Developing Models in the Study and the Traking of Mouvement of Buildings

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Abstract: *The development of measuring techniques has permitted and created the possibility to determine and put into evidence even the finest movements of a building or of land. Even so, the movement of some elements of a building are hard to determine because, while choosing the method or a model to determine the movement and deformations of buildings, the aprioric knowledge which refer to the type of movement, at the most probable moment when this happens are not known and are not taken into consideration or, in other cases, even impossible to determine. In this piece of work, the author proposes the usage of deformation models and gives examples of the use of these in the determination of a special type of building in Timisoara.*

1. Introduction

The development of measuring techniques has permitted and created the possibility to observe and emphasize the behaviour of the studied buildings. There are loads of clasification criterias of the methods of research and observation of buildings and land.

Taking this into consideration, there have been developed critearias have been made by types of deformations, types of equipments and place where the equipement is situated during the research.

By place of situation of equipement during the reasearch process there are 2 possibilities to determine the movement and deformation:

- ***physical methods:*** with the equipment inside the building; in this case the equipment move at the same time with the building so relative movements and deformations can be evaluated. This type of measurements can be done using mechanical methods, physical methods, electrical or electronically.

In this case there has to be a definite relative model, because there are no exterior points, having only relative movement determinations between the moved points on the same object. Taking into account different parameters, in this group we can find the following types of measurements of movements:

- linear movement and deformation measurements (levelling, horizontal movements) with the help of arrow amplifier or of the comparator with a line.
- the measurement of angular movements (rotations) with the help of clinometer with stick, clinometer with level, clinometer cu pendulum;
- the measurement of relative movements from sliding using vernier caliper or comparatorul with stick;
- the measurement of specific deformations with the help of tensometres and traductors tensometric electric, mecanichal, optico-mecanichal, pneumatic, fotoelastic or electroacustic;
- the measurement of movents, speeds, accelerations and dynamic deformations with the help of vibrometer, vibrograf, etc.;
- the measurement of expanding edges with the help of teledilatometer, micrometer of gap.

Physical methods are often used in the study of buildings in the conception and projection phase, and also in order to study the behaviour during constructions.

- ***geometric methods:*** in the case where the equipment is placed outside the building or of its influential area, the measurements will be linked to a network of fixed spots situated outside of the influential area of the factors that affect the building and the ground that it is situated on.

Through this process absolute values of the horizontal or vertical movement will be established. The topographic-geodesic methods belong to this category of determinations of movements and deformations.

2. Classic models for determining deformations

2.1. Cause and effect relationship

To determine the movement of some buildings or land surfaces, the local or regional, specially created and always updated using the most precise equipment, topographic-geodesic networks are used. **These procedures are some of the most precise and secure methods of following,** being a lot better than those ungeodesic or fotogrammetical or even satelating.

During the determination of a deformation, we will always find a cause that through a transmitting function will lead to the effect (figure 1) :

The transmitting function is expressed through mathematical relations, is part of the statistics category, we cannot be sure of what is going on just with a certain probability we can find a relationship. The effect is always the deformation, defined as a spatial modification.

