Revitalization of older building machines for road engineering applications

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Abstract – **The main question of the presented paper is revitalization of older building machines, especially used in repair of old and building of new roads. The state of Polish road net is commonly known, so any help in improving it should be taken into account. The problem seems to be of real importance, since new countries entering European Community must get ready to new regulations, new requirements, which some times can be very expensive. In the paper authors would like to share their experience in really cheap and cost effective way of preparing older building machines to the new situation.**

1. Introduction

The paper presents a simple and cost effective way of revitalization of very popular machines used in the road building and repairing like drilling rigs. The machines are very useful in sensitive to vibrations areas - like towns – were other methods of reinforcing of the ground is too dangerous to the environment. The drilling rigs are very expensive so every way extending their lives is worth mentioning.

Polish building firms have many older, but technically operating building machines, like cranes, bulldozers, pile-drivers or drilling rigs. Frequently, the machines are after restoration, rebuilding or even of changing their function (e.g. bulldozer can be converted into a drilling rig).

In spite of fact they are OK from technical point of view many of them can be used no longer on a building site; why? They simply do not fulfill requirements concerning recording of the performed process.

It can be most dramatically seen in the drilling rigs. Since the 'product' of such equipment is hidden deeply in the soil, checking it is not easy. Classical methods, like making test digging along the made pile are not only extremely expensive, but they ruin main advantage of this kind of technology: low interferences in the ground structure. Current investors require other method of proofing the correctness of the job – recording of main values describing the drilling and pile forming quality.

Apparently simplest method is to buy the full measuring, recording and data processing system from the manufacturer of the machine. There are two obstacles: very high price of such a service or – in the case of older equipment – lack of the system in the market.

Fortunately, another solution exists: to buy the system designed and made in Poland. Poland has some good manufacturers of drilling machines of really good quality [1], who are easily able to equip a drilling rig with proper set of sensors, converters and electrical wiring, and some electronic firms of good enough knowledge and experience to design and made proper digital data recorders and data processing systems. The proposed paper presents some examples of this kind 'face lifting' systems.

2. Recording v. quality

The owners of older drilling rigs should not treat the necessity of modernization of their machines only as an expensive must, on the contrary, the recording system gives them really powerful tool for improving the quality of their work and optimization of the used process. The recorder gives the technological engineer full information on drilling and pile forming process. He can almost 'view' the pile in the ground. The record of the drilling phase gives information on the structure of the ground, so it can be a kind of verification of the geological survey performed at the beginning of the designing of the underground structure. Pile forming phase gives precise information on the process, especially total volume of the pile and all other requested values. Probably the most interesting is visualization of the mean diameter of the pile. The system presents approximated shape of the pile, so the operator can recognize the density of the soil or even the presence of a cave or simply a pipe drilled through. Generally we can say the recording systems that were recently used in research work now are applied at the building site.

3. Example of revitalized drilling rig

3.1 The machine

The drilling machine presented in Fig 1 is over 30 years old, but in good technical condition.

It has been equipped with a new set of converters, digital recorder and modern data processing program. The data to record comprise depth, speed of a drilling head, inject pressure, volume and flow of inject, rotary speed.

Fig. 1. The drilling rig

The machine must be equipped with a set of industrial sensors and converters that are ale to work in hard environmental conditions on a building site. The sensors set is the source of primary data like depth increment, rotary speed of drilling head, pressure and volume of the inject. The primary data are the base of finding the secondary ones, like drilling head speed or inject flow.

3.2 Measuring and recording system

Besides the sensors set, the device consists of four functional parts: analogue to digital interface, operator's console and data recorder and data processing program (on a PC) [2]. The interface performs analogue data processing, like filtering, range limiting and a/d conversions. Operator's console makes it possible to control the system and to display taken values. Recorder stores the values in its memory for further processing. After recording, the stored data is transferred via infrared communication channel to a PC or laptop in which raw data is processed into the form convenient for the operator. Usage of highly efficient LabView platform [3] resulted in user friendly, multilayer windows tool. It provides information on various level of precision: from concise report showing basic data required by investor up to detailed graphs and tables (in Excel format) for the engineers being in charge of technology of the process. Every data can be printed and/or further processed by a user for instance with Excel.

