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WEATHER CONDITIONS AS A RISK FACTOR IN SEWAGE SYSTEM CONSTRUCTIONS

Summary

Construction works in the open air, in particular laying sewage systems, are susceptible to weather conditions. Weather conditions, such as very high or low temperatures, strong winds, intense and prolonged precipitation, interfere with work and they can even lead to cessation of construction. In consequence, the construction work lasts longer than originally assumed. On the other hand, it is impossible to alter weather. Therefore, it is vital to conduct a thorough identification of threats related to adverse weather conditions.

This work makes an attempt to determine basic relationship between adverse weather conditions and the possibility of completing construction work according to a schedule. This analysis is a part of Schedule Risk Assessment.

The findings show that the frequency of adverse weather occurrence is high and it affects schedule risk with special regard to air temperatures below -5°C and above 25°C. Thus, before starting construction, the probability of adverse weather conditions should be considered. Accurate identification of weather factors during the planning phase may help in accumulation of adequate reserves. Therefore, any unavoidable circumstances that are forced by adverse weather seem to be allowed in the schedule.

This work focuses on air temperature, precipitation and wind because of their greater impact on construction. The presented research covers one calendar year. The conducted analysis proves that adverse weather conditions during construction are risk triggers. To asses its true significance further research is needed, especially concerning longer time of observation.

Key words: sewage system construction, schedule risk, air temperature, precipitation, wind velocity

INTRODUCTION

The high level of construction cost risk and schedule risk can result in cost increases, work delays and contractual fines. Under these circumstances, the reliability of a company can be undermined, or they can even drive the company out of business. Risk factors must be thoroughly identified in order to determine the risk level. Risk factors cover: adverse events during construction, the probability of their occurrence and impact. Appropriate identification of these factors during the planning construction phase gives an opportunity for collecting adequate reserves. This helps to manage unforeseen circumstances during construction.

Risk that hinders construction work according to the schedule is the subject of the analysis in this paper. This particular risk is described as a 'schedule risk' [Pritchard 2002]. An assessment of schedule risk size requires prediction of construction stoppages and work output lower than assumed in building specifications of technology and organization. The source of such problem can be adverse weather conditions during construction [Koehn, 1985; Moselhi, 1997; Skorupka, 2008; Rybka and Bondar-Nowakowska, 2010]. The aim of this paper is to identify the weather conditions as a risk schedule factor in the construction of sewage systems in rural areas. The article focuses on air temperature, precipitation and wind.

THE WEATHER CONDITIONS' INFLUENCE ON SEWAGE SYSTEM CONSTRUCTION

The sewage systems construction work is regarded as linear. Because of deep excavations, the needs of lowering ground water level, de-watering the trenches and the requirement of trench shoring, sewage system construction is regarded as complicated work. It also diversifies into a range of technological processes. Sewage system construction includes demolition work, earthworks, installation (laying and jointing of pipes), and transport. A diagram of this work is presented in Fig. 1. Most of the presented actions are done manually. The next shared feature of these activities is that they are all done in the open air. Under these conditions, each of them is exposed to adverse weather conditions such as too low or too high air temperature, heavy precipitation, strong wind, fog, black ice, storm and floods. Such adverse weather conditions can result in stoppage and influence a reduction in work output, and thereby bring on a limitation of construction work progress. [Lenkiewicz (ed.), 1985; Taczanowska and Jaśkowski, 1998; Żaba et al., 2002; Rozporządzenie, 2003; Połoński (ed.), 2009].