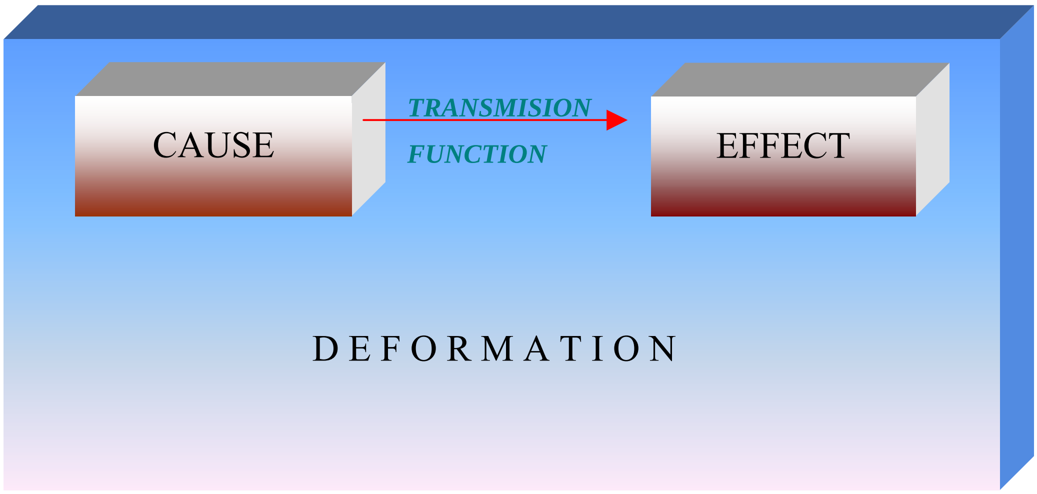

Fig. 1 The relation cause-effect

Taking into account the domain of use and the physical cause that provoke the deformation phenomenon, we can establish the following provoking cases of deformation and movement of constructions and land: tectonic conditioned movements, sliding phenomenon, diverse meteorological phenomenon, endogens causes, proper causes of each object as well as the action of man.

2.2. Aprioristic knowledge of a certain deformation model.

The role of geodesic tracking networks is to observe and determine whether or not movements or deformations to a certain building occur. Usually there is initial information of the movements that interest us or of movements critical to an object.

The precision and integrity of the apriorical knowledge on the behaviour of the building are differentiated, but the base parameters for a deformation model that must be taken into consideration are:

- representative points;
- the delimitation of the information domain;
- the evolution in time of the movements;
- the direction of the studied movements;
- size of the movement.

After every measuring cycle a different type of information model appears, that must be verified or modified. Often the aprioristic knowledge and every modification of the model influences the configuration of the network as well as the observation program, thus taking birth an interactive effect between measurements and model.

2.3. Discetisation in geometric domain

The number and the position of points in the tracking network is not made by rules. They must be found according to the specific domain of tracking. Thus, we must take into consideration two main problems:

- **choosing representative points**: in order to discretisate and object through points we must take care that the determination of these points does not constitute the final point of a tracking problem but only to draw some conclusions referring to the modification of an entire studied object.
- **delimitation of deformation influenced domain:** for most massive buildings, movements are not limited only to the building itself, but they extend to an entire area around the building. In order to find the deformation domain, we must always take into account the influential area of the movement around the studied objects. During every observation cycle an analysis of the stability of the chosen points must be done (figure 2).

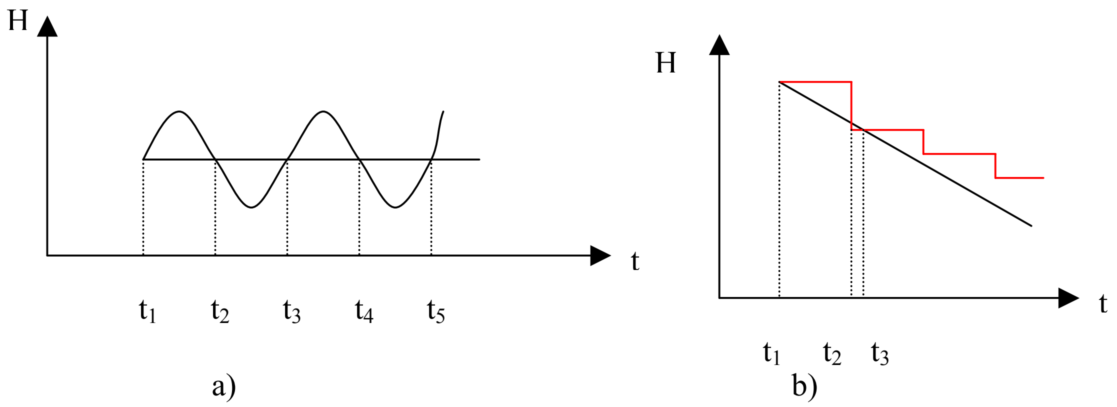

Fig. 2 Describes mouvements in time

In some situation like land slides or movements of the earths shell, where all points suffer movements greater or smaller, the knowing and comprehension of the moving status is a geodesic purpose. In some cases we cannot formulate a univocal and functional relationship between physical causes and geometric effect of the deformation, so the moving process is described in time and sometimes because of the positions of the reference points.

If in classic modeling, the dicretisation in geometric domain seems relevant, in cinematic view the dicretisation in time is more relevant. The description of observations in cinematic parameters makes obvious the difference between two fundamental possibilities:

- movement modeling as a time function;
- the modeling of movement as a function of time and place.