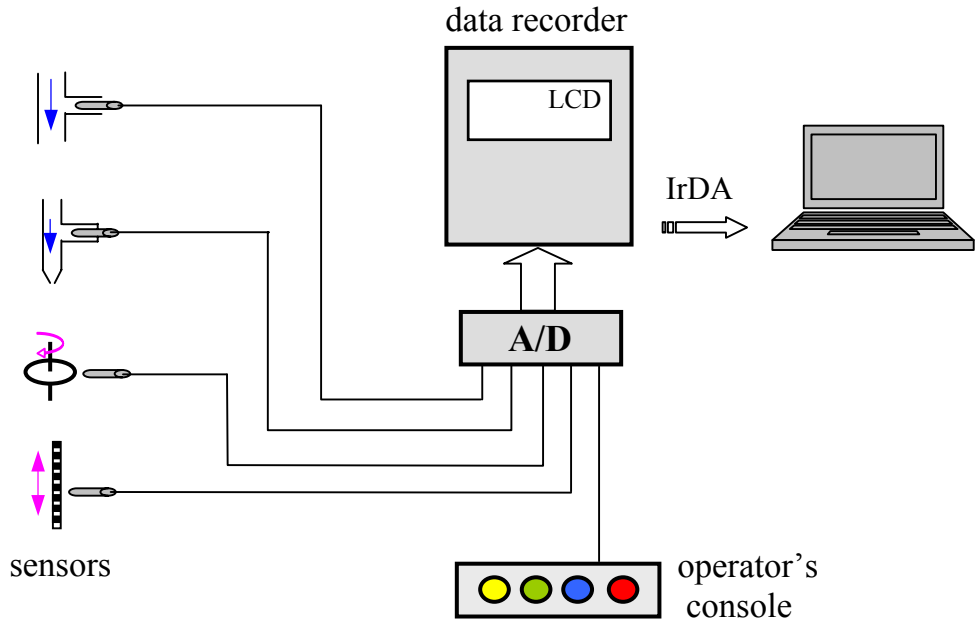


Fig. 2. Block scheme of measuring and recording system

Fig 3 presents the recording device and control panel in operator's cabin. The recording device has a display that shows the current measurements results and performs interactive dialog with operator while changing the mode of operation. The interactive way of controlling the device makes the process user's friendly, which is required in small cabin room, in heavy work conditions and in the case of not highly educated operator. In such circumstances, there is no good to apply sophisticated way of controlling the drilling process, for instance with full keyboard. In our case operator has only four keys and changing menu on the display to make all orders to the system.

Fig. 3. The system in operator's cabin

The recording device can be easily taken out from the cabin and carried to an office. Since the communication with the device is performed via IrDA channel, downloading data to a PC or a laptop could be done either in the cabin or in the office.

Transmission is made in fixed format.
First 36 bytes (3 records) comprise the header of the data file. There are identity information and scaling factors, that will be attached to any data file of forming process of every pile. The header format is presented in Table1.

Table 1: Data file header

Order	Size (bytes)	Variable type	Variable	Notes
0	2	uint16	fileVersion	
2	2	uint16	softVersion	
4	2	uint16	serialNo	Recorder serial number
6	4	uint32	recordCnt	Number of records
10	1	uint8	pumpAddr	Pomp address
11	1	uint8	recTimeout	Recording span [s]
12	4	float	depthFactor	
16	4	float	rotationFactor	
20	4	float	pressureFactor	
24	4	float	volumeFactor	
28	8	-	N.U.	

After transmission the header is separated from the data, and the data are divided on parts concerning particular piles. At the beginning the events concerning the pile are defined.

