ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

FACULTY OF ENGINEERING HUNEDOARA – 1970

ANNALS of Faculty Engineering Hunedoara
International Journal of Engineering

fascicule 1
[January - March]
TOME II [2009]

ACTA TECHNICA CORVINIENSIS
– Bulletin of Engineering

FACULTY OF ENGINEERING HUNEDOARA
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Scientific supplement of
ANNALS of FACULTY ENGINEERING HUNEDOARA
– INTERNATIONAL JOURNAL of ENGINEERING
ISSN: 1584-2665 [print]
ISSN: 1584-2673 [CD-Rom]

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CONTENT

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FASCICULE 1 [JANUARY – MARCH]. TOME II. 2009

Abstract:
The wide spreading of computer networks and of the Internet will result in the necessity of developing distributed software, which is supposed to work under these media, and to turn into account the advantages of a distributed and concurrent environment. The implementation of such techniques can be done in any programming language allowing a distributed programming, such as Java, by means of RMI. Nevertheless, for the study of such techniques, for the analysis of their completeness and for their evaluation, it is easier and more efficient to implement the techniques under certain distributed media, which offer various facilities, such as NetLogo.
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The purpose of this paper is to develop an integration theory for these functions, with respect to a semigroup valued measure, using families of pseudosubmeasure and the associated topological rings.
AMS Subject Classification Code (2000):28A20, 28B15

Abstract:
In this paper we emphasize the notion of skew-evolution semiflows, considered a generalization of semigroups, evolution operators and skew-product semiflows, which arise in the stability theory. We define and characterize a particular case of trichotomy, called the H-trichotomy, which is useful in describing the behaviors of the solution of evolution equations. We emphasize the fact that the trichtomy, introduced in finite dimensions in [1] and [5], is a natural generalization of dichotomy. A similar concept for stability was studied for evolution operators in [2]. This paper considers also other asymptotic properties, as exponential growth and decay, stability and instability.
Mathematics Subject Classification: 34D09

Abstract:
This paper presents a study on fatigue performance of adhesive/rivets joints in an aluminum structures. Hybrid joints were shown to have greater strength, stiffness and fatigue life in comparison to adhesive joints. The results from fatigue tests confirm the static tests made on the same type of test samples.

Abstract:
The operation of separation of seeds is realized due to the vibration of sieve. The operation of separation is analyzed with the help of the particle model which executes vibration motions on a plane with friction. There are analyzed displacement regimes of particle by forward sliding and back sliding without detachment. Because of velocity discontinuity which appears as consequence of friction between particle and plan or of dropping on plan in the case of detachment, vibro-impact motion regimes appear. That is why, for the study of motion, there are applied the specific methods, concerning the vibro-impact regimes.

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BULLETIN OF ENGINEERING

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[3.] TEODORA PETRAS, [4.] MANUELA PĂNOIU

DISCSP-NETLOGO-EDUCATIONAL SOFTWARE MEANT FOR THE IMPLEMENTATION AND EVALUATION OF THE ASYNCHRONOUS SEARCH TECHNIQUES IN NETLOGO

Abstract:
The wide spreading of computer networks and of the Internet will result in the necessity of developing distributed software, which is supposed to work under these media, and to turn into account the advantages of a distributed and concurrent environment. The implementation of such techniques can be done in any programming language allowing a distributed programming, such as Java, by means of RMI. Nevertheless, for the study of such techniques, for the analysis of their completeness and for their evaluation, it is easier and more efficient to implement the techniques under certain distributed media, which offer various facilities, such as NetLogo.
In this article there is proposed a general implementation and evaluation model in NetLogo for the asynchronous techniques. This model, we believe, will allow the use of the NetLogo environment as a basic simulator for the study of asynchronous search techniques. This model can also be used for building educational software which can be used when studying the asynchronous search techniques with agents.

Keywords:
artificial intelligence, distributed programming, constraints, agents

INTRODUCTION

The adjustment of the software technologies to the distributed equipment represents an important challenge for the next years. The wide spreading of computer networks and of the Internet will result in the necessity of developing distributed software, which is supposed to work under these media, and to turn into account the advantages of a distributed and concurrent environment.
The constraint programming is a model of the software technologies, used to describe and solve large classes of problems as, for instance, searching problems, combinatorial problems, planning problems, etc. A large variety of problems in the A.I field and other domains specific to computer sciences could be regarded as a special case of constraint programming. Lately, the A.I community showed a greater interest towards the distributed problems that are solvable through modeling by constraints and agents. The idea of sharing various parts of the problem between agents that act independently and that collaborate between them using messages, in the prospective of gaining the solution, proved itself useful, as it conducted to obtaining a new modeling type called Distributed Constraint Satisfaction Problem(DCSP) [3,4].
There exist complete asynchronous searching techniques for solving the DCSP, such as the ABT (Asynchronous Backtracking) and DisDB

(Distributed Dynamic Backtracking) [1,3,4]. There is also the AWCS (Asynchronous Weak-Commitment Search) [3,4] algorithm which records all the nogood values. The ABT algorithm has also been generalized by presenting a unifying framework, called ABT kernel [1]. From this kernel two major techniques ABT and DisDB can be obtained. The implementation of asynchronous search techniques based on distributed constraints can be done in any programming language allowing a distributed programming, such as Java, C, C++ or other. Nevertheless, for the study of such techniques, for their analysis and evaluation, it is easier and more efficient to implement the techniques under certain distributed environment, which offer various facilities, such as NetLogo [8], [5,6,7].

NetLogo, is a programmable modelling environment, which canl be used for simulating certain natural and social phenomena. It offers a collection of complex modelling systems, developed in time. The models could give instructions to hundreds or thousands of independent agents which could all operate in parallel. NetLogo is the next generation in a series of modeling languages with agents that began with StarLogo [8]. It is an environment written entirely in Java, therefore it can be installed and activated on most of the important platforms (Windows, Unix) .

The aim of this article is to introduce an as general as possible model of implementation and evaluation for the asynchronous search techniques, in two possible cases: synchronous and asynchronous. This model can be used in the study of agents behavior in several situations, like the priority order of the agents, the synchronous and asