical, chemical, bacteriological and biological features. Some of the water physical and chemical parameters are:

- The temperature: it has effects on potential chemical reactions and aquatic life.
- The density: it allows the development of the density currents, in the sedimentation tanks or other treatment units.
- The color: it is caused by the dissolved substances in the water.
- The turbidity: it is caused by the suspension of the solid or colloidal particles.
- The pH: the limits within the concentration of hydrogen ions can fluctuate are small enough so that the biological life not to be affected.

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- The chlorides: derive from the rocks which are in contact with the water, from the agriculture, industry or sewage.
- The alkalinity: results from the presence of the bicarbonates, phosphates, silicates, etc.
- The hardness: is given by the amount of soluble salts of calcium and magnesium.
- The dissolved oxygen: is necessary for the respiration of the microorganisms or other forms of aerobic life.
- The ammonia: results from the first stage of decomposition of organic nitrogen compounds from the water or it derives from the soil.
- The nitrites: derives from the ammonia and they indicate an older pollution.

Based on the parameters complexity that defines the water quality, there are two measuring methods: for laboratory (off-line) and automatic (on-line).

The laboratory determination method consists in taking the water samples regularly and their analysis by chemical means (reactions with various solutions of reagents).This type of analysis is used to determine all the properties of water: organoleptic, bacteriological, physical and chemical. Sampling can be done manually (operator moves the field) or automatically (by an installation of pumping water that is brought to the lab on request), automatic sampling assuming a series of technological arrangement (adduction pipes and drain, pump, its power supply).

The continuous parameters measurement is generally used for some of the water physical properties, applying the principles of electro-chemistry, electromagnetism, etc. Currently there are analyzers for automatic determination (online), using reagents of chemical properties (organic substances, heavy metals, nitrate salts, etc.).

The conservation of water properties and maintaining them at optimal quality values is a decisive phase in the process of water supply. To streamline this activity is necessary to inform continuously and rapidly the human operator (who supervises) on the most important parameter values that define the water quality. To achieve this, in the modern water supply and water treatment installations is used the on-line measurement of these parameters by specialized transducers. The transducers are specific measuring devices, which collect the information directly from the process.

The treated water quality monitoring must be conducted in accordance with the requirements of Directive 98/83 / EEC on the water quality for human consumption.

2. SHORT DESCRIPTION OF THE WATER TREATMENT PLANT CALAFAT

Calafat is a municipality in the county of Dolj (fig.1) , Romania, with a population of 18,322 inhabitants, of which 14 010 inhabitants in urban areas (according to data provided by the Statistics Department on 01 January 2007) and 4312 inhabitants in rural areas.

The water treatment plant Calafat was realized in 1978-1981 period to ensure a flow of 300 l / s of drinking water for domestic and industrial use and a flow rate of 600 l / s of industrial water. Water treatment will be normal, physical, chemical and disinfection (ozonization, coagulation, flocculation, decantation, filtration and chlorination).

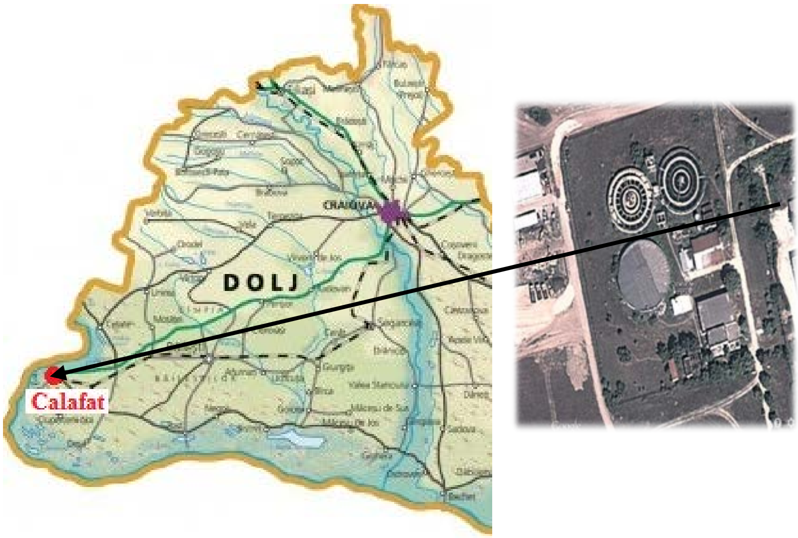

Fig.1. The location of the water treatment plant Calafat [16]

The water treatment plant (fig. 2) has water catching from surface sources, the source being the Danube.

The natural water reaches a pumping station with the engines located in the subterranean chamber and the electrical equipment above. The pumping water to the treatment plant is realized by two steel pipelines with a length of 280 m and a diameter of 1000 mm, which merge into a single thread with a diameter of 1000 mm and a length of 220 m.

From the pumping station, the water discharges into the distribution chamber which is feeding the two radial settling reservoirs. One of the settling reservoirs suffered structural damages and it is no longer operational.

The decanted water is conveyed by gravity to six sand filters provided with pumping station. The blowers are located in a separate building, adjacent to the building for filters. The filtered water tanks are used for backwashing and chlorination and they are positioned under the camera filters.

From the chlorination tank, the water is pumped into a storage tank with a capacity of 5000 cubic meters; from here, the water is transported to the consumers.

Taking into account the appreciable age of the treatment plant Calafat, the technologies that formed the basis for achieving it and the deterioration of the water quality at the source, it is necessary to rehabilitate and modernize the treatment plant.

During the construction of the new treatment facilities, the plant will be operational to provide drinking water to the consumers. As the minimum necessary facilities, the existing clarifier and a line of filtration, chlorination and water pumping station will remain operational.

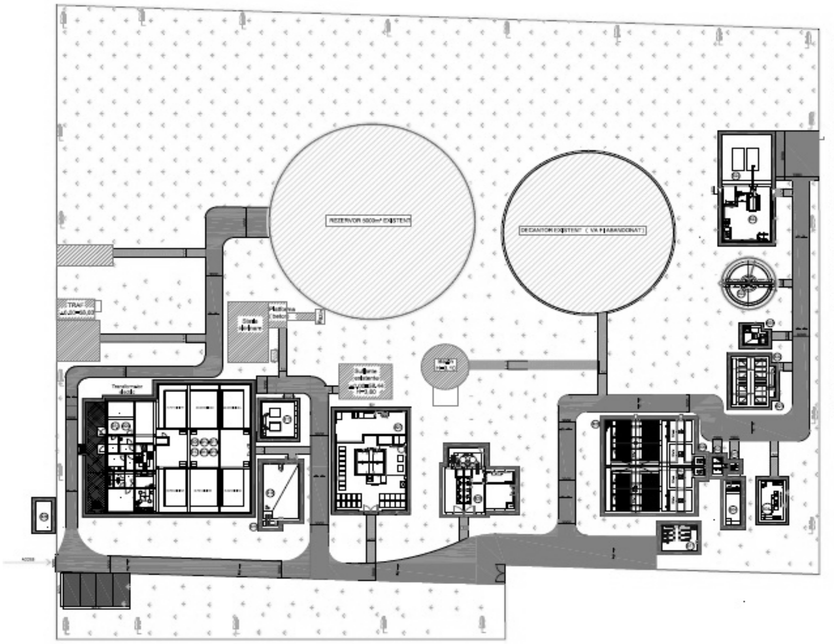

Fig.2. Plan view with the technological objects of the water treatment plant Calafat

3. RESULTS AND SIGNIFICANCES

The treated water quality must be within the Law no. 458/2002 and Law no. 311/2004. In table 1, the allowable maximum values are done for some studied parameters.

Table 1. The allowable maximum values (according to Law 458/2002 and Law 311/2004**)**

Parameter	Turbidity	pH	Hardness	Alkalinity	Amonium (NH_4)	Nitrite (NO_2)	Chlorine	Residual chlorine
Unit of measurement	NTU	unit. pH	°Ge	ml HCl	mg/l	mg/l	mg/l	mg/l
Allowable maximum values	5	6,50 -9,50	min. 5	-	0.50	0.50	250	0,1-0,5

Analyzing the turbidity of treated water we observe that this parameter exceeds, in most cases, the maximum allowed (5 NTU) (fig. 3). The average turbidity in 2010 is 10.93 NTU for the samples from settling reservoirs and 6.76 NTU for the samples from discharge. The maximum value is recorded in January (11.67 NTU at discharge) and the minimum in October (4.43 NTU at discharge). Given that the level of turbidity exceeds the limit provided by Law 458/2002, we believe that the filter operation is unsatisfactory, caused by the poor quality of the decanted water introduced to the filters, filter washing at insufficient intensity or duration, temporal change in the particle size of the filtering layer or damage of the drainage system.

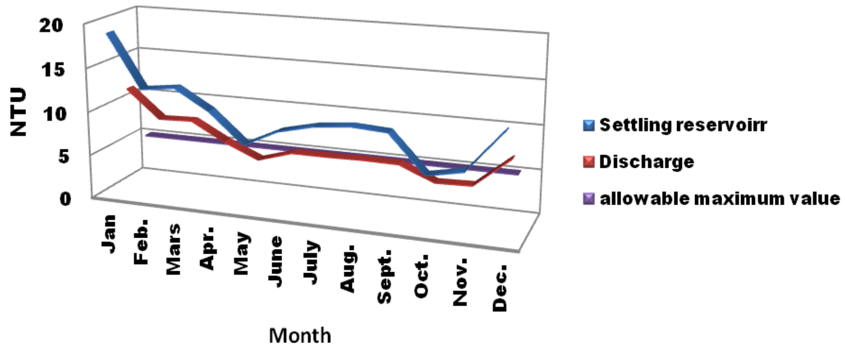

Fig. 3. The monthly variation of turbidity

Concerning the pH, the fig.4 shows that it remains constant throughout the year: 7.8 pH units for the samples had taken from the settling reservoir and 7 pH units to discharge and fall within acceptable limits (6.50 and 9.50 pH units). If the pH would have a value less than 7, the water should be acid and the values greater than 11, too alkaline, which would have led to irritate the consumer's eyes and skin. In the water treatment plant, adjusting (reducing) the pH is achieved by dosing the agent correction H_2SO_4 (sulfuric acid) to increase the efficiencies of the organic load in the retention of coagulation.