Table 2: Events

Type	Description
1	Power on
2	Start a new pile
3	Stop
4	Restart
5	Power off
6	Memory clearing
7	System reset

Every event is recorded in the event record, that format is presented in Table3. The pile comprises precise date and time of an event and pile number (written in two bytes (PileH and pileL)).

Table 3: Event data record

1	2	3	4	5	6	7	8	9	10	11	12
type	year	month	day	hour	minute	seconds	pileH	pileL	n.u.	n.u.	n.u.

After occurrence of event of type 2 or 4 (accordingly to the Table2) so after new pile or after restart of the recorder, result data are read from result records that comprise measured values taken during forming a particular pile. Result record format is presented in Table 4. There are 5 values of 2 bytes length.

Table 4: Measured data record

1	2	3	4	5	6	7	8	9	10	11	12
type	w1_h	w1_l	w2_h	w2_l	w3_h	w3_l	w4_h	w4_l	w5_h	w5_l	n.u.

After dividing of the data and ordering them for every pile, a new data file is generated to which the header is attached again. These files are used in a PC to visualization and storing in computers hard disc.

3.3 Visualization and storing measuring data

Downloaded data is processed with a program made in LabView platform. The platform gives almost infinite possibilities of converting raw data to a form most friendly to the user. All processed data can be sent as a files or printed as a hard copy.

Below some example screens of the data processing program are presented.

Fig 4 shows home screen of the program. This screen displays pile number and the history of its forming in shape of events list occurring during the forming process. Virtual buttons make it possible to choose required function of the program. There are also fields to type in required information on the localization, conditions and any other useful notes concerning the building site.