The limited number in time of geodesic measurements can hardly describe some complicated movements. (Figure 2 a and b).

3. Modern models for establishing deformations. Use of dynamic models in studying and tracking deformations.

These models establish deformations taking into account the generating causes. Dynamic models describe through mathematical relations the relationship between cause and effect. These models can be grouped in stochastic models and determinist models. An eloquent example of these models is given in the following diagram (figure 3):

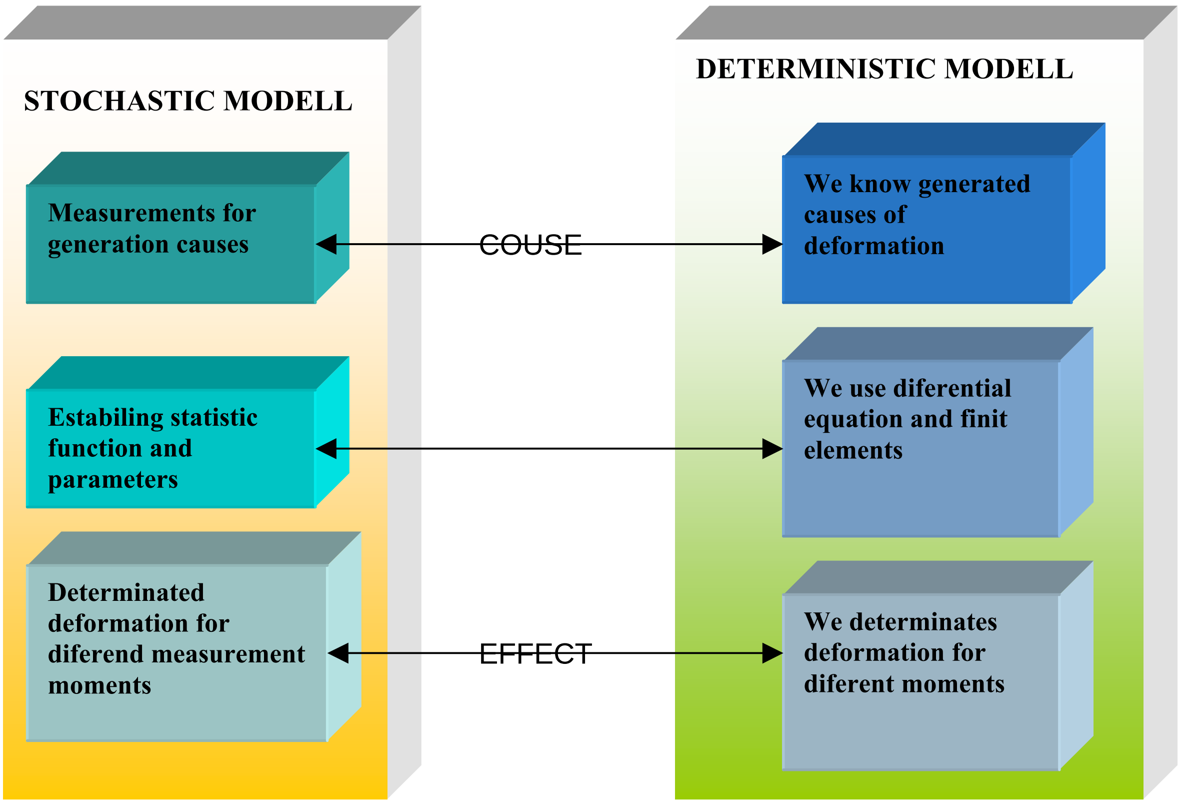

Fig. 3 Dinamic model

4. The use of dynamic models in determinating movements of the rail roads of transport of coal from cet south timisoara

The vehicle that runs on the route is a **"Vehicle for taking and staking coal"** with a frequency of 1200 t/h, type T 3214, having an arm 35 m long and weighing 460 tons.

The foundation of the running way is made of prefabricated cement with metal, having another layer of cement 32 cm thick to fix the rail to the foundation having the rails embedded 70-80 cm with small variations.

The foundation is 50 cm wide on the top part, and the bootom part 125 cm, being at the same level with the ground and in some parts underneeth this level, being covered along by coal powder.

In the following image I have prezented the creating mode of a running rail.

