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Ivan Milojković , Nikola Radojlović, Roland Kröpfl, Dragan Stefanović

Modeling the protection of environment regarding climate change in the design and construction of water supply

Institute for Water Resources "Jaroslav Černi" , Belgrade, Serbia

GP "GraditeljNS" , Novi Sad, Serbia

TIROLER ROHRE GMBH, Innsbruck, Austria

BINVEX-STANDARD d.o.o. , Belgrade Investment and Export Company, Belgrade, Serbia

INTRODUCTION

Objective function in the following procedure is selection of an adequate pipeline which would be stable in terms of floods, landslides and earthquakes. Due to climate change, there was a new requirement that is placed in front of water supply systems. In terms of variable rainfall, possible flooding, the emergence of new landslides is required detailed sensitivity analysis of water supply to these influences. It should not be adverse impact on the environment. In the case of a pipeline it is essential to choose the appropriate type of pipeline that would be resistant to new influences [3], [6], [7], [8], [10], [11], [12]. In the case of main water supply pipeline Ø 800 of Zučka kapija to the settlement Kaluđerica [5] in this paper describes the procedure for selecting the types of pipes which were adopted in the design and with whom he performed this pipeline. Authors used a contemporary MCDS PROMETHEE method in order to more realistically comprehend the conditions of operation and maintenance of water supply systems.

INTRODUCTION

The result of selecting the type of water supply pipeline is ductile pipes Ø800 [2]. The subject of this paper is a section of the projected shaft connecting the regional water supply system Makiš-Mladenovac (km 14 + 374 - code manhole V8), to connect with the previously completed section showed on figure 1.

The layout of the pipeline route and the diameter are defined previously in the planning and technical documentation for the city of Belgrade in Serbia. The pipeline is designed and made from ductile pipes. On the route of the pipeline is envisaged to develop two manholes for discharges, one for air vent and one for the sectoral valve. Section length is 1593.84 m.

The route of the pipeline passes through several morphological units. In the first chainages is located in Put down relatively wide, the valley of the river Zavojnička. At the end of the valley the pipeline passing through several meters high embankment of the highway.