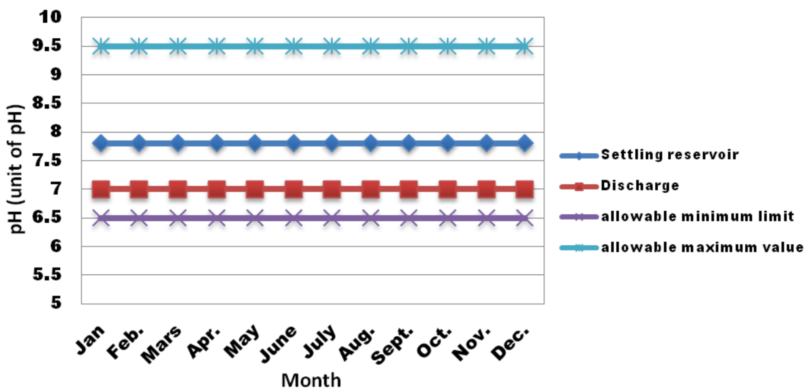

Fig. 4. The monthly variation of pH

Analyzing the hardness variation of the treated water, we note that it exceeds the minimum permissible value of 5 ° Ge, in all sampling points. Maximum values were recorded for the samples taken from the settling reservoir. Very hard water is not harmful only for the installations, but also for the human body, the water-is composed of soluble salts. In this case, the values are less than 20 mg / l, which shows that the treated water out of the water treatment plant is potable.

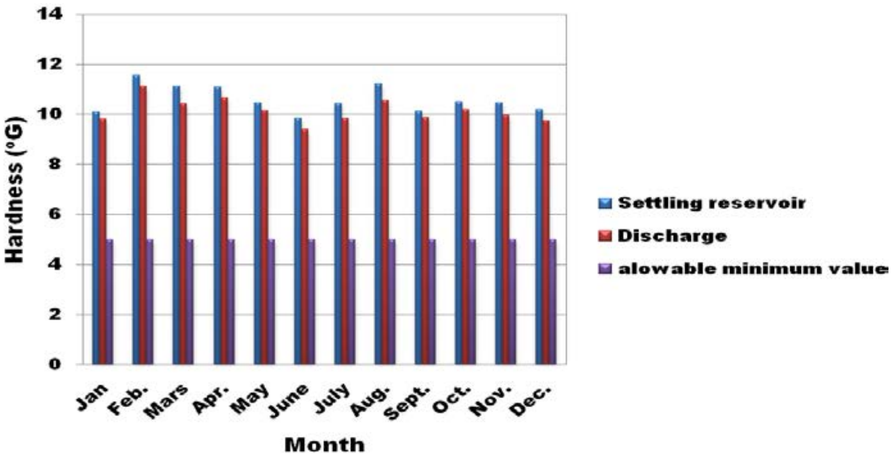

Fig. 5. The monthly variation of hardness

For the alkalinity, the maximum or minimum values don't impose by Law 458/ 2002. In fig. 6 is represented the variation of alkalinity. A drinking water with balanced high alkalinity pursues the chemical reactions in the body and, as the alkalinity is higher, the acids accumulate in the excess fat bodies are more effectively neutralized and removed. The alkaline drinking water is good for health and for a good general condition, but is aggressive, corrosive on metal pipes and installations.

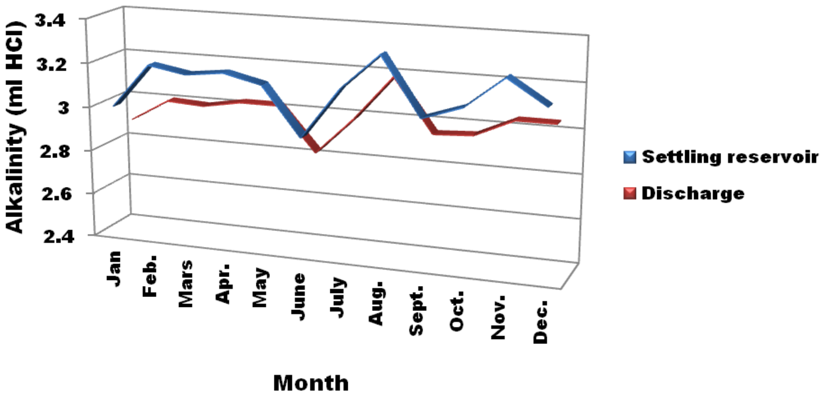

Fig. 6. The variation of alkalinity

In terms of the ammonium presence in the treated water, we notice much lower values than the maximum allowable (0.50 mg/l), in June even recording a value of 0 (Fig. 7). To know the ammonium concentration of treated water is very important, because it expresses the degree of manure load. The presence of ammonium is associated with iron and manganese and the reduction treatment thereof decreases their effect oxidation. It is eliminated by the chlorination process.

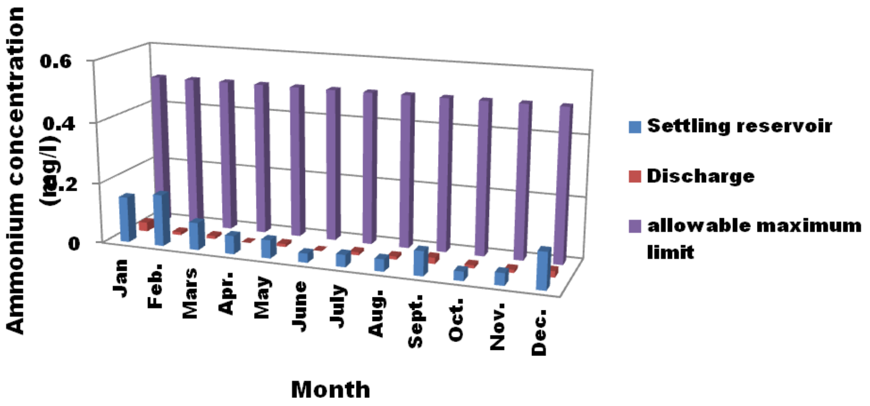

Fig. 7. The variation of ammonium concentration

Concerning the nitrites concentrations, can be seen in Fig. 8 the maximum concentration value are recorded in July, 0,17 mg/l at the settling reservoir and 0,02 mg/l at discharge. We note that not exceed the maximum allowable nitrite concentration (0.5 mg / l). So, from this point of view, the water is potable and the consumers' health is not affected.

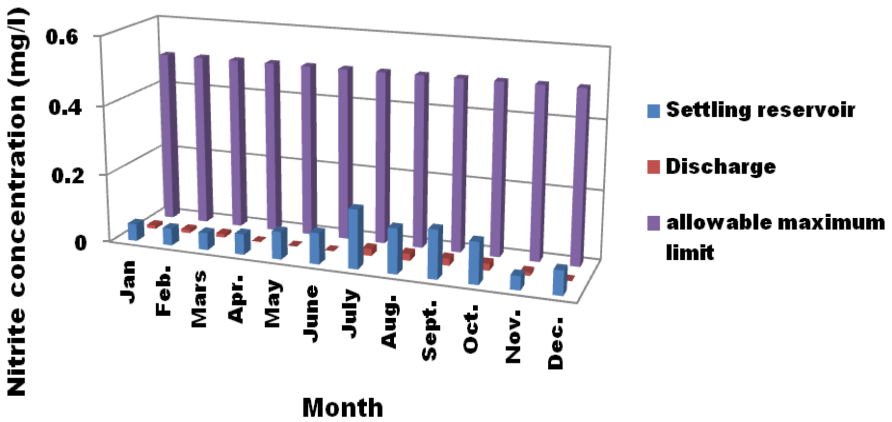

Fig. 8. The variation of nitrite concentration

In terms of chloride concentrations, we see that the average values recorded are 20.84 mg / l at settling reservoir and 22.58 mg / l at discharge (fig. 9). In any month of the year, these concentrations don't reach the maximum allowable concentration of chlorides.

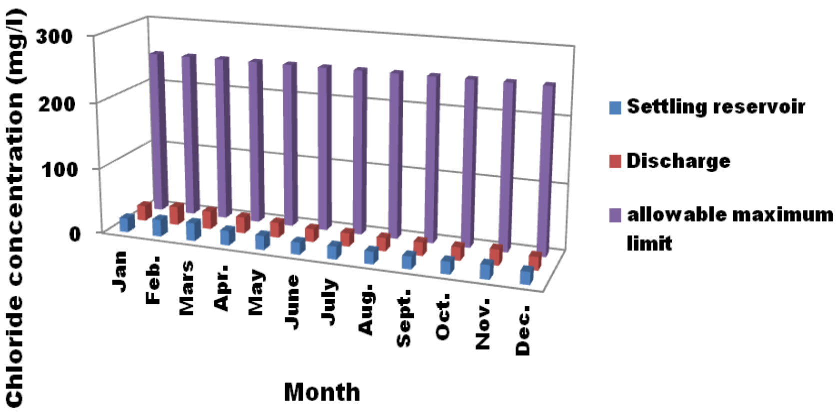

Fig. 9. The variation of chloride concentration

Analyzing the concentrations of the free residual chlorine in treated water, we observe that the maximum allowable is totally exceeded when the water is taken at discharge. The minimum recorded value of residual chlorine at the outlet, 0,70 mg/l, exceeds the permissible maximum limit (0,50 mg/l) with 0,20 mg/l. The residual chlorine is one of the main combatants of undesirable water organoleptic characteristics, but it can become an enemy of human health if it is present in the water in large amounts and should be monitored. The presence of residual chlorine in the water subjected to disinfection is important, indicating on the one hand the introduction of a sufficient amount of chlorine to ensure the disinfection, and on the other hand indicates the integrity of the water distribution network.