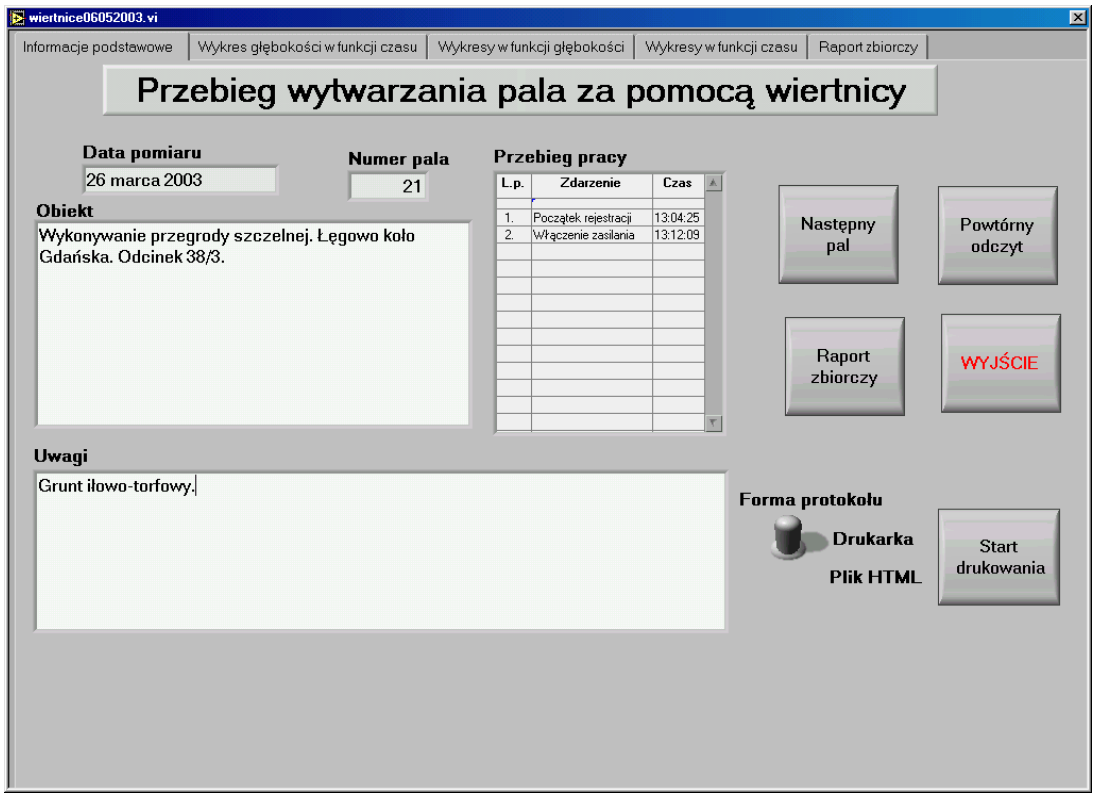


Fig. 4. First screen of the LabView program

One of these functions is presented in Fig.5 shows a recorded process of drilling and forming small pile used as a element of tight wall along a road in a flooded area. Besides natural functions of time, LabView makes it possible to convert a function of time into function of depth. Fig.6. presents some values converted in this way. Most interesting function of this kind is approximated diameter of a pile as a function of depth. This gives an apparent shape of the pile in the ground, showing such unpleasant cases as drilling through a cave or even a pipe.