INTRODUCTION

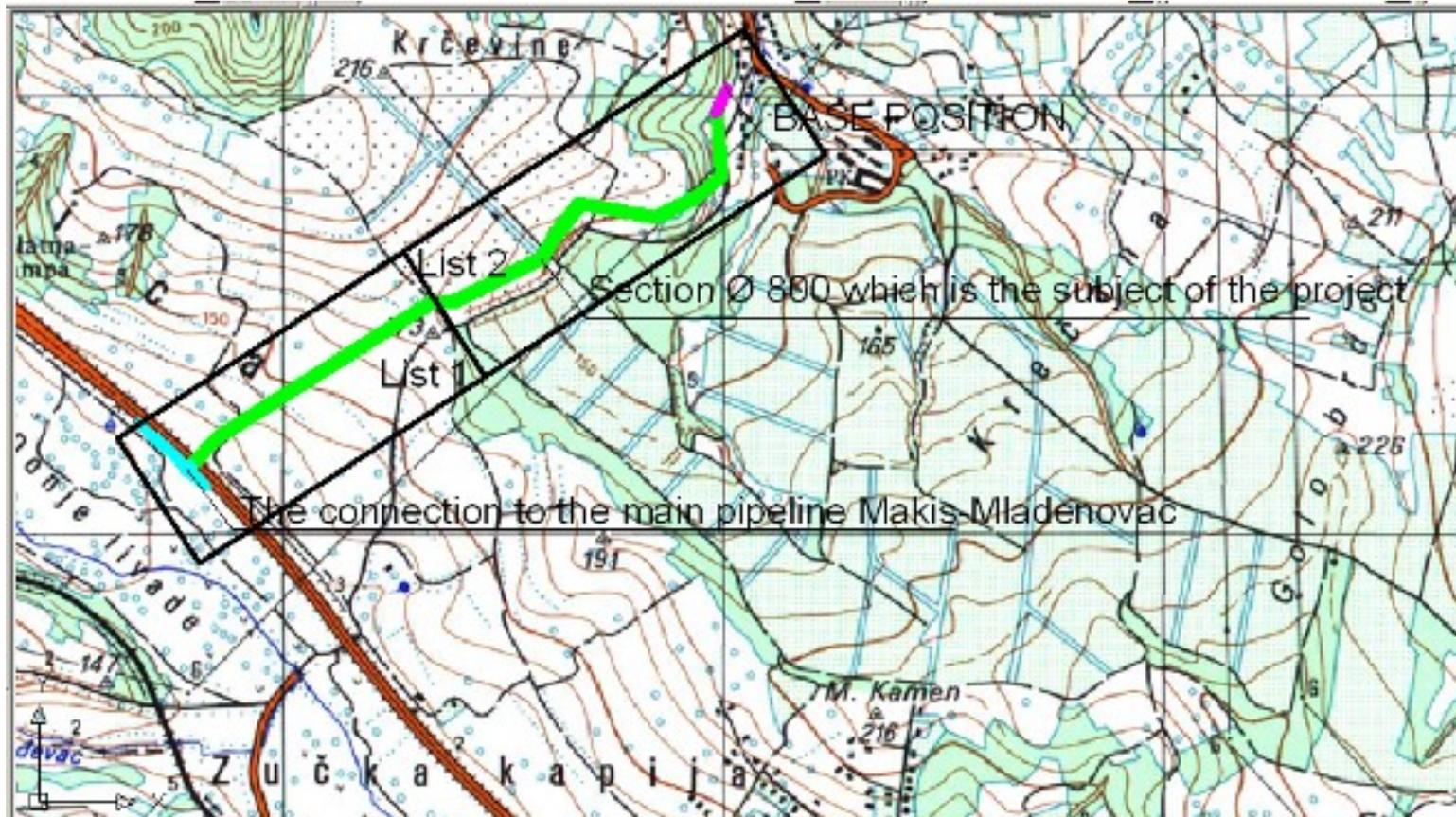


Fig. 1. A section of the projected shaft connecting the regional water supply system

INTRODUCTION

Then, the route rises by undulating slopes, a distance of about half a mile, passing over a short plateau and down into the valley of a tributary valley Bolečica.

Hypsometrically terrains there are no major differences angles have values from 110 to 170 meters above sea level. Slope terrain, no steep slopes (up to 10 °) made it possible to develop deluvial, to a lesser extent and proluvial processes. Denudation by their accumulation eased the work of the slope. Corrugated surface due to local terrain depressions and projections, indicate that in the geological history happened before slipping lower. Under present conditions, the terrain is stable.

METHODS

Visual PROMETHEE and GAIA is a multicriteria decision methods (MCDA). PROMETHEE stands for Preference Ranking Organization METHod for the Enrichment of Evaluations. GAIA stands for Graphical Analysis for Interactive Aid. MCDA stands for Multi Criteria Decision Aid. It includes many approaches, models and methods to handle decision or evaluation problems where multiple evaluation criteria have to be taken into account. MCDA methods are designed to assist decision-makers in such a context. The PROMETHEE Sort procedure will help engineers, economists and other to allocate an item to a predefined class. The GAIA visual analysis will help analyst to understand better the decision problem, to see what is possible and what is not, to justify your choices or to acknowledge that some choices cannot be justified. It will also help analyst to explain to other persons why some decisions are better.

EXPERIMENTAL

The projected water supply pipeline is planned and constructed by the ductile pipe with diameter of 800 mm. Operating pressure for the pipeline is designed to 16 bar. In this case, alternative solutions are different types of pipe material, when choosing tubes. With regard to the offer pipes, which is very topical in the market to build stocks observed proposed the following types of pipe material: ductile iron, polyester, high density polyethylene (HDPE), steel and reinforced concrete.

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- a) High density polyethylene (HDPE)
- b) Polyester
- c) Ductile iron
- d) Steel
- e) Reinforced concrete

EXPERIMENTAL

The aforementioned types of pipes with regard to the pipe material (alternatives) are evaluated on the following criteria:

1. Durability of pipes
2. Corrosion and abrasion protection
3. Length tube segments
4. Eligibility from the maintenance of pipelines
5. Eligibility from the standpoint of the design of pipelines
6. Resistance on rainfall
7. Resistance on flood
8. Resistance on landslides

RESULTS AND DISCUSSION

Conditions for the design of external water supply network PUC "Belgrade Waterworks and Sewerage" causes the mode design of water supply network for a given location. The main project was prepared in accordance with the requirements for the design and applicable technical regulations for this type of work.