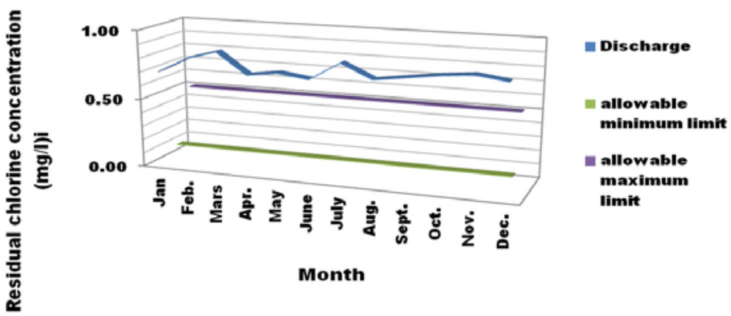

Fig. 10. The variation of residual chlorine concentration

4. CONCLUSIONS

To establish the water quality, by the physical, chemical and biological features, we used only the ones which are considered significant.

Treated water quality monitoring should be carried out in accordance with the requirements of 98/83/EEC Directive on the quality of water intended for human consumption.

Achieving compliance with Law no. 458/2002, the quality of water intended for human consumption involves several steps:

- the analysis of the natural water quality parameters;
- treatment plant performance evaluation;
- the identification of deficient sectors;
- the identification of the measures to be taken;
- the rehabilitation and the modernization of the systems, to achieve quality parameters which are stipulated by law;
- a plan for maintenance and reconditioning;
- the monitoring of the drinking water quality.

The new technological process of water treatment plant aims to:

- bringing all the drinking water quality parameters in normal limits;
- optimizing the energy and reagents consumption;
- reducing the negative impact on the environment.

Among the treated water quality parameters, the turbidity and de residual chlorine concentration exceed the limits permitted by the Law 458/2002, the other parameters are within the legal limits. This fact demonstrates that the water treatment plant has to be rehabilitated.

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Hydrological and Geomorphological Vulnerability on the Romanian Cliffs Shore Sector under Climate Change Influence of the Last Decades – Case Study: Costinesti Flood from 22nd of September 2005

E. Vlasceanu, R. Mateescu, I. Grigoras, M. Lungu, I Omer

***Abstract* – The arisen changes in the degree of stability of marine cliffs, which required extended design terrace, reflect an increase in precipitation intensity and level, the share of extreme events occurring at a higher frequency and duration the ever before and the high increase in erosion in the Dobrogea area, due to a variable climate of regional hydro-meteorological phenomena. As such an increase in rainfall has been recorded, leading to intense flooding and slope runoff on the semi-arid marine cliffs, which in the case of extreme weather events that are correlated with the climate change at a global scale, present a pronounced vulnerability. Thus, at the regional scale of Dobrogea, climate hazards are found especially in the marine and coastal hydrological field. In the Romanian Black Sea marine and coastal sector it is highlighted that the increased importance of managing situations of vulnerability of the coast to the action of natural environmental factors. This is how the case study of an exceptional environmental event that occurred at Costinesti shore sector in September 2005 is presented.**

***Keywords* – exceptional hydrological events, climate regime, Dobrogea, coastal erosion, coastal cliffs, exceptional storms, coastal protection.**

1. Introduction

The southern Romanian littoral is climatically individualized due to the influence of the Black Sea and its geographic position, in the context of complex

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actions of the main baric centers of the atmosphere, which enforce numerous aspects of climatic distinctiveness, in relation with averaged annual thermal amplitude and averaged annual precipitations quantities.

An exceptional event, leading to intense flooding and slope runoff on the semi-arid marine cliffs with pronounced vulnerability, were registered in Costinesti area in 22nd of September 2005, where due to the tidal rain of a cloud burst it were produced a strong accumulation on the railway train embankment without proper designed under-crossing, which were produce huge damage on site, and several causalities. Significant damages were made on the sand belt's beach areas, separating the sea and a small lake, due to the collapse of the railway train embankment acting like a wave of a dam breaking.

Subsequent to the event, as rapid response for risk mitigation with long period time of occurrence, it were realized an implementation of a complex hydro-technical scheme for hydrological and coastal protection, as well [1].

Fig. 1a and 1b. Beach damage after flooding within Costinesti sector - September 2005 (Ruined railway embankment and Beach are, source: *www.amfostacolo.ro)*

2. MATERIAL AND METHODS

The spatial data were considered in accordance with the Reference Plan of extension hydrological strategy was focused on the characteristics of the hydrological parameters afferent to the area, such as maximum variations of the precipitations. The coastal changes induced by marine driving forces, accenting the new influence of the existent conditions of the placed hydro-technical works, it were considered in order to delineate the remaining hydrological risk on the touristic beach sector of Costinesti resort.

The geomorphological analysis of the shoreline changes was realized by comparing historical topographical maps and remote sensing data in ArcGIS environment, including representations of the spatial data in a referenced plane of configuration, which provided the assessment of the erosion trends adjacent beaches. For the geodynamic processes evaluations were used for the trends and multi-annual changes analysis the topographical maps from 1982 at scale of 1: 25 000, and SPOT data, with 2.5m resolution, at two time horizon: 2007 and 2012, all redesigned in Stereo70 and subsequently vectorized. Certain differences of the shoreline evolution were shown for this period.

The spatial data needed for the overall site plan of flood protection works and the coastal protection related, were focused on the distribution characteristics of hydrologic parameters, such as areas of rainfall variability and the maximum values at local and regional level.

The geomorphological analysis of the shoreline variance was performed in ArcGIS by comparing the historical topographic maps with the satellite images, including vectored spatial data representation in a master plan to provide data on the magnitude of beach erosion processes related to Costinesti. So, for evaluating the multi geomorphological processes have been used topographic maps since 1982 at 1: 25,000 scale and SPOT satellite data with the 2.5 m resolution, at two timelines, 2007 and 2012, all redesigned in Stereo 70 and then vectorized. In this period it was evidenced a clear evolution of the shoreline.

3. RESULTS AND SIGNIFICANCES

At the regional scale of Dobrogea, climate hazards are found especially in the marine and coastal hydrological field, its occurrence in the natural cliffs sector it were highlighted, as well as the importance of early managing situations of coast vulnerability to the action of natural environmental factor.

The inland induced flood occurred in the Costliest area with strong damages of the coastal system formed by the lake separated by sea with a sand belt on the place of an old marine lagoon, request fast measures in order to make a rehabilitation of the private property damage of the Costinesti village and its afferent public beach area. In order to make a rehabilitation of the Romanian Waters Authority had ordered a project design followed by a rapid execution of a complex scheme for hydro-technical works against floods, encompassing a coastal protection works of a free opening running-duct, untied in to the sea.

Because the solution was impose at short terms the solutions the study of environmental impact assessment (EIA) was realized after construction, with insufficient ground studies. The effect on the coast geomorphological dynamics on medium term show strong erosion in adjacent areas of the small port jetties, and a lost unity of the sand belt.

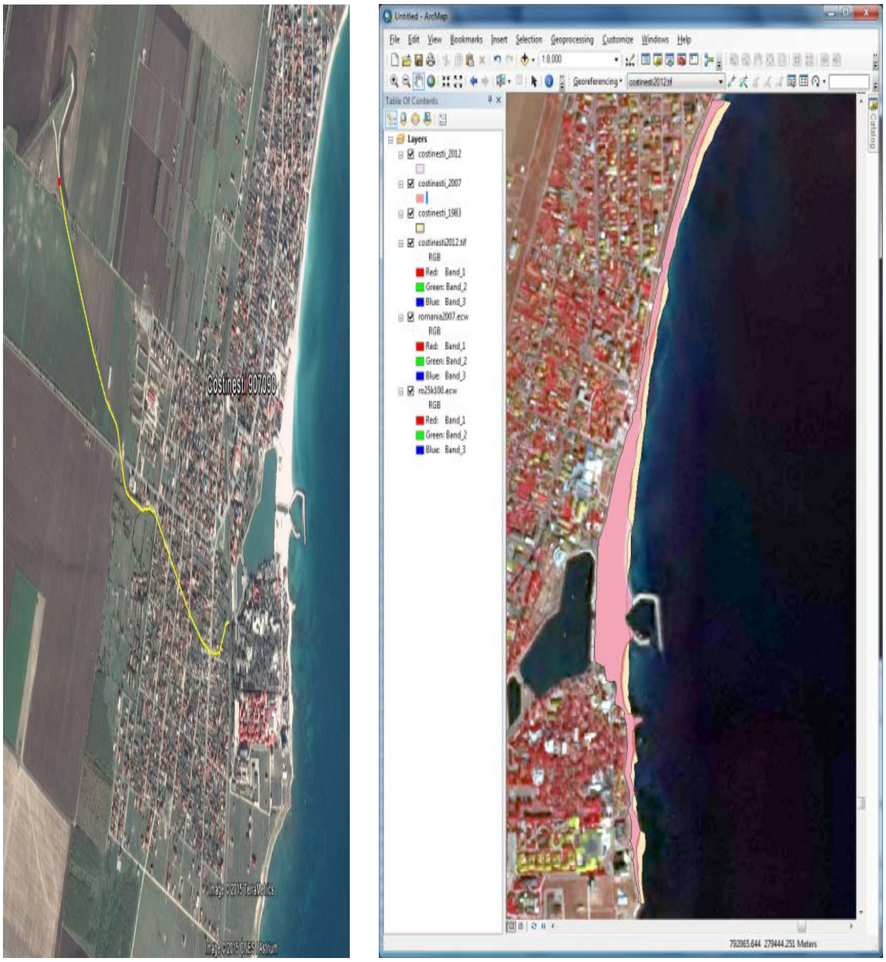

Fig 2a and 2b. The hydro-technical scheme for the shore protection against floods ith inland causes and Costinesti beach surfaces between 1982-2012

Dynamics of the beach surface between 1982 and 2012 is presented in the graphic from the figure 3.