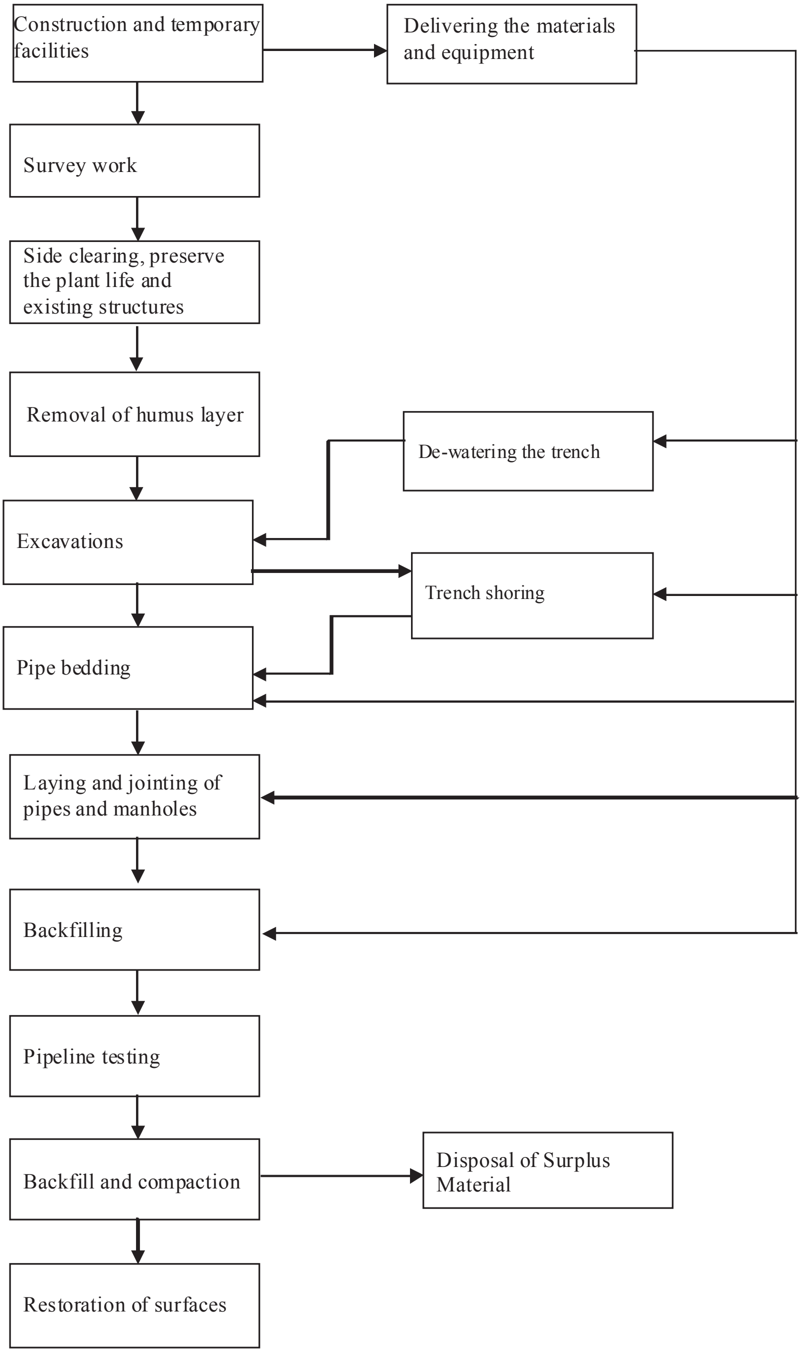


Fig. 1. Diagram of the technological process of sewage system construction

Based on Fig. 1, it appears that most of the work is sequential during sewage system construction. This means that stoppage in one job causes the rest of work to stop.

A detailed description of adverse weather threat to the course of sewage system construction is shown on Ishikawa's diagram (Fig. 2). Five areas of threat are indicated in that diagram. The first area includes air temperature; the second is concerned with precipitation, the third with wind, the fourth with extreme hydrological occurrences. The last part deals with such weather evens as fog, storm and black ice.

In analyzing the diagram as it appears, temperature has to be studied separately in two ranges - above and below zero. With regard to low temperatures, the construction restrictions concern:

– earthworks – excavations, pipe bedding, backfilling and compaction,
– transport and installation (pipeline construction) - delivering, laying, jointing of pipes (often) PVC and manholes,
– pipeline testing.

The problems in low temperatures are mostly connected with frozen ground and water. The temperature below 0°C and above 25°C has an adverse effect on work quality and output. Lower efficiency during work requiring manual dexterity is driven by high temperature. A reduction in capacity for hard, physical work occurs at temperatures above 30°C [Koradecka (ed.), 2008]. At such temperatures, as with low temperatures, PVC pipe should not be transported and laid.

The influence of precipitation on working time depends on its intensity and duration, the topography, soil type, and machinery design and specifications. Research conducted showed that, as a general rule, machine excavators do not work on days when the daily precipitation is above 10 mm [Lenkiewicz (red), 1985].

The influence of wind on sewage system construction technology mostly concerns installation and demolition work. The effect of wind depends on the size of the installed elements, their locality, and the kind of machine used. However, the assembly of pipeline in sewage system construction is not complicated. Workplace health and safety rules indicate that installation should be stopped during wind velocity above 10 m/s. [Rozporządzenie, 2003].

As a result of weather events such as those presented above, there is not only delay in construction but also a higher probability of additional work.

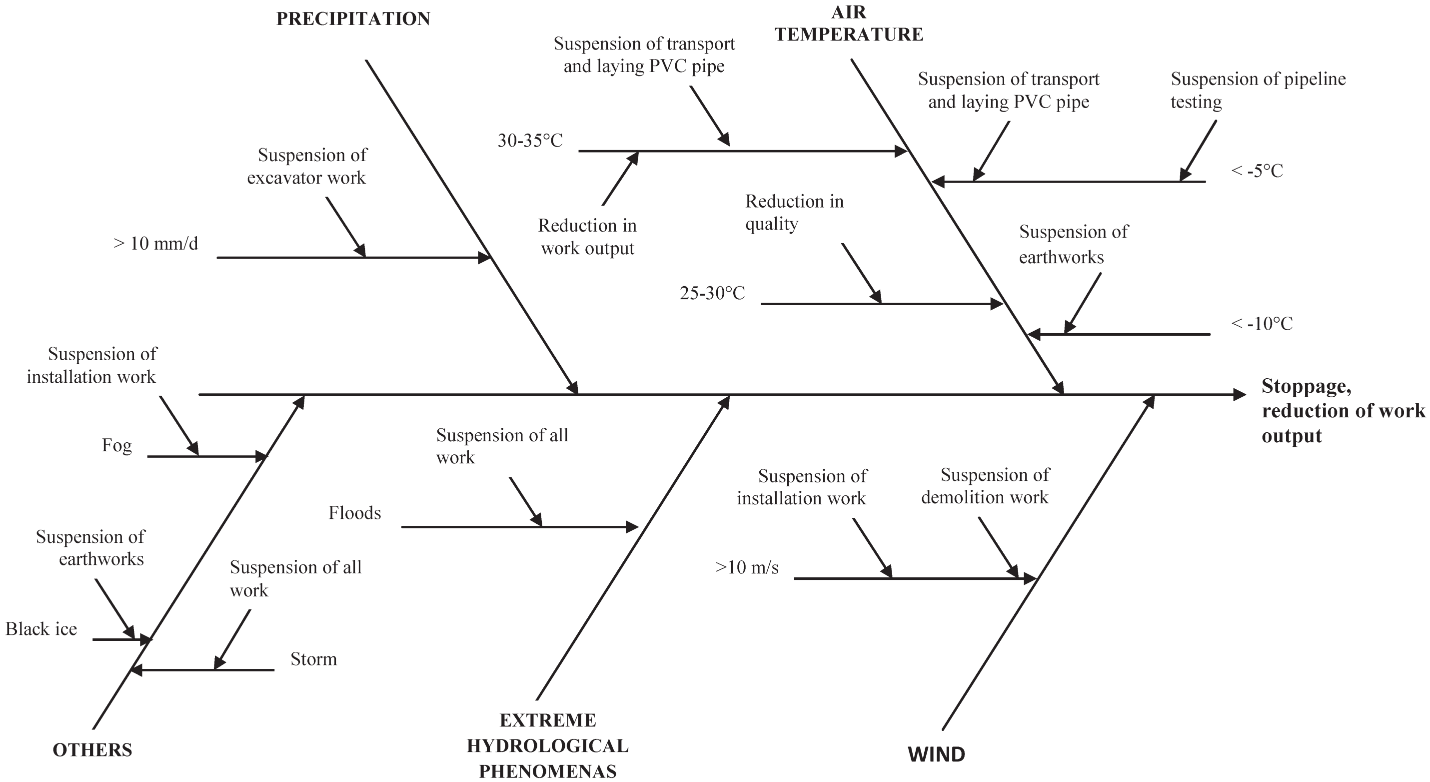
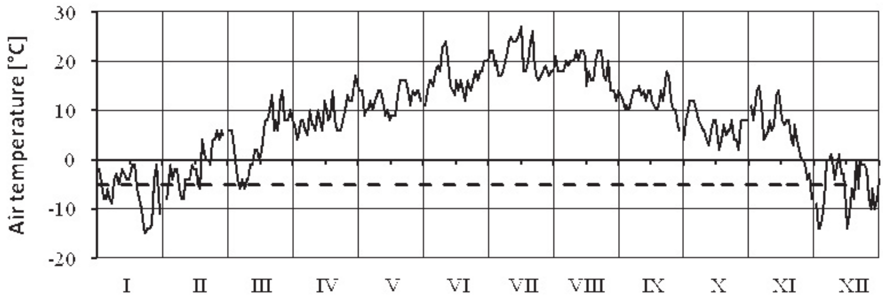


Figure 2. The influence of weather conditions on sewage system construction

THE OCCURRENCE OF STOPPAGE DUE TO ADVERSE WEATHER CONDITIONS - THE ASSESSMENT OF POSSIBILITY

This analysis of adverse weather conditions was based on meteorological data from the weather station Wrocław Port Lotniczy, [www.wunderground .com]. The analysis covers one year because the duration of the examined construction works did not exceed this particular period in time [SIWZ a, b, c, d, e, f]. The year 2010 was taken into account in this paper.