In Figure 2 you can see the site at the beginning of the section that is being built and it was concluded that a good accessibility of the pipeline, which enables its good maintenance. Ductile pipes are highly resistant to mechanical and chemical influences. No special conditions for their storage and manipulation which greatly facilitates the construction. Before and during the construction of the building was carried out a detailed collection of data on the area where the works are performed, as well as on the position and function of the structure in relation to the entire water supply system and other infrastructure systems.

RESULTS AND DISCUSSION



Fig. 2. View of construction site from the point of eligibility of maintenance and durability of pipelines and pipeline landfall resistance

RESULTS AND DISCUSSION

Figure 3 shows a good overview of the operator on construction machine that performs very well carry out the excavation. Close to the highway construction site and pipeline places very high demands in terms of resistance to the impacts of the pipeline from landslides. They are very large forces that affect the pipeline and work construction of traffic which is transmitted to land close to the site and pipeline.

Accuracy embodiment works is 1 cm, the construction works, or 1 mm for assembly work in setting up the pipeline. This is achieved by adequate geodetic and surveying information system that supports the carrying out.

RESULTS AND DISCUSSION



Fig. 3. View of construction site from the point of eligibility of maintenance and durability of pipelines and pipeline landfall resistance

RESULTS AND DISCUSSION

Figure 4 also recorded high levels of underground water which poses major problems for the builders, owners and users of the water system. Durability of pipes comes into play since it is necessary to incorporate a permanent pipe segments to ensure quality functioning of the water system without jeopardizing the surrounding content. In Serbia, water systems and sometimes last more than a hundred years. The lifespan of water supply systems administered prior to all participants in the project as a priority in the application of quality materials and technologies.

Corrosion and abrasion protection are of great importance, especially in water supply systems. It is necessary at all costs to ensure healthy drinking water without any impurities that are harmful to human health. Often corrosion and abrasion products reach the water, and the source of the contamination is usually the water pipes.

RESULTS AND DISCUSSION



Fig. 4. View of construction site from the point of eligibility of maintenance and durability of pipelines and pipeline landfall resistance

RESULTS AND DISCUSSION

Therefore, it is necessary to pay special attention to the materials used during construction. In addition maturities of corrosion and abrasion in drinking water, it is very dangerous and the release of these products into the environment water supply system. If you come to the release of toxic substances into the environment, water pipes, are in danger and residents who live near these facilities, animal and plant life as well as employees working on maintenance. The high level of groundwater, especially for long periods, can have a very negative impact on the water supply system facilities.

In Figure 5 you can see a comparative view of the resistance of sewer pipes built of different materials where tests show that the ductile pipes are most resistant to abrasion [2], which was taken into account in the multi-criteria decision making. The tests of resistance of different materials water supply pipes show that the ductile pipes are most resistant to abrasion, which was taken into account in the multi-criteria decision making. These tests were performed according to standard Darmstädter tip shanneling test ac. to DIN EN 295-3 and DIN 19565-1.