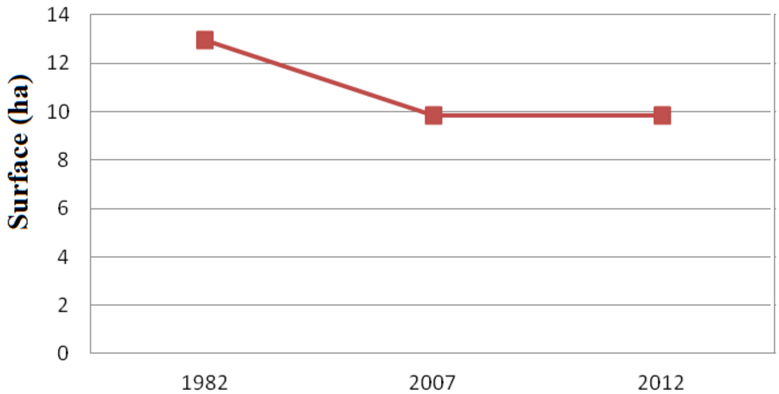

Fig. 3. Annual rate of the beach surfaces retreat

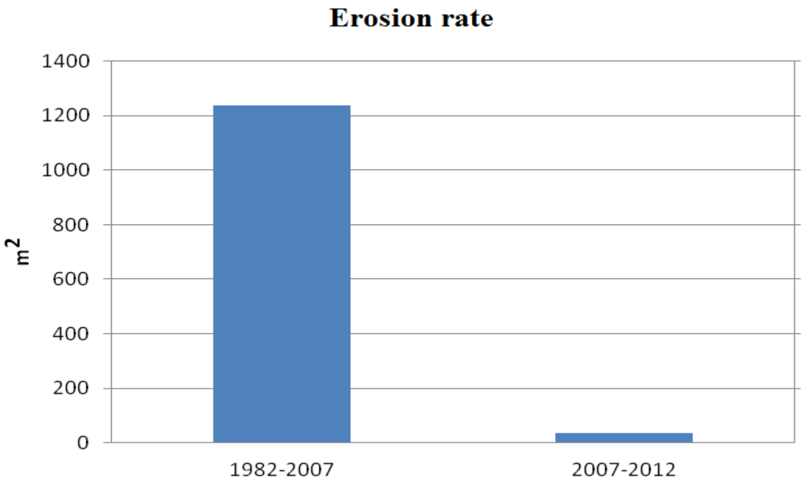

Fig. 4. Annual rate of shoreline retreat in Costinesti area between 1982-2007 and 2007-2012

The graphs from the figure 4 shows the decreasing of the intensity of the shoreline annual retreat after 2006, the year of hydro-technical works extensions, and respectively, its stabilization after new equilibrium setup [2]. The beach surface areas which were eroded are passing one hectare for the time period of *1982-2007 and 2007-2012*, thus emphasizing the impact of coastal jetties and its undesirable role of the beach unity splinting.

Dynamics of the beach surface between 1982 and 2017 is presented in the graphic from the figure 5.a and 5b.It was emphasized that the effect of a not enough grounded research before execution of a hydro-technical works may cause long-term impacts on the sea-land interface [3].

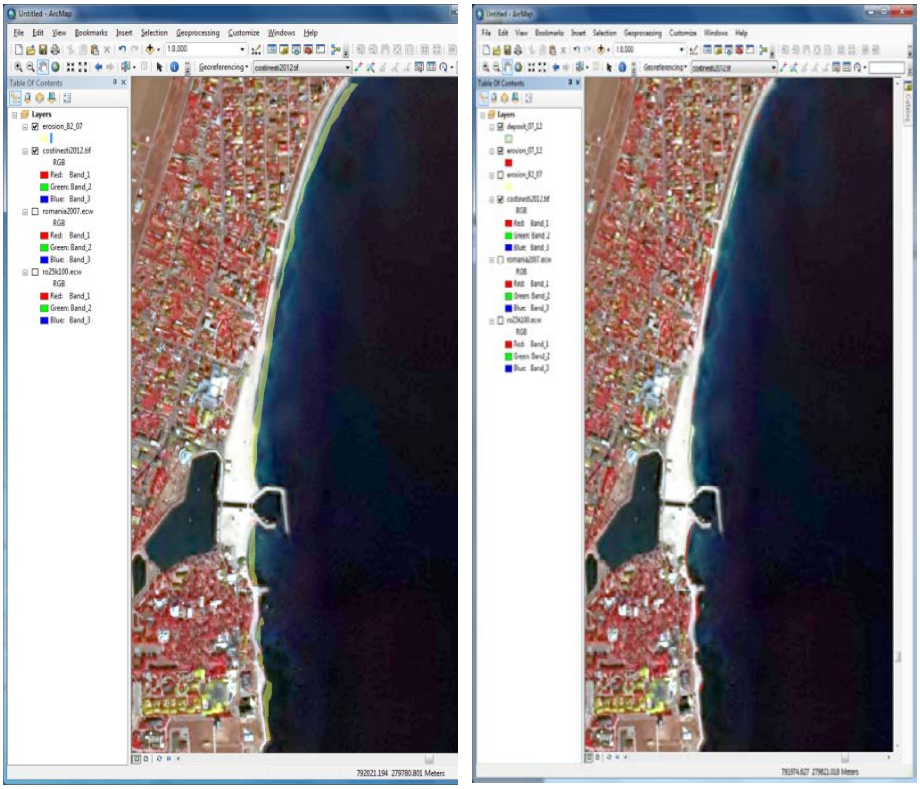

Fig. 5a and 5b. Loss beach areas between 1982 - 2007 and 2007 – 2012

In the present the railway undercrossing channel is at the same stage of non-functionality as before 2005, because of the restoration works for railway were coordinated by the Ministry of Transports and the works for the village rehabilitation and protection against floods, were coordinated by the Environmental Ministry, the same risk of catastrophic flooding from the territory still exists, due to delay of execution.

Since 2011 it was started the construction of a proper bridge to assure the continuity of hydrotechnical ensemble passing under railway, but the works were not finished after five year – fig 6.

Fig.6a and 6b. The railway bridge and The stage of works in the summer of 2015

4. CONCLUSIONS

Because the potential impact analysis did not had relevant data on hydro-geomorphological conditions and local impact, we need to consider that the activities related to the designed works described above, have an effect that cannot be precisely determined in the future, in terms of intensity and magnitude of the potential influence on the marine parameters / coastal environment.

In the present time is required reconsider the shore area systematization, where the natural landscape would be promoted and protected with new coastal protections works, in parallel with the execution of protective measures against natural factors from seaside as well inland side, which include the finalization of the execution of a properly dimensioned under-crossing bridge in order to eliminate the flood risks and beach damage at a later time, despite of its existence for almost 10 years.

5. ACKNOWLEDGMENT

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Technological design - One stage required for constructions located in special conditions

Draghici Gabriela

Abstract: **Port field in Romania is an economic area serves several industries each with its specifics. For the design of economic facilities is required to draw up the first technological project to ensure optimal fitting, relative to neighboring industries and to the fulfilment of the conditions of safe operation for the mitigation of risks, including the risk from fire. Also in establishing constructive system, its constituent materials of special importance for the establishment of fire protection measures**

Keywords: **technological project, fire, Harbour, reinforced concrete**

1. INTRODUCTION

Port field is a complex system with multiple functions. Mainly the area of a harbour refers to the arrangement and function of ports. In the meantime, to define the harbour as an entity, have developed several definitions. One of the most complex is the definitions given by H H Linda in the book " Harbour Management", thus: "a port is a geographical and economic entity having specific name, situated on the sea, a river or a lake, where they engage and where ships transferring goods and passengers on public transportation-one land where plants can be placed on land or on the water in order to make complementary services required by ships, goods and their users in order to contribute to the smooth operation of transport and the development of international trade, and industry in general, the economies of the countries that are in the area of influence of the ports. " [2, p. 8]. One reader even if read only this definition realizes the complexity and importance of the system called "Harbour".

Harbours, depending on location and technology used for landscaping, can be natural, synthetic or mixed. In turn, the ports may be mixed natural and maritime or inland (eg ports on the Danube).

For proper operation of a port is running outside its facilities such as waterbank protection for protection against waves and interior design consisting of

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construction berths, and construction (buildings and industrial buildings with different functions) required on dry land.

Together with those in the area are building the necessary facilities of the loading - download or plants serving the construction of the area of land.

2. DESIGN PRINCIPLES FOR PRODUCTION FACILITIES AND INDUSTRIAL ENTERPRISES

2.1. Technological design - a necessity of equipping the land

We can say that the whole system works on the basis of plans for port development and work plans. In this sense, the technological design of each port zone is answering to all the problems related to the optimal functionality of the port. Thus, the main streams of the operating system (loading - unloading), transportation by land, supplies, secondary threads running on the main and operational circuits in the event of emergencies are designed to meet the requirements.

An chapter important within these plans is given to the prevention of fires and the measures and means fast with minimal damage in the situation of production, however, fire. The challenge may be performed if :

1. is the equipment appropriate to specific installations of fire extinguishing
2. facilities and equipment are protected from burnout and from the spread of fire

2.2. Considerations on the protection of the building against the spread of the fire

Constructions, in this case, shall consist of buildings, spaces of production and deposits closed or open for all types of materials.

The standardisation SR EN ISO lays down rules for the calculation of the actions at temperatures the normal working hours of the structure (SR EN 1991-1-1) and under conditions of fire (SR EN 1991-1-1). Also there is a correlation of the data [4] in the case of the structures of concrete (SR EN 1992-1-1 for normal temperatures and SR EN 1992-1-2 for temperatures of fire), the structures of the masonry (SR EN 1992-1-1 for normal temperatures and SR EN 1992-1-2 for temperatures of fire), the structures of the wood (SR EN 1995-1-1 for normal temperatures and SR EN 1995-1-2 for temperatures of fire) and mixed structures dun concrete and steel (SR EN 1994-1-1 for normal temperatures and SR EN 1994-1-2 for temperatures of fire).