Fig. 4 The rail roads and machine

Acros rail roads I executed 5 (five) geotechnical drills have been made along the rail: F1, F2, F3, F4, F5 and 10 (ten) easy and dynamic penetrations: PDU1, PDU2,..., PDU10.

Seismically talking, the building is set in area "D", with T_c=1,0 sec, and K_s=0,16, extract from the seismic zone map of Romania found in Normative P 100-92, for the design of antiseismic rezidential, cultural, agrozootechnic and industrial buidings.

The foundation land is made from a succecion of sandy grounds that have the density I_D = 0,47 ... 0,56. These values of the density correspond to a state of mid density of foundation.

After the topo-geodesic measurements done, we have established the difference between rail A and B, presented in table 1 as maximal and minimal values.

Tabelul 1 – Valoriel minimale şi maximale orizontale şi verticale ale celor doua fire se şină

Measurement cicle	Line	**HORISONTAL DEVIANCE mm**		**VERTICAL DEVIANCE mm**		**ECARTAMENT DEVIANCE Mm**
		Int.	Ext.	Min.	Max.	
I	A	**-45**	**+30**	**-14**	**-169**	**-36**
	B	**-36**	**+28**	**-14**	**-196**	**+15**
II	A	**-54**	**+43**	**-14**	**-177**	**-40**
	B	**-41**	**+33**	**-14**	**-213**	**+19**
III	A	**-58**	**+46**	**-14**	**-182**	**-40**
	B	**-46**	**+37**	**-14**	**-215**	**+22**

The representation of the leveling on PDU was realized in figure 5.

On the base of the determinations done, some statistics have been made in figure 6, as well as the determination of the instant leveling in figure 7.