RESULTS AND DISCUSSION

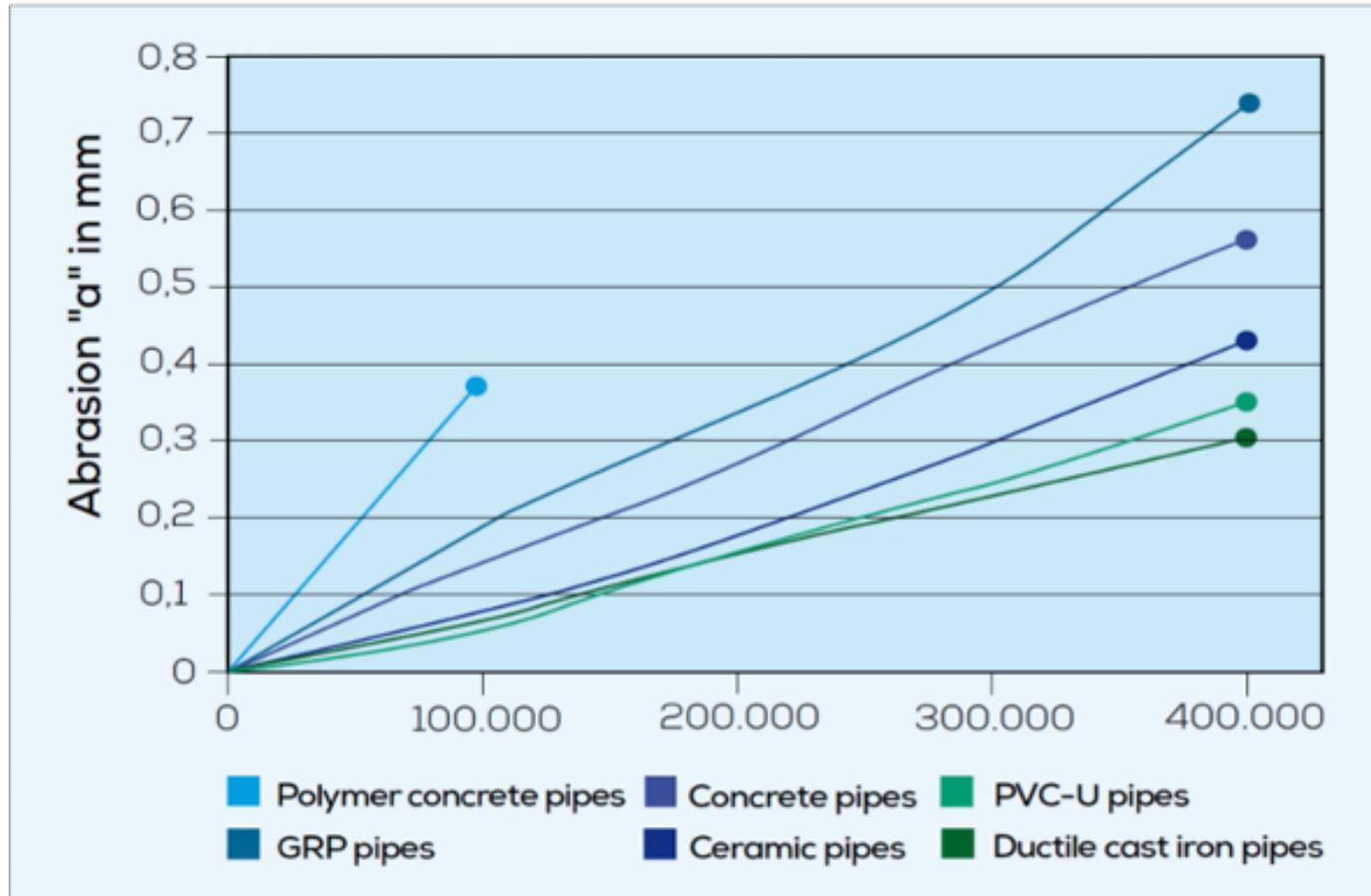


Fig. 5. Comparative display of resistance to abrasion of various tube

RESULTS AND DISCUSSION

Eligibility from the maintenance of pipelines is very important in water supply systems since they have a very strong great length of operation and maintenance. It is essential to use the most suitable pipeline systems from the point of installation, replacement of damaged pipes, and stability of the pipeline on various external, climatic conditions. Also, water is usually located right next to other infrastructure facilities and maintenance of water supply systems must be fully in accordance with the surrounding infrastructure. In Figure 5a you can see a Eligibility from the maintenance of pipelines

RESULTS AND DISCUSSION



Fig. 5a. Eligibility from the maintenance of pipelines

RESULTS AND DISCUSSION

Eligibility from the standpoint of the design of pipelines conditional use of the latest technologies related to all aspects of water supply, especially when the water supply network in question. Planning sewer is critical to anticipate all the conditions in which the object is to operate waterworks. How to build pipeline, so needed to maintain that there is such a pipeline system, which could be easily installed and dismantled. There are different installation technologies and the construction of the pipeline. There is also the possibility of welding the pipeline of different materials. Each method has its advantages and disadvantages, and it should always strive for the best solutions for given design conditions. In Figure 5b you can see a Eligibility from the standpoint of the design of pipelines