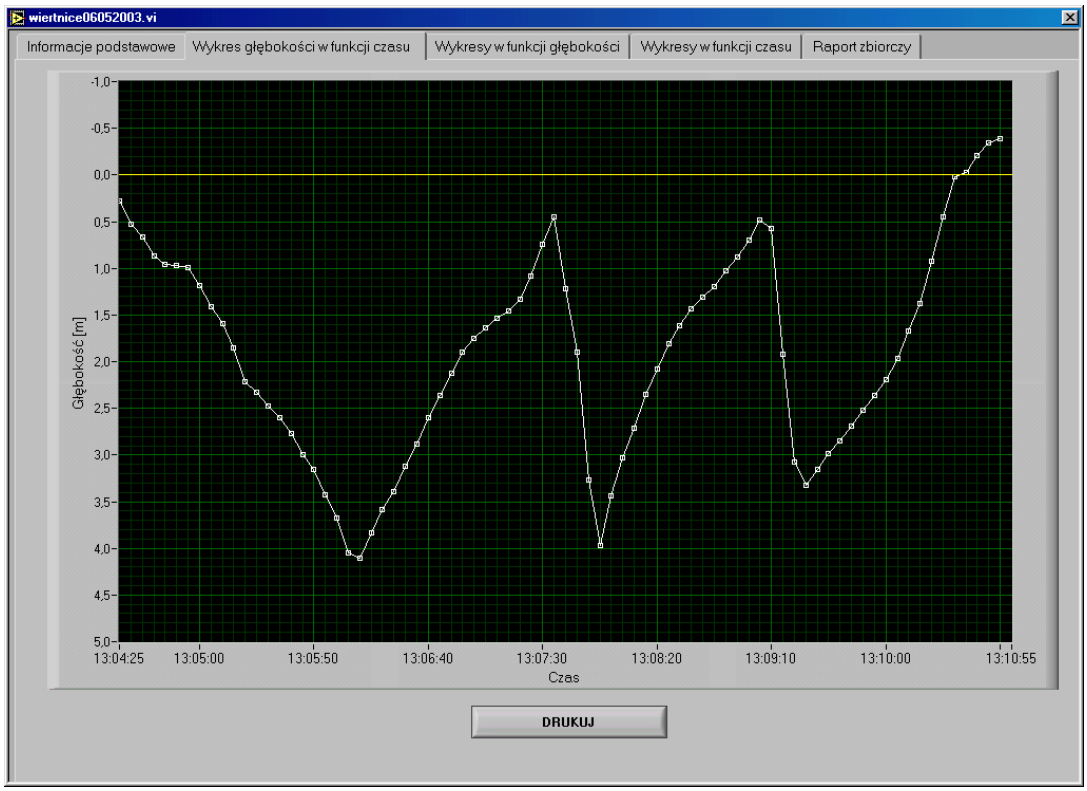


Fig. 5. Depth as a function of time

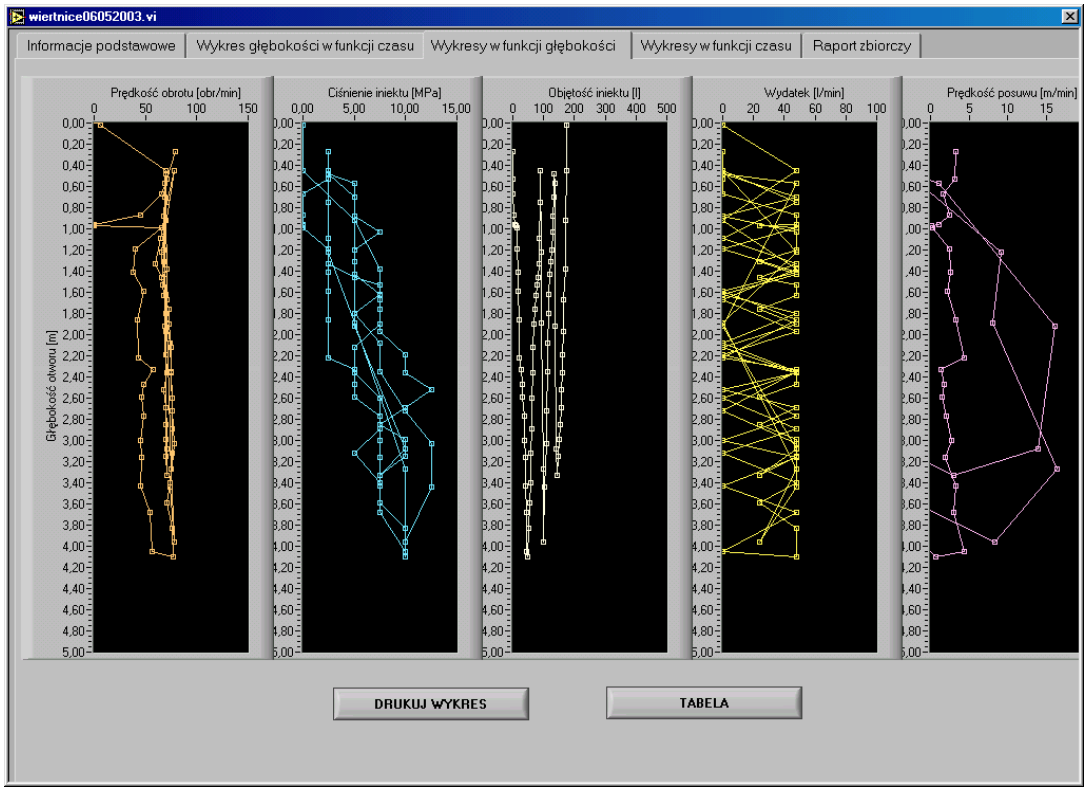


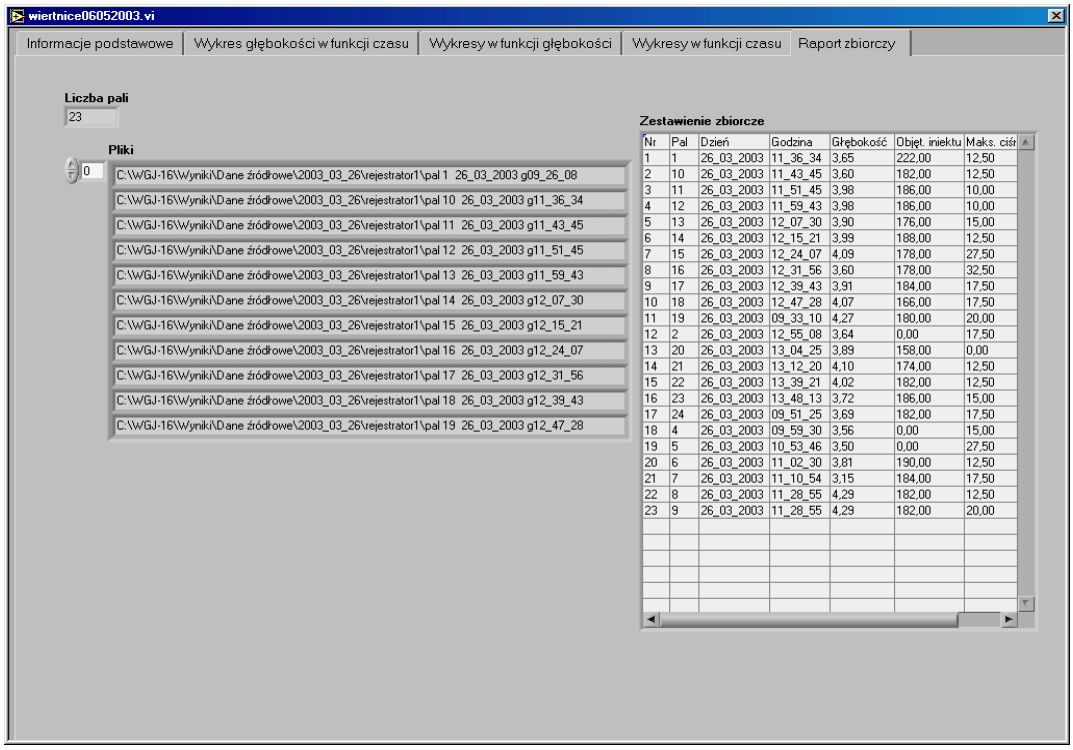
Fig. 6. Some values as functions of depth

Time functions presented in Fig.5 and 6 are ere excellent for printed extended report, but experienced engineer will extract from Fig.7, presenting all parameters in the function of time.

Fig. 7. All recorded values presented as functions of time

This panel has various useful tools, like zoom, filters or averaging.

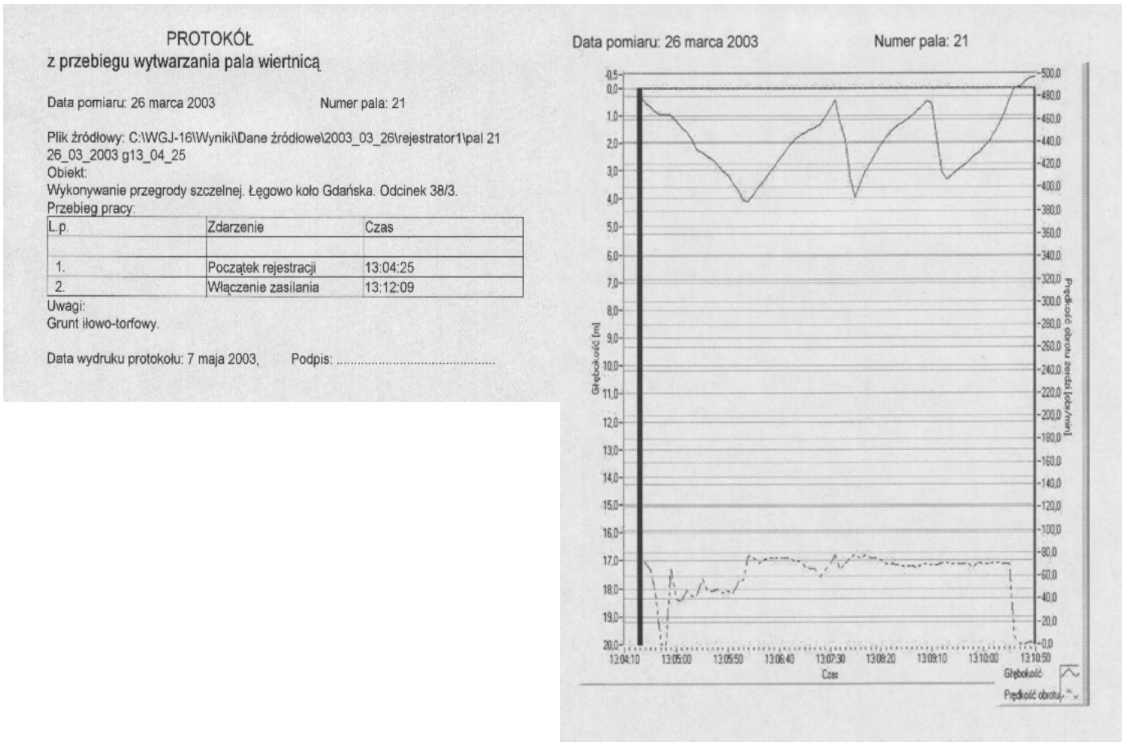
Due to the number of piles, detailed reports are rarely printed; more often common daily reports are applied. This kind of report is presented in Fig.8.