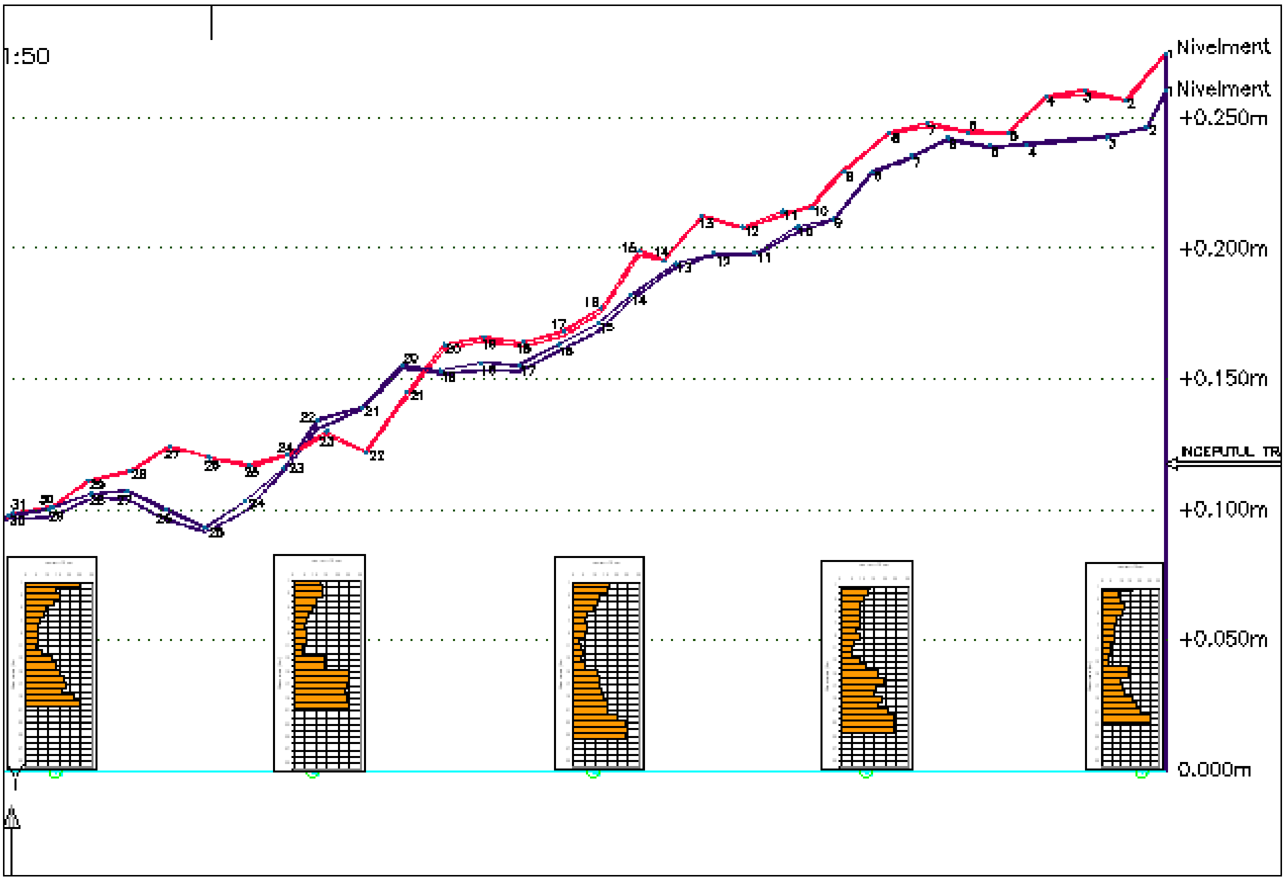

Fig. 5 Settlements reprezentation with PDU

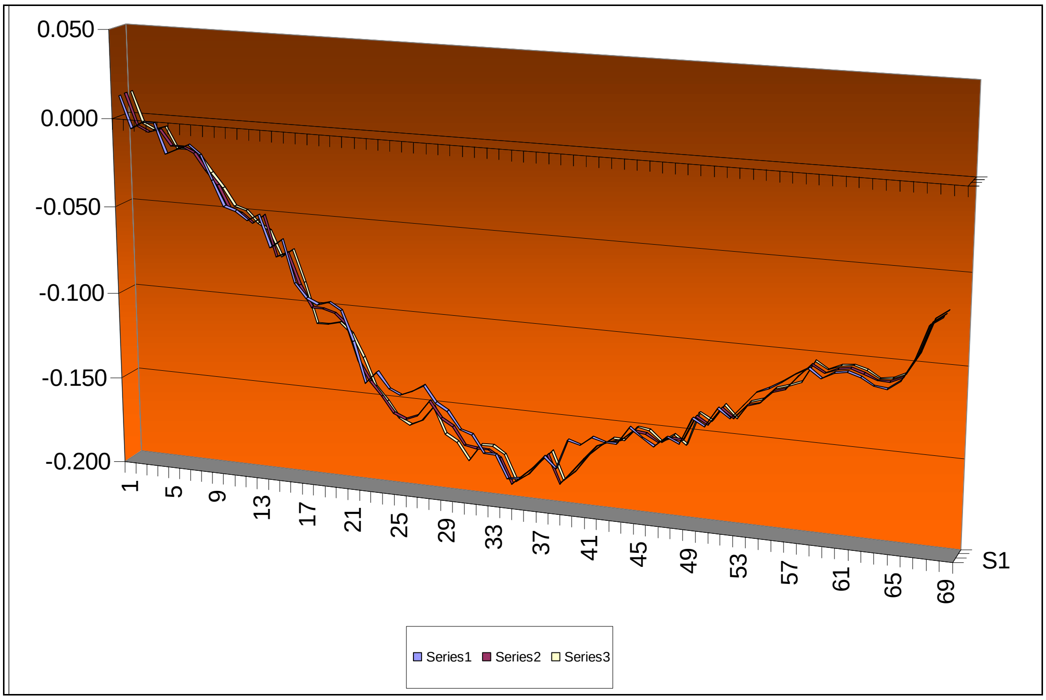

Fig. 6 Statistical representation of settlemnts of A track

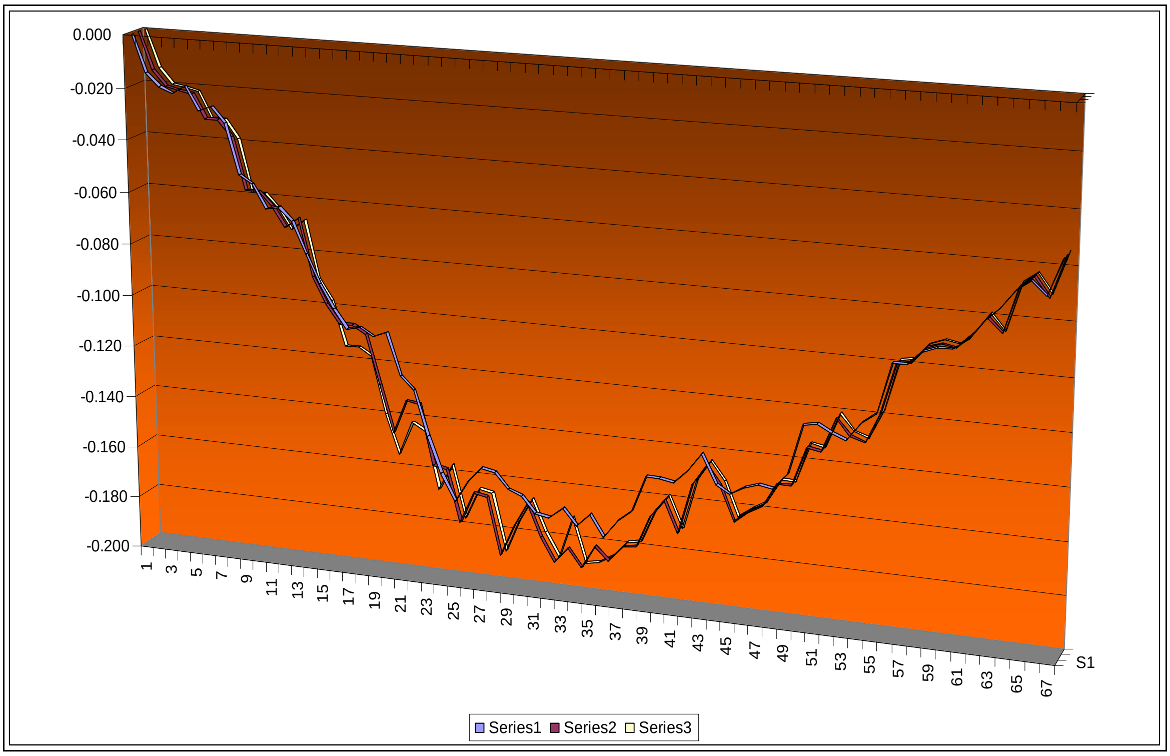

Fig. 7 Statistical representation of settlemnts of B track

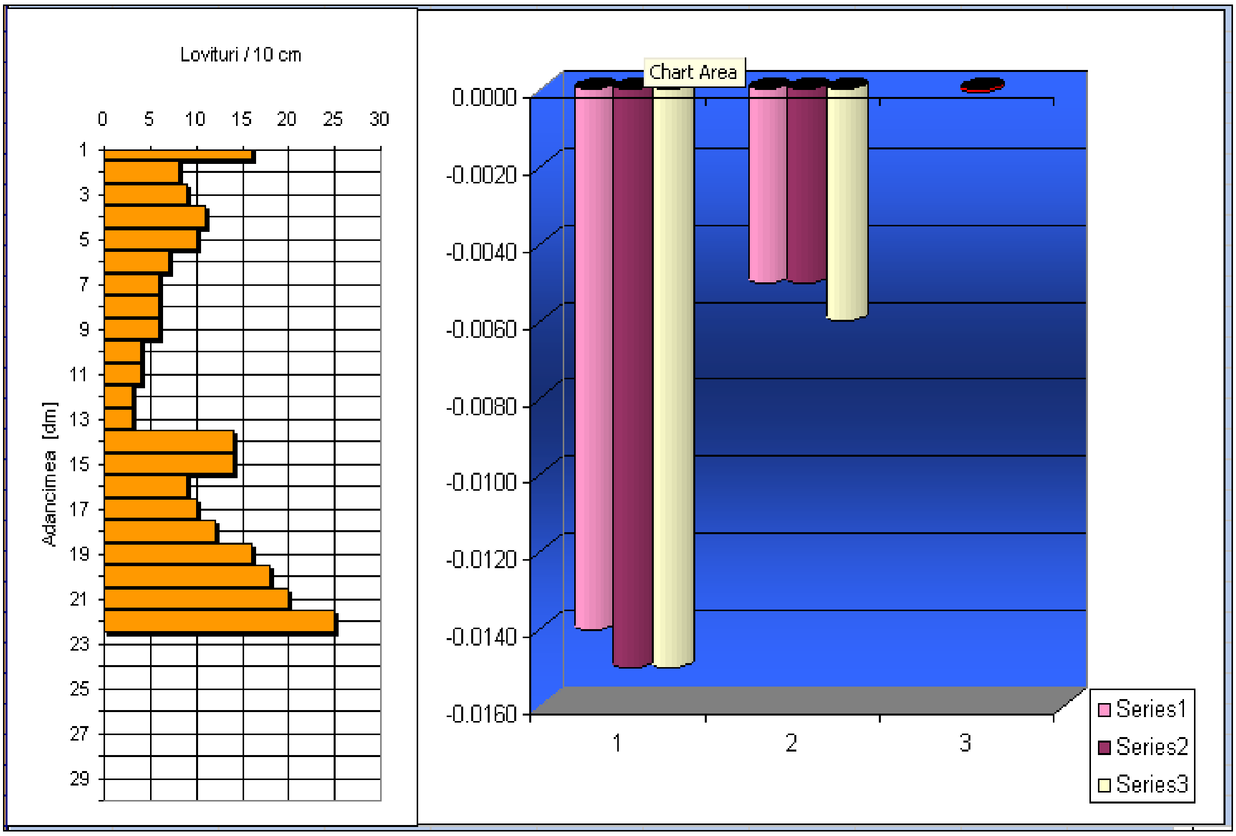

Fig. 8 Representation of instant settlements in the right of SS PDU