RESULTS AND DISCUSSION



Fig. 5b. Eligibility from the standpoint of the design of pipelines

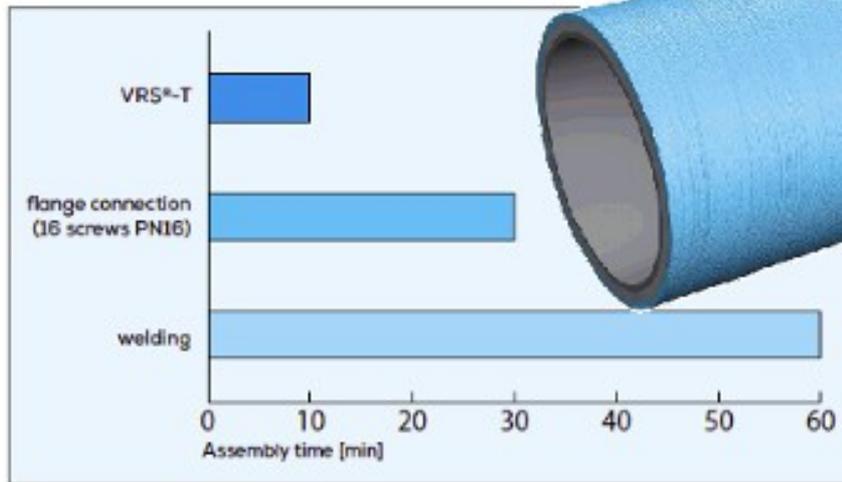
RESULTS AND DISCUSSION

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Figure 6 shows an advantage when mounting and dismounting of ductile pipe in the application of newly developed mounting compound. This is very important for mining, pipelines when moving to another location, in accordance with the growth of landfill.

RESULTS AND DISCUSSION

VRS®-T at a glance



Up to **3x faster** installation than flange connections.

Up to **6x faster** than welding steel pipelines

Fig. 6. Benefits during installation of ductile pipes

RESULTS AND DISCUSSION

Resistance on flood is particularly important since the pipeline runs on relatively flat ground, near the highway and pass under the highway, so that in case of occurrence of local flooding in the area can easily come to the damage of water supply and the highway. Buildings, water supply and highway are of regional and republican character, so it must provide absolute protection against possible floods that may occur in large, unpredictable rainfall. Resistance on landslides and slope stability of land along the highway must be absolutely satisfied, given the importance of water supply and the highway. The technology used must be the best for this type of work. There no way not to compromise the functionality and stability of the considered objects. All terrain data, spatial model of terrain, groundwater, and soil bearing capacity must be taken into account in the design and construction of these facilities. Drilling in under a highway must be carried out in accordance with the weather conditions.

Performing works on the manhole belonging to this part of the Belgrade water supply system had to be adapted to the environmental conditions that are found (Figure 7). Manholes are made watertight, the required dimensions, along the highway.

RESULTS AND DISCUSSION



Fig. 7. Benefits during installation of ductile pipes

RESULTS AND DISCUSSION

The pipeline of Ø800 Zučka kapija to the village Kaluđerica is connected to the regional water supply system Makiš-Mladenovac which was built in ductile pipe material. Advantages of pipes of ductile pipe material are as follows:

- They have excellent and stable hydraulic characteristics;
- They have excellent mechanical properties;
- Easy to install and do not require a mandatory set of sand in the trench as well as cots and more can be fine-grained materials;
- They are very stable and inert to climatic conditions;
- Suitable for installation in aggressive soils;
- Long-life are extremely reliable and does not require maintenance;
- It does not require cathodic protection, galvanized pipe from the outside before applying the final anti-corrosive coatings;
- In anchored type pipeline no anchor blocks, serving a much larger displacement and settlement of land than any other pipeline. Input data for model in process of evaluating which pipe is good for building pipeline for water supply pipeline Ø 800 of Zučka kapija to the settlement Kaluđerica showed in table I.