Nr	Pal	Dzień	Godzina	Głębokość	Objęt. iniektu	Maks. ciśn
1	1	26_03_2003	11_36_34	3,65	222,00	12,50
2	10	26_03_2003	11_43_45	3,60	182,00	12,50
3	11	26_03_2003	11_51_45	3,98	186,00	10,00
4	12	26_03_2003	11_59_43	3,98	186,00	10,00
5	13	26_03_2003	12_07_30	3,90	176,00	15,00
6	14	26_03_2003	12_15_21	3,99	188,00	12,50
7	15	26_03_2003	12_24_07	4,09	178,00	27,50
8	16	26_03_2003	12_31_56	3,60	178,00	32,50
9	17	26_03_2003	12_39_43	3,91	184,00	17,50
10	18	26_03_2003	12_47_28	4,07	166,00	17,50
11	19	26_03_2003	09_33_10	4,27	180,00	20,00
12	2	26_03_2003	12_55_08	3,64	0,00	17,50
13	20	26_03_2003	13_04_25	3,89	158,00	0,00
14	21	26_03_2003	13_12_20	4,10	174,00	12,50
15	22	26_03_2003	13_39_21	4,02	182,00	12,50
16	23	26_03_2003	13_48_13	3,72	186,00	15,00
17	24	26_03_2003	09_51_25	3,69	182,00	17,50
18	4	26_03_2003	09_59_30	3,56	0,00	15,00
19	5	26_03_2003	10_53_46	3,50	0,00	27,50
20	6	26_03_2003	11_02_30	3,81	190,00	12,50
21	7	26_03_2003	11_10_54	3,15	184,00	17,50
22	8	26_03_2003	11_28_55	4,29	182,00	12,50
23	9	26_03_2003	11_28_55	4,29	182,00	20,00

Fig. 8. Example of printed basic report of all piles made during a period of time

More detailed information can be printed in individual report, presented in Fig.9.



PROTOKÓŁ
z przebiegu wytwarzania pala wiertnicą

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Przebieg pracy:

L.p.	Zdarzenie	Czas
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2.	Włączenie zasilania	13:12:09

Uwagi:
Grunt iłowo-torfowy.

Data wydruku protokołu: 7 maja 2003, Podpis: .....

Fig.9. Example pages of individual reports

Reporting and data storing presented above give precise monitoring of production process, resulting in obtaining high quality with old machines. And this increases not only investor's trust but economical effectiveness of the building firm as well.

4. Conclusions:

1. Revitalization of a building machine can be very cost effective mean of modernization of a road building or repairing firm.
2. Polish recording system can be much cheaper then its imported counterpart.
3. Both cases can lead to make Polish firms more competitive in coming up common market in European Community.

5. References

[1] Katalog maszyn i urządzeń, Przedsiębiorstwo Innowacyjno-Wdrożeniowe WAMET, Bydgoszcz 2002.
[2] LESIAK P., ŚWISULSKI D.: *Komputerowe technika pomiarowa w przykładach*, Agenda Wydawnicza PAK, Warszawa 2002.
[3] LabVIEW User Manual, National Instrument, Austin, July 2000.