In this way, the using of Eurocodes, it can be said in the first place if a structure to resist and if so, how long can the su action of the fire.

In SR EN 1992-1-2 specifies that "the construction works must be so designed and constructed that in the event of fire:

- the resistance of the axle components of the building can be computed separately for a specified period of time;
- the emission and propagation of smoke under construction should be limited;
- to be limited the propagation of the fire to other buildings in vicinity;
- The occupants be able to leave the construction or can be saved by other means;
- the safety of rescue teams save to be taken into account." [5, p. 8]

Design may be carried out at the limit of the load capacity and check the condition of the last limit of deformation will.

Very important in this situation is and verification at deformability, under conditions of fire, of the element separation between the element from the structure and atmosferaa temperaatura with high (fire), element separation represented by the middle of the (e.g., material) for protection of the component.

3. CASE STUDY - THE ACHIEVEMENT OF A STRUCTURE MADE OF CONCRETE, LOCATED IN THE PORT AREA

The following, is a structure made of concrete, located in the border area, inside the port area. The structure (building) is used in wood industry for the manufacture of the products of the layered wood.

To operate this function has been chosen as constructive system structure of reinforced concrete, as it is known in the literature of specialized [8] that the structures of concrete behave very well on fire in comparison with the various other structures made of other materials.

Such a structure must submit a high resistance to fire i.e. under conditions of high temperatures to preserve the properties for a period of time more than in comparison with a normal structure.

Also such structure will hold the compartments of fire. By the name of "the bay of fire" shall mean a site (an area) of the construction that bounded by FM Approved welding elements that do not allow the propagation of the fire further, in the inside of the building.

The project of technology referred to in this case at the design of the hall of production, adjacent spaces of service (for example the administrative premises) and equipment appropriate to the installations concerned, required.

In the first phase were identified technological flows of primary and secondary. For each stream in part have identified the activities of the components. The next step consisted in the development of the balance sheets of resources.

At this stage it has been established the necessary equipment with the dimensions clearance and the unions concerned and thereafter were established the dimensions of the premises in which they operate. It was also established the layout of the premises, depending on the function of each for that flows to be as direct, short and with a minimum of junctions or overlaps.

In the production area has been to centralize the necessary equipment and machinery and it has been established that they will be fixed and which will be mobile portable. For the equipment and machinery fixed technological there were designed tanks in which were installed to these machines. It was also provided for and access in the tank to keep clean and remove remaining combustible gases (sawdust or other debris woody).

In order to avoid the risk of fire, have delimited separate premises, one for the debiting to size of the wood and the other for the application of substances of the impregnation purposes. In the enclosure in which they apply the treatments and substances for the impregnation there were designed installations of heating and melting behavior that are not working with an open flame. Adjacent to these premises it was foreseen and one workshop for the maintenance of the tools within the meaning of their sharpening and check them.

In the production area was sized and an installation for the filtration of dust in the air, dust arising during the performance of the production process. This was positioned, together with the other plants on the trestles. In the main, in addition to this installation, were positioned installation of the air conditioning and ventilation, the electrical installation of power and lighting, the installation of water supply, installation of the system in the waters of the technology. It was provided that, equipment who work in areas at risk to be ex meaning not to produce sparks or be able to generate a fire.

In the storage area have been provided for corridor of circulation, used for disposal of both longitudinally and transversely taking into account that the raw materials, wood and finished products, multi-layer elements are combustible materials.

Between the transverse aisles, the two corridors that will be used in the event of an operation PSI were located at a printing bug less than 30 meters of each other. In order to optimize space, cross aisles have been equipped with doors at both ends, letting thus and the requirement to facilitate access in the event of fire.

The width of the aisles was established to match the gauge of the plant and equipment of production, handling and transport, resulting in widths of 2.10 m for the aisles main and 1.80 m for the cross sectional cuts.

The dimensions of the relevant parts of the premises have been calculated depending on the account for the thickness of the walls and their plating with fire resistant to increase resistance to fire for a period of time of 2 hours.

4. CONCLUSIONS

The harbour is an economic area located in a permanent development and change. The production must be optimal, flexible and to permit the operation in complete safety.

At the choice of the site must be taken into account that the new industry to be consistent with other existing industry in the area or otherwise the safety measures to be increased in order not to There are interactions which can cause a fire.

For this reason the technological design is very important to determine the vision on the whole project and to identify the statutory requirements to which they must respond to the project and the objective of the executed and put into service.

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Optimization of the composition of waterproof concrete using a genetic algorithm

Efrem V., Şerban C.

Abstract: **In this paper we propose a genetic algorithm to optimize the concrete composition by maximizing the volume of aggregates so that the volume of voids within the concrete to be the minimum possible. The performance of the proposed method is evaluated through several sets of tests on control parameters of the algorithm.**

***Keywords*: genetic algorithms, concrete, aggregate, sustainability**

1. INTRODUCTION

Currently, construction sustainability is no longer a concept ignored. We can not speak of quality without taking it into consideration. It represents the period over which a building retains its properties needed for its functioning within the parameters and demands set by the project.

The need of ensuring sustainability is necessary especially for concrete constructions exploited under aggressive environment. Severe environmental conditions, such as chemical aggression of the earth or large outdoor humidity, require the development of resistant and waterproof concrete.

Major climate changes registered worldwide and in our country have led to an intensification of natural aggressiveness, the corrosiveness of the environment in general and of the coastal marine environment of Romania as well.

Ensuring performance of a building requires acting in several directions at the same time: proper design, usage of modern materials with superior properties, correct installation and subsequent treatment, maintenance and inspection to prevent from damage.

In this paper we propose a genetic algorithm that finds the proper parameters needed to obtain a composition of the concrete with high resistance and impermeability properties.

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In order to obtain high strength concrete, one of the conditions is to reduce the amount of water. Maintaining the optimum dosage of cement (all in order to achieve a better resistance) results in a reduced amount of sand and aggregates with large sizes in higher proportions.

The basic idea of the research can be summed up as: knowing that aggregates form the rigid skeleton of the concrete, we want to obtain low porosity of the concrete structure. A small volume of the voids will lead to a reduced amount of cement, as well. In this respect, our approach attempts to optimize the concrete composition by maximizing the volume of aggregates so that the volume of voids among the aggregates to be the minimum possible.

2. THE PROPOSED GENETIC ALGORITHM

We want to find the optimal percentages of aggregates types, and a genetic algorithm is proposed to find optimal solutions for this problem in a reasonable computational time.

2.1 Basic principles of genetic algorithms

Genetic Algorithms (GAs) are adaptive heuristic search algorithms, based on the evolutionary ideas of natural selection. They are used in a wide area of practical problems in science and industry, e.g. optimization, machine learning, economics or population genetic problems (e.g. [1], [4], [5]). GAs are specially designed to find good solutions to problems that were otherwise computationally unsolvable: the solution sets are finite but so large that brute-force evaluation of all possible solutions is not computationally feasible.

An implementation of a genetic algorithm begins with a population of random chromosomes, which are string representations of solutions to a particular problem. The most common size for a population is between 30 and 100 individuals.

The objective function f provides a measure of individuals performance with respect to the problem domain. This performance is transformed by the fitness function F into a measure of allocation of reproductive opportunities for individuals in a GA. The fitness function is problem specific and is derived from the objective function.

Genetic operators used in GAs maintain genetic diversity and are analogous to those which occur in the natural world: selection, crossover and mutation.

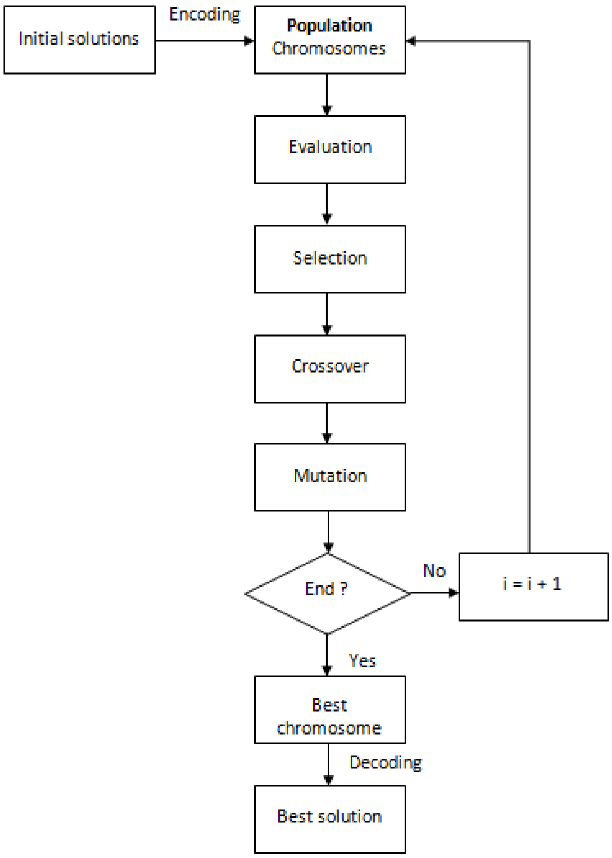

Fig. 1 The proposed GA flowchart

Selection determines the individuals chosen for reproduction. Chromosomes evaluated with higher fitness values will most likely be selected as the parents of a pair of offspring, whereas, those with low values will be discarded from the current population.

Crossover is the process by which chromosomes selected from a source population are recombined to form members of the next population. According to a user-definable probability, p_c, called crossover rate, some of the least fitted individuals will be replaced by a new set of offspring that inherit traits of both parents and are inserted, one or both of them, into the next population.