METHODS

TABLE I. PART OF THE INPUT DATA USED IN THE MODEL

actions	Values criteria functions							
	1.Durability of pipes	2.Corrosion and abrasion protection	3.Length tube segments	4.Eligibility from the maintenance of pipelines	5.Eligibility from the standpoint of the design of pipelines	6.resistance on rainfall	7.resistance on flood	8.resistance on landslides
	point	2 – in 1 – middle 0 – out	m	point	point	point	point	point
a) High density polyethylene (HDPE)	9	0	6.0	9	10	8	9	9
b) Polyester	9	0	6.0	9	9	8	8	8
c) Ductile iron	10	2	6.0	10	10	10	10	10
d) Steel	6	2	6.0	5	6	10	9	9
e) Reinforced concrete	7	1	2.0	6	4	10	9	5
extremization	max	max	max	max	max	max	max	max

RESULTS AND DISCUSSION

On the PROMETHEE I Partial Ranking showed on figure 8, the leftmost bar shows the ranking of the actions according to Φ^+ : c) Ductile iron is on top, followed by a) High density polyethylene (HDPE) , b) Polyester , d) Steel and e) Reinforced concrete. The rightmost bar shows the ranking according to Φ^- : c) Ductile iron is still on top, and it is followed by: a) High density polyethylene (HDPE), b) Polyester, d) Steel and e) Reinforced concrete.

We can conclude that:

- c) Ductile iron is preferred more in compare to all the other actions in the PROMETHEE I ranking.
- c) Ductile iron, a) High density polyethylene (HDPE) and b) Polyester are on top.
- All actions are comparable because they have a similar score on Φ^+ and on Φ^- .
- c) Ductile iron, a) High density polyethylene (HDPE) and b) Polyester are close to each other.
- d) Steel is worse material by score according to Φ , Φ^+ and Φ^- from c) Ductile iron, a) High density polyethylene (HDPE) and b) Polyester which are close to each other.
- e) Reinforced concrete is worse from all other materials