The course of the average daily air temperature in 2010 is presented in the Fig. 3. The temperature of -5°C, below which there is a possibility of stoppage, is marked with a broken line. These delays can result from technological restrictions derived from frozen ground, delivery and laying the PVC pipe.



Source: Own study based on data from the weather station Wrocław Port Lotniczy, [www.wunderground.com]

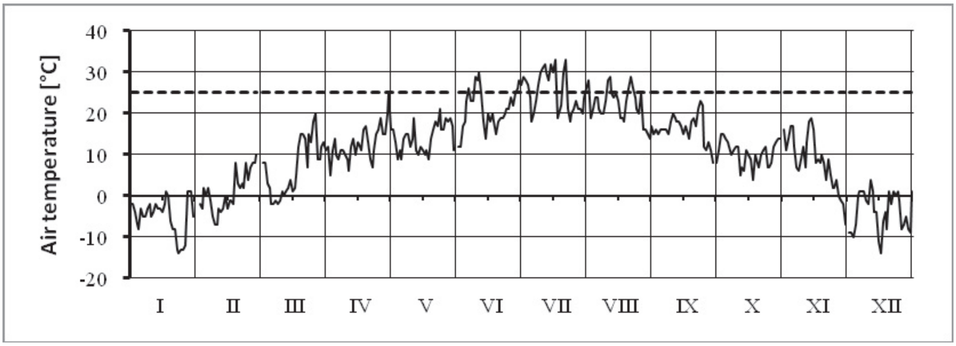
Fig. 3. The average air temperature in 2010 at weather station Wrocław Port Lotniczy

According to Fig. 3, if the earthworks, delivery and laying of the pipes are done in winter, this particular threat occurs quite often. Detailed data analysis pointed out that there were 36 days when work could not be done. The influence of air temperature on efficiency of work was analysed considering air temperature measured at 12.00 p.m.

Temperatures over +25°C are assumed to be detrimental to the course of the sewage systems construction – in Fig. 4. they exceed the dashed line.

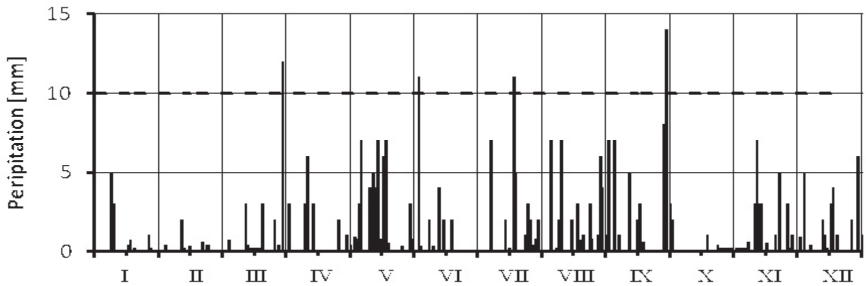
Fig. 4 shows that the threat of a decrease in work quality and efficiency as a result of high temperature occurs mainly in July during the analysed period. The detailed analysis points out that this problem concerns 23 days in total. However, the temperature exceeds 30°C only four times. At a temperature of 30°C, just as at -5°C, transporting and laying the pipes must cease because of changing material properties.

Precipitation in Wrocław occurs frequently in 2010, as shown in Fig. 5. However, precipitation exceeding 10 mm, which makes earthworks difficult to construct, occurs sporadically – four times.



Source: Own study based on data from the weather station Wrocław Port Lotniczy [www.wunderground.com.]

Fig. 4. Air temperature at 12.00 p.m. in 2010 at weather station Wrocław Port Lotniczy



Source: Own study based on data from the weather station Wrocław Port Lotniczy [www.wunderground.com]

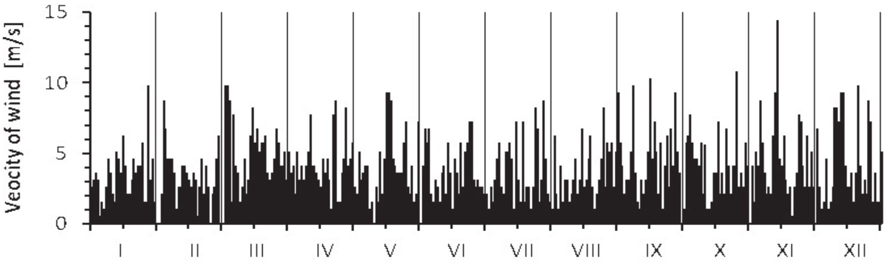
Fig. 5. Daily precipitation in 2010 at weather station Wrocław Port Lotniczy

In the analysis concerning the effect of wind on the construction continuity, the velocity of wind measured at 12.00 p.m. is taken into consideration (Fig. 6).

The velocity of wind that exceeds the permissible limits to continue the assembly and demolition work (equal to 10 m/s) was noted only three times during the 2010.

The presented data and analysis demonstrates that in 2010 there were all together sixty-six days during which construction was forbidden or impeded.

In risk analysis, the probability of adverse event occurrence is generally presented as a percentage value. This occurrence can also be considered as a predictable frequency of event during a year or a construction period. This approach seems to be the most suitable with reference to the assessment of weather conditions' influence.



Source: Own study based on data from the weather station Wrocław Port Lotniczy [www.wunderground.com]

Fig. 6. The velocity of wind at 12.00 p.m. in 2010
at weather station Wrocław Port Lotniczy

Since the classification of the frequency of adverse weather conditions during sewage systems construction has not yet been draw up, the proposed classification has been prepared based on data shown in Figs. 3 to 6. This is presented in Table 1. A three-point scale was used in the given proposal. Particular classifications are applied to risk evaluation very often [Pritchard, 2002].

Table 1. The classification of the frequency
of adverse weather conditions during sewage systems construction

Point scale	Descriptive scale
1 Small	The occurrence of adverse weather conditions ones a year/construction
2 Medium	The occurrence of adverse weather conditions up to 10 times a year/construction
3 Large	The occurrence of adverse weather conditions above 10 times a year/construction

On the basis of the above scale, it should be said that adverse weather conditions as a risk factors in pipeline construction is characterised by high frequency. However, if the risk analysis is done with regard to specific weather elements, this classification proves different. According to the established scale, high frequency equals adverse air temperature, and medium – precipitation, wind velocity.

The direct connection between occurrence of risk events and time of year has to be taken into consideration during risk evaluation. From figures 3 to 6 it appears that the most unfavorable time for construction is winter. This fact has to be considered in a construction schedule.

SUMMARY

When analysing the influence of weather on sewage systems construction, such threats as air temperature, precipitation and wind have to be taken into consideration. The risk resulting from the weather's impact is connected to its random character. This problem needs extensive identification regarding its strong relation to time and the cost of investment.

The analysis as conducted covers just one calendar year and one region. It has been demonstrated that adverse weather conditions during construction are a risk trigger. This risk trigger is marked by a high frequency of occurrence with special regard to air temperatures below -5°C and above 25°C. In order to verify these particular findings further research is needed, especially concerning a longer period of observation.

There is no possibility of affecting air temperature, precipitation or wind velocity. Taking into account that the frequency of such adverse weather occurrence is high, it has to be remembered that it does affect schedule risk. This particular risk can be minimised through an appropriate construction schedule, the introduction of building technology adjusted to high and low temperatures, and materials with higher endurance parameters.

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SPECYFIKACJE ISTOTNYCH WARUNKÓW ZAMÓWIENIA: a) Budowa kanalizacji sanitarnej w miejscowościach: Białobrzezie, Karczyn, Księginice Wielkie, Rakowice, Prusy, Górka Sobocka oraz Prusy wraz z przyłączeniem do oczyszczalni ścieków w Kondratowicach, 25 ss.; b) Zaprojektowanie i wykonanie robót budowlanych polegających na budowie kanalizacji sanitarnej oraz oczyszczalni ścieków w miejscowości Niechlów, 42 ss.;

c) Budowa kanalizacji sanitarnej w miejscowości Świba, 17 ss.; d) Kanalizacja sanitarna w Zagwiździu. Etap II, 18ss.; e) Budowa kanalizacji sanitarnej - tranzyt Tyniec Legnicki - Ruja oraz dla miejscowości Ruja w ramach projektu: *Sieć kanalizacji sanitarnej dla wsi Dzierżkowice oraz Ruja,* 46 ss.; f) Budowa kanalizacji sanitarnej w miejscowościach Mianowice i Olszowa w gminie Kępno w ramach projektu: *Uporządkowanie gospodarki wodno – ściekowej w aglomeracji Kępno,* 42 ss.; g) Budowa sieci kanalizacji sanitarnej na terenie gminy Marcinowice, 28 ss.

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