Mutation alters one or more gene in a randomly chosen chromosome with a user-definable probability, p_m, called mutation rate. This operator has two roles, firstly to recover good genetic material that may be lost through selection and crossover, and secondly, to provide the genes that were not present in the initial population.

All these operations form one generation in the execution of a GA (Fig. 1). After several generations, the best individual is obtained.

2.2 Enconding and initialization

In our model, the aggregates types are numbered from 1 to *n*. A chromosome is a feasible sequence of the types of aggregates and is encoded using an integer array having size equal to *n*; each element of this array denotes the number of particles of a specific aggregate.

For our problem, we suppose we have 3 types of aggregates. The shape of the particles is considered spherical, regardless of their type. For example, the following chromosome, [6 2 3], indicates that the first type of aggregates represents 55 percent of the total aggregate structure, the second: 18%, and the third: 27%.

2.3 Evaluation

The objective function represents the difference between one unit of volume and the summation of the volumes of aggregate particles.

Being a minimization problem, the most fit individual will have the smallest numerical value of the corresponding objective function; moreover, due to the fact that some operators need non-negative values of the fitness, it is necessary to map the underlying natural objective function to fitness function form. A most commonly adopted fitness mapping is the one from relation (1), which does not alter the location of the minimum.

$$F(x) = \frac{1}{1+|f(x)|} \tag{1}$$

2.4 Selection, crossover and mutation operators

The chromosomes were evaluated by using the fitness function and the parents were selected by one of the most commonly used selection methods, namely the roulette-wheel selection, also known as the fitness proportionate selection. This method can be thought as a game of Roulette, each individual getting a slice of the roulette wheel equal in area to its fitness. The wheel is spun and on each spin, the individual under wheel's arrow is selected to be parent.

Next, the single-point crossover operator was applied. A random number is generated within the length of the chromosome to specify the crossover point (position at which the two selected parents will change their parts), then the first offspring is produced by combining the first part of the first chromosome with the second part of the second chromosome; the second offspring is produced in the same manner (see Fig. 2).

Parent 1 (P1)	4	2	3	5	6	9
Parent 2 (P2)	3	1	2	3	4	6
Offspring1	4	2	2	3	4	6
Offspring2	3	1	3	5	6	9

Fig. 2 An illustrative example for the single-point crossover operator

In next step of the GA, we used the uniform mutation operator in which some of the chromosomes belonging to the current population and one gene of each of them are randomly selected; the uniform operator replaces the value of the chosen gene with a uniform random integer selected between the upper and lower bounds for that gene.

The algorithm was implemented in Matlab R2011a and the terminating condition was to either a predefined number of generations reached or 97% of the population had same fitness value. The best solution is the one with the smallest numerical value of the objective function.

3. RESULTS AND DISCUSSION

For our problem, where n = 3, we considered $r_1 = 1$ mm, $r_2 = 2$ mm, $r_3 = 4$ mm, where $r_i, i = 1, \dots, n$ are the particles radius corresponding to each type.

We evaluated the performance of the proposed GA through several test cases on the control parameters of the GA: the population size and the crossover/mutation rates. Each of the test cases was solved using the proposed GA for 25 replications. The mean and standard deviation of the objective function values and the CPU time in seconds for the test cases are recorded in Table 1. These results indicate that the combination of 0.8 and 0.2 for crossover and mutation rates have the best performance among all the tested combinations. The results also demonstrate that cases C4 and C6 show the best performance among other cases.

Tabel 1 The proposed GA results

						Solution (average)		
Case	**Pop Size**	**Cross. /Mutat rate**	**Mean**	**SD**	**CPU(s)**	***p_1* (%)**	***p_2* (%)**	***p_3* (%)**
1	25	0.9/0.1	9.17	29.12	39.41	16	39	45
2	25	0.8/0.2	9.67	25.13	39.67	19	48	33
3	50	0.9/0.1	1.11	1.36	79.57	23	29	48
4	50	0.8/0.2	0.613	5.6E-14	78.19	22	33	45
5	75	0.9/0.1	0.78	0.82	117.55	18	40	42
6	75	0.8/0.2	0.613	7.1E-14	127.28	20	40	40

By comparing the results of cases C4 and C5 with the ones given by the limits of aggregates Annex LA - SR 13510/2006 (Fig. 3), we observe that the solutions obtained imply increasing the percentage of large (8 mm) and medium (4 mm) aggregates above standard values, and decreasing the percentage of small aggregates (2mm), which favors reducing the amount of water in the concrete.

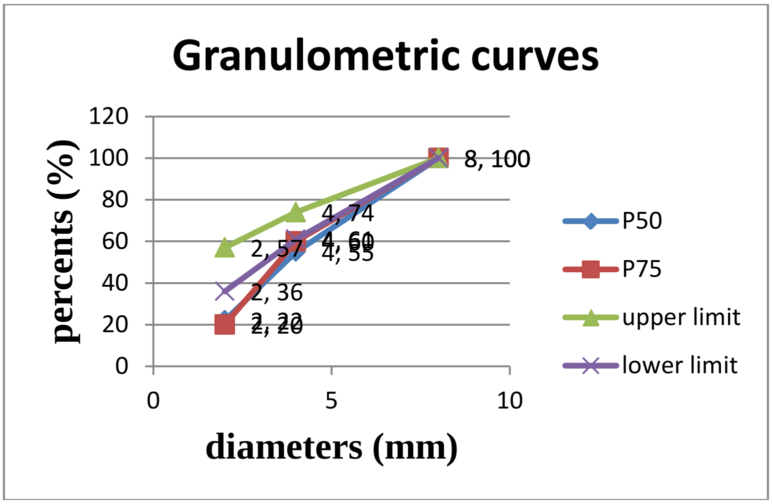

Fig. 3 The grading curve

4. CONCLUSIONS

The conclusion that emerges out of this study is that it is recommended to use a combination of units containing a higher proportion of medium and large size aggregates, thus obtaining a minimum volume of voids of the skeleton rigid (as close to 100%) of concrete.

In further development we will take into consideration several particle diameters of aggregates, and practical determination of resistance and impermeability of the concrete obtained using the calculated optimal parameters.

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The Consolidation of Historical Buildings' Floor Slabs

Gelmambet Sunai

***Abstract* – Consolidation of the historical buildings by various conservation and restoration solutions is part of the current national and international works, especially in the current context of conservation and protection of heritage buildings. The current thesis will have as main objective the analysis and examination of certain types of existing buildings (old buildings, historical and/or cultural monuments, which have different structural systems) in terms of structure and conceiving - designing solutions and necessary interventions for making them safe for future action of major earthquakes. We will focus on low rigidity that horizontal slabs have, on their lack of anchoring to the structure, on the influence that these issues have on the entire structure and on the methods to improve the overall seismic response of the structure by ensuring the compound effect between elements mentioned above.**

***Keywords* – consolidation solutions, historical buildings, slabs, structural analysis**

1. INTRODUCTION

The subject of the thesis is up to date, motivated by the fact that in our country there are many historical buildings that are part of Class A and B and are in an advanced state of degradation and seismically vulnerable. For these reasons it is necessary to take measures to consolidate conservation and restore in order to maintain their genuine value for future generations.

The buildings are subject to several causes of degradation, but many of them are due to lack of maintenance and timely intervention. Further consolidation solutions of the historical buildings can be difficult and costly equally, but also invasive. For these reasons it is very important to choose and study the optimal consolidation solutions to conserve the heritage value through minimally invasive interventions and reduced costs.

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Regarding the consolidation, it is very difficult to fix certain methods and general rules, both because of the large number of causes and cases that may occur in practice and the diversity of shapes in which defects can appear.

The study of various cases of degradation and the analysis of appeared damages and accidents is the best way to know these deficiencies and avoid them in the future.

The problem of defects and damages is closely related to quality and safety. The prevention of deficiencies must be made both by providing appropriate conditions of execution and by respecting the rules laid down in current standards.

In determining the correct consolidation solutions there are several key issues that need to keep in mind. A first problem is a more accurate investigation of the building's state of degradation, establishing accurately the causes for removing the effects of degradation and to secure the building. First, it is very important to determine the physical, chemical and mechanical characteristics of the structure's materials for a more accurate evaluation of the structure's strength capacity. Currently, in general, this step is treated superficially, resulting inadequate or excessive consolidation solutions.

In this regard, the objective of the research regarding these construction and the necessary interventions, will be especially the superstructure and the manner in which non-structural elements are done (divisive walls and closing walls, plates, architectural ornaments, attics, etc.) but also their links with the main resistance structure. We will focus on low rigidity that horizontal slabs have, on their lack of anchoring to the structure, on the influence that these issues have on the entire structure and on the methods to improve the overall seismic response of the structure by ensuring the compound effect between elements mentioned above.

A frequently encountered problem regarding old buildings is the constructive system for the slabs. The slabs construction systems have evolved with the development of construction materials. Plates made of wood and those with metal beams and thick brick vaults characterize the 1890-1920 period in Romania. The slabs over the ground floor and the other floors were built, usually, from wood with thick beams placed at 50 - 80 cm with a suspended plaster ceiling on cane laths, while those above the basement (cold areas) were made with thick metal beams and apparent masonry vaults.

These types of floors have several deficiencies, including:

- they do not provide spatial interaction between load bearing masonry walls because it doesn't form the rigid slabs. In this case, the low bearing capacity of walls (such as those with big or dense holes) cannot be substituted by spatial redistribution of the seismic force to the walls with large load bearing capacity.
- the lack of anchoring between walls and slabs. Because structures were not provided with reinforced concrete beams, the plate's wooden beams were simply supported on the walls. This has resulted in increasing the flexibility of the plates for vertical loads and the detachment of front walls with relatively large openings.