RESULTS AND DISCUSSION

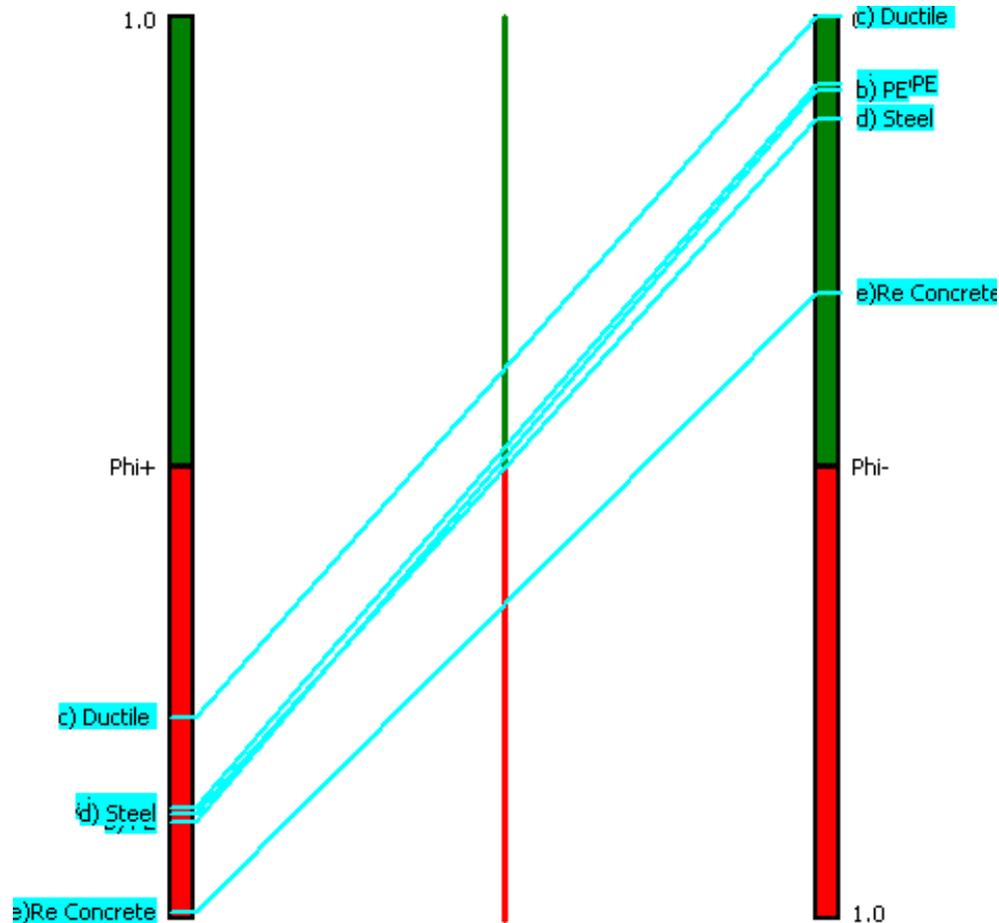


Fig. 8. PROMETHE ranking I

RESULTS AND DISCUSSION

This is confirmed by the PROMETHEE II complete ranking (figure 9). Three groups of actions appear clearly:

- c) Ductile iron has a higher Phi score, but near score a) High density polyethylene (HDPE) and b) Polyester.
- d) Steel has lower scores from c) Ductile iron, a) High density polyethylene (HDPE) and b) Polyester. They is more average action.
- e) Reinforced concrete has also very close but negative scores. They are at the bottom of the PROMETHEE II ranking.

While the PROMETHEE II complete ranking is easier to explain it is also less informative as the differences.

RESULTS AND DISCUSSION

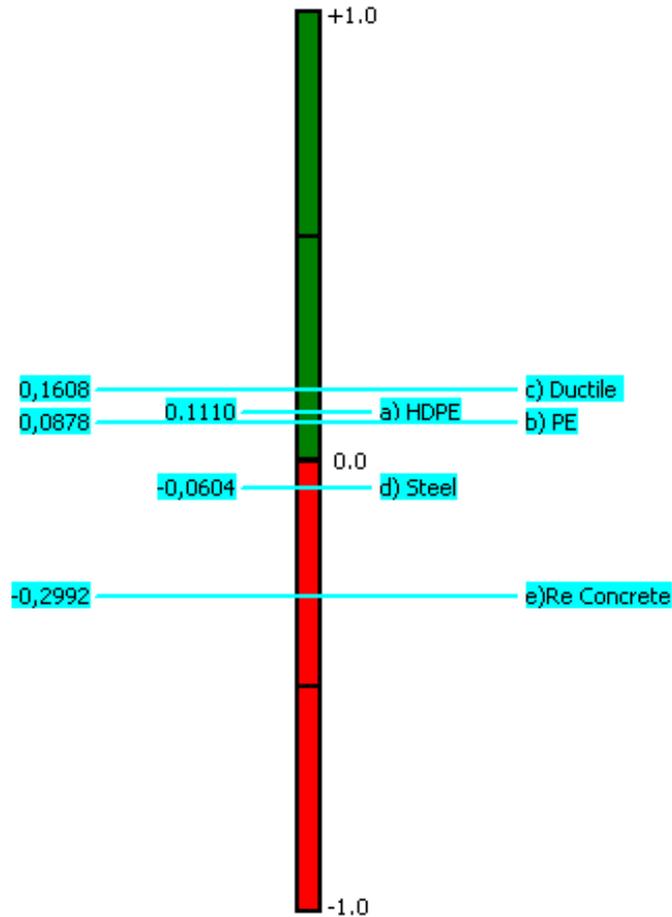


Fig. 9. PROMETHE ranking II

CONCLUSIONS

The result of selecting process the type of water supply pipeline is ductile pipe for main water supply pipeline Ø 800 of Zučka kapija to the settlement Kaluđerica. Ductile iron, high density polyethylene (HDPE) and polyester are on top on the ranking.

All pipe materials are comparable because they have a similar score on Phi+ and on Phi- in PROMETHEE method. Authors include in procedure for selection an adequate pipeline, criteria functions: floods, landslides and earthquakes and are get acceptably solution.

ACKNOWLEDGMENTS

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Thank you very much for your attention.