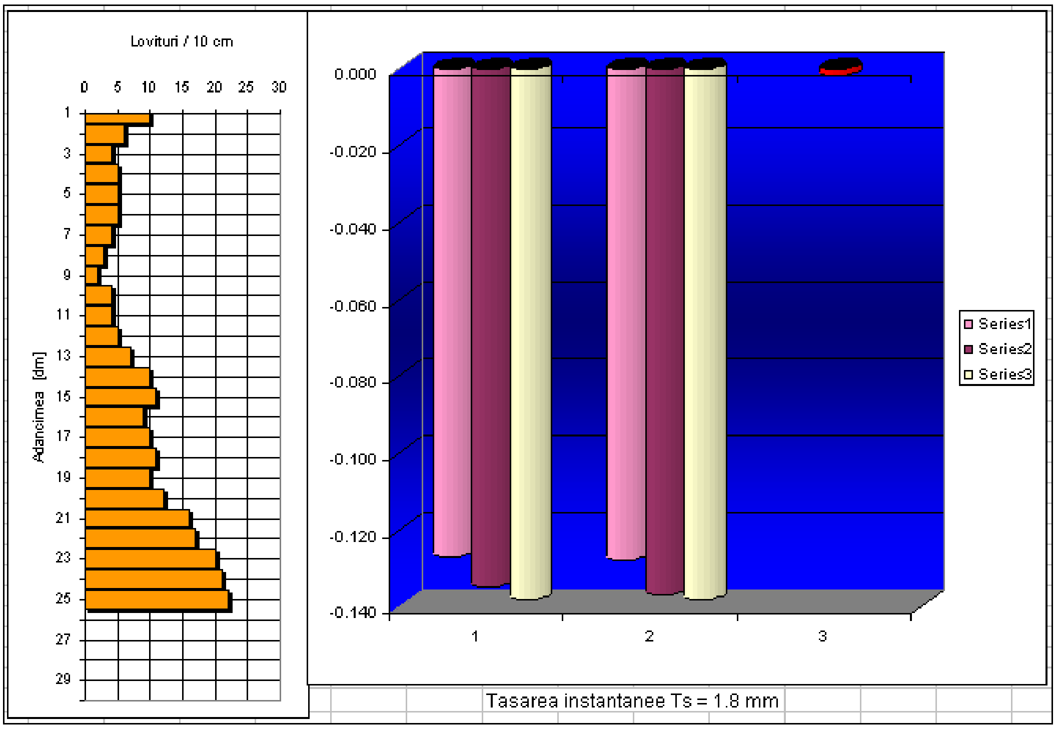

Fig. 9 Representation of instant settlements in the right of SS PDU

5. Conclusion

The topographical methods used for determining vertical and horisontal mouvements are the are the most accurated methods for evaluated real deformations and inducted security exploatation.

To shown the subsides I used an representation model with setlements diagrams thru PDU tests.

The tests executed have shown the necessity of an modern approach based on different quality reports according to the precision factors evaluated and characteristical elements of the error ellipsis for the monitoring network points.

6. References

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