2. CONSOLIDATION SOLUTIONS FOR HISTORIC BUILDINGS FLOOR SLABS

Construction systems for floor slabs have evolved together with the development of construction materials. Wooden floor slabs and those with steel beams and dense brick arches are characteristic for the 1890-1920 period in Romania. The constructions made during this period are characterized by a maximum height of GF+3S, most of them were calculated using empirical rules, because strength computation notions were limited and concrete and reinforced concrete were not introduced as materials for structural systems. Floor slabs over the ground floor and over the other stories were usually built out of wood, with dense beams, set at a distance of 50-80 cm and with suspended plaster ceiling over slats (Fig. 1.), and those over basements (cold areas) were made out of dense steel beams and visible brick arches (Fig. 2.).

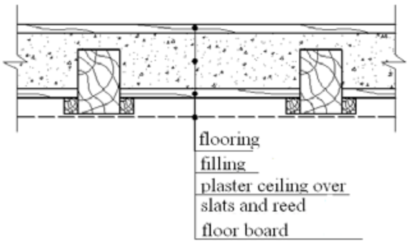

Fig. 1. Wooden floor slab

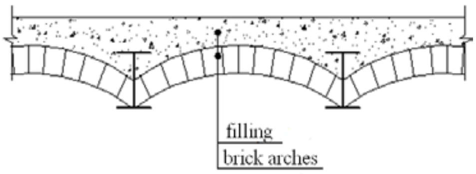

Fig. 2. Steel beams and brick arches floor slab

Consolidation solutions for wooden floor slabs

The consolidation of the floor slab so it can take higher live loads and so it can transmit loads over both directions by tying the wooden beams with three steel beams. To ensure a good connection between the beams, the steel beams have an L-shaped profile attached. Screws (between wooden and steel beams) and bolts (between the U-shaped and L-shaped profiles) are used for the connections. Welding and other open flame operations are not used to avoid starting a fire.

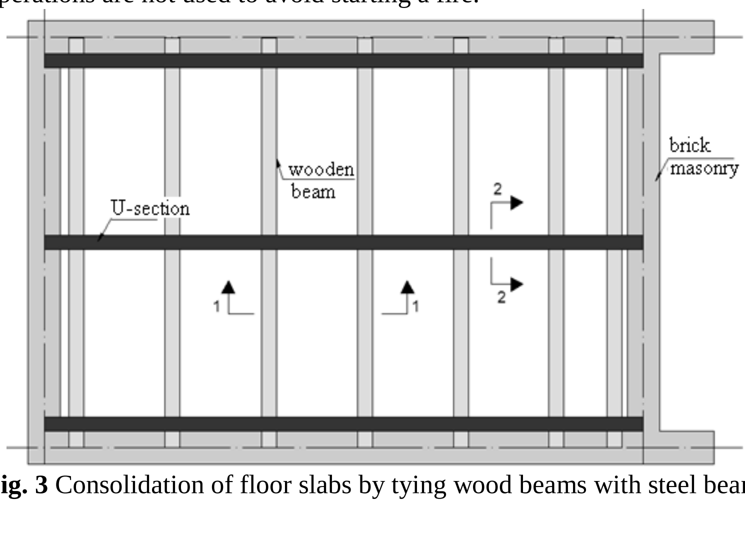

Fig. 3 Consolidation of floor slabs by tying wood beams with steel beams

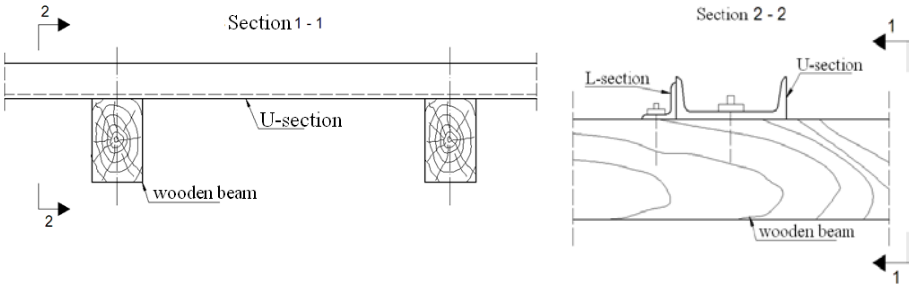

Fig. 4 Details for the floor slab strengthened by tying the wood beams with steel beams

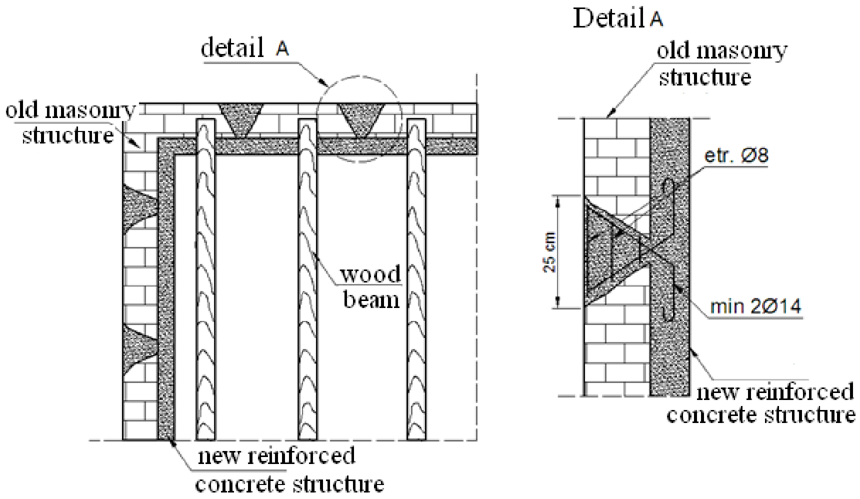

Fig. 5 Consolidation of the floor slab by creating new reinforced concrete connections.

Consolidation solutions for floor slabs using steel beams and brick arches.

The consolidation of floor slabs using brick arches is necessary when degradations in the steel beams and brick arches, when, because of the changing of the building destination, the loads taken by the slabs increase or to make the structure and the slab work together in all directions.

When floor slabs have small or moderate damage in the brick arches (Fig. 6), the solution is to inject grout or mortar into the cracks.

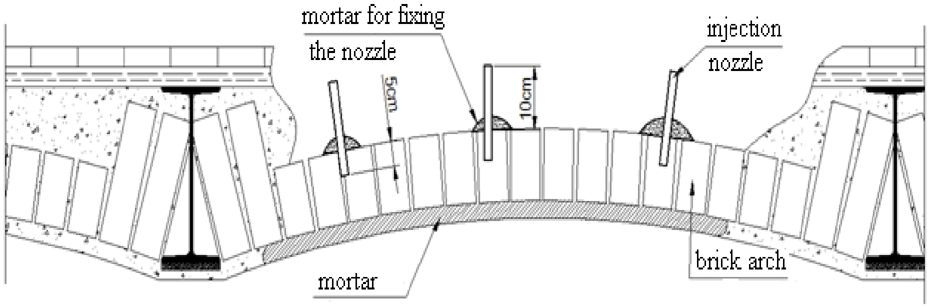

Fig. 6 Consolidation of a floor slab having small or moderate damage

When taking larger live loads and ensuring the structure and the slab work together on all sides is desired, the consolidation of the steel beams and brick arches floor slabs is done by increasing the inertia moment of the steel sections. This is done by tying the I-shape beams with three U-shape beams. To ensure a better connection, the U-shape may be strengthened with an L-shape. It is recommended that the connections are made using bolts.

Another method for increasing the live load bearing capacity and the transmission of loads from the slab to all of the sides is the strengthening of the steel beams and brick arches floor slabs by reinforced concrete topping.

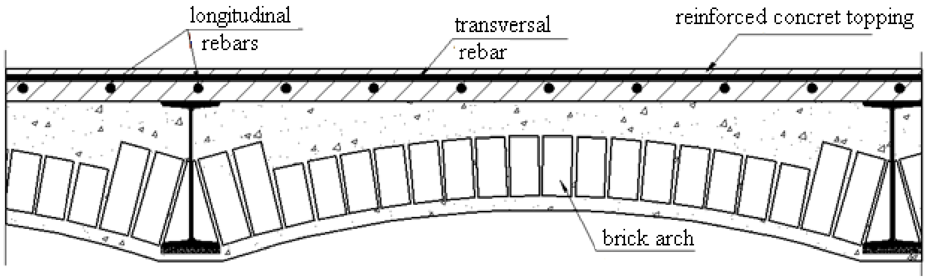

Fig. 7 Consolidation of the floor slabs by reinforced concrete topping

When the supports and the anchorages for the steel beams are not well made, a strengthening solution is presented in the following figure.

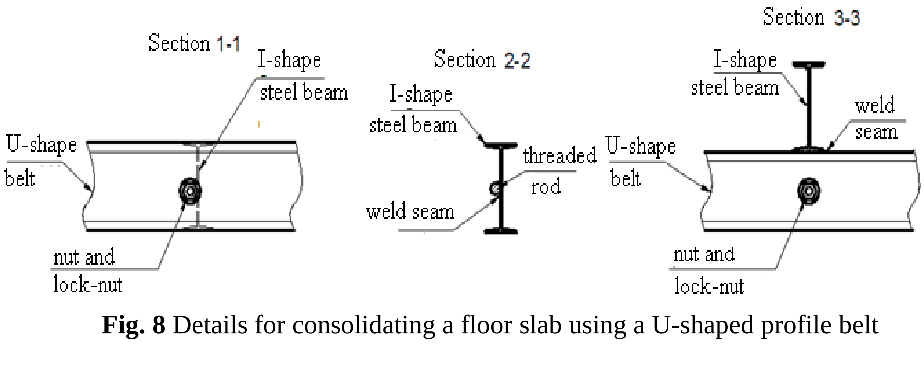

Fig. 8 Details for consolidating a floor slab using a U-shaped profile belt

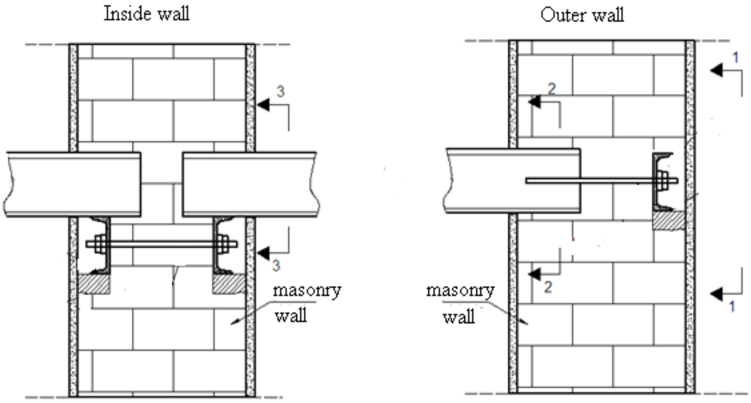

Fig. 9 Consolidation of the floor slab by creating a belt made of U-shape sections

3. Case study

In this paper a study was made concerning a GF + 1S structure in Constanta County (see Fig. 10)

According to the structural design code P100-1/2013, the structure has the following characteristics:

- the seismic design ground acceleration ag = 0,20g and the corner periods TC= 0,7s, TB = 0,14s and TD = 3s;
- the building is in class III of importance (regular buildings, that do not belong to other categories) having the importance factor γI = 1.

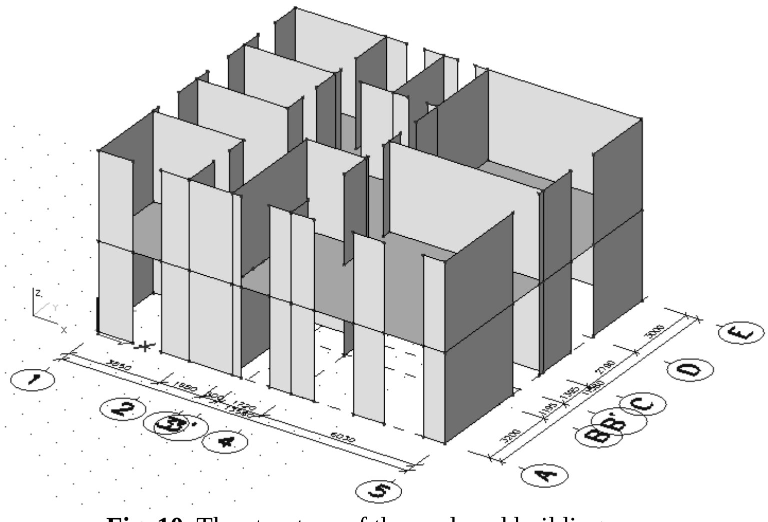

Fig. 10. The structure of the analyzed building

The studied building has the following structural system:

- continous foundations made out of stone masonry and lime mortar;
- dense structural masonry made out of old type bricks (28x14x7), with a thickness of 1½ bricks for the outer walls (42 cm without plaster) and 1 brick for the interior walls (28 cm without plaster);
- steel beams floor slab over the ground floor, made out of I12 sections at 60 cm apart and with brick arches between them and wooden floor slab over the first story with sawn timber roof structure and ceramic tiles roofing;

The structure was built before 1940. It has a well-designed general structure, having dense structural masonry walls, but it has no anti-seismic elements like reinforced concrete columns or beams.

The main problem which arises in the case of this structure is the lack of anchorage between the floor slabs and the structural walls. The walls and the slab do not work together in what concerns resisting horizontal loads.

The seismic evaluation of the structure will be done according to the seismic design code part III – Rules for seismic evaluation of existing buildings, P100-3/2008.

The seismic evaluation requires a quality and quantity (by computations) evaluation. The totality of the quality and quantity evaluations make the methodology for assessing the structure, which may be level 1, level 2 or level 3.

Depending of the results obtained after the seismic evaluation, the building is categorized in a risk class. Depending of this determined information, together with the importance class of the building and its expected life-span, the necessity for consolidation and the minimum safety level to be attained are determined.

The values for the R3 coefficients for the two main directions of the structures are 0.65 (65%) and 0.51 (51%).

Depending of the value of the R3 coefficient, the structure is inserted in one of the seismic hazard classes, according to table 7.3 in P100-3/2008 [7].

Table 7.3 Values for R3 associated with seismic hazard classes (P100-3/2008)

Seismic hazard class			
I	II	III	IV
Values for R3 %			
<35	36-65	66-95	95-100

It is observed that the building is in the seismic hazard class II. This class comprises buildings that, under the effect of design earthquakes, may suffer major structural damages, but for which loss of stability is unlikely.

According to table 7.3. from P100-3/2008, the building requires structural intervention. Being a building in class III of importance and the future lifespan desired of 40 years, the minimum safety level which needs to be ensured after the consolidation is satisfying the conditions for a newly designed building for an earthquake with the maximum acceleration $\geq 0{,}75a_g$.

The intervention measures proposed and the following computations will refer only to the floor slabs and to the influence which they have on the structural behavior. Two methods for consolidation are proposed regarding the beam and arch slabs.

The first method is consolidation through the anchorage of the slabs in the structural brick walls. This will ensure the transmission of loads between the slab and the structural walls on one direction.

The execution of belt walls form UPN120 section profiles is proposed and their connection to the existing steel beams. The connection will be made by the use of steel coupons welded on the beams and screwed at the other end.

The brick arches do not have degradations so only their plastering is necessary.

The second method consists of reinforced concrete topping to ensure the transmission of loads in both principal directions. The existing flooring will be removed and part of the filling. The lower rebars will be placed perpendicularly on the steel beams and will be connected to the by welding.

The brick arches do not have degradations so only their plastering is necessary.

A linear dynamic analysis of the structure was done using SCIA Engineer structural design software taking into account the following three hypotheses.

Hypothesis 1 The unconsolidated building was modeled having the structure made out of masonry walls only. The effect of the slabs was not taken into account because it does not contribute to the seismic load resistance, since it does not have anchorages to connect it to the walls.

Hypothesis 2 The consolidated building using the first method was modeled having the structure made out of masonry walls and slabs connected to them on two sides only.

Only the slab above ground floor was considered, because on the wooden slab only measures to replace the ends of the beams were taken. No special measures were taken for their anchorage.

Hypothesis 3 The consolidated building using the second method was modeled having the structural system made out of masonry walls and slabs connected to the walls on all four sides.

Only the slab above ground floor was considered because on the wooden slab only measures to replace the beam ends were taken. No special measures were taken for their anchorage.

4. RESULTS AND CONCLUSIONS

The present paper had as purpose the presentation of methods for consolidating floor slabs that have no rigidity in their plane, like those made out of wood or those with steel beams and brick arches, and the influence that the consolidation has on the seismic response of the entire structure.

In this perspective, we emphasized not only on the interaction between the slabs and the structures to resist gravitational loads but also on their interaction to resist seismic loads.

The case study shows that the structure behaves better after the consolidation of floor slabs.

Thus, in what concerns the natural frequency of the structure before and after the consolidation, a significant decrease is noticed from one case to the other. This drop is noticeable in the case of maximum lateral displacements of the structure. The maximum displacements were registered in the y direction, for the M20 mullion and they decrease while the structure becomes more rigid.

Another thing worth mentioning is the way loads and stresses develop with the structure becoming more rigid. While before the consolidation their values are quite large on the whole height of the wall, they begin to decrease at ground floor level after the anchorage of the slab above ground floor on one direction, reaching insignificant values after the interaction of the slab and the structure is ensured in both directions. This is noticeable in the stress and effort diagrams. Analyzing the bending moment diagram, we can notice, that in certain situations the stiffening of the slabs in one direction only is not enough and that, to ensure a decrease of the effort in the walls it is necessary that the slab works in both directions.

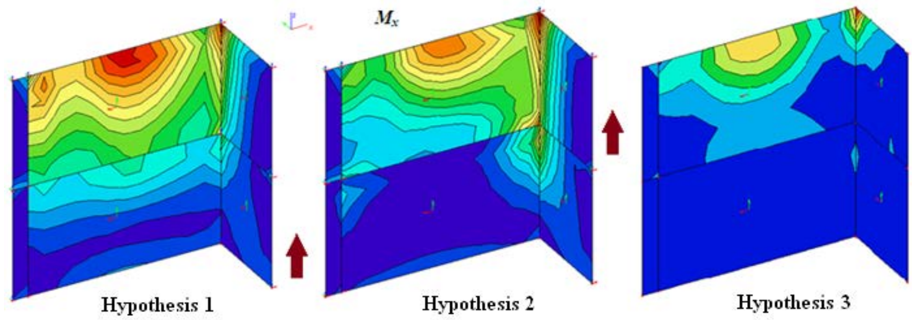

Fig. 11. My bending moment diagrams

It is important to state the fact that, after the interaction between the structure and the slab over ground floor only, the stresses, efforts and displacements are concentrated in the walls of the first story. Thus, in certain situations it is not enough to consolidate only the current floor slabs (like it's usually the case in practice) but also the attic floor slabs.

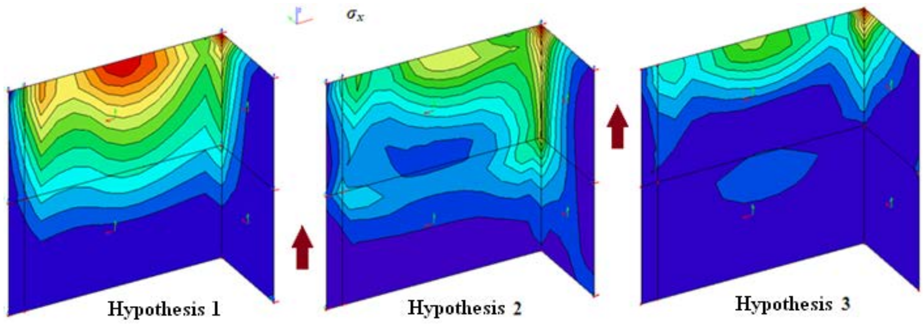

Fig. 12. Stress diagrams σ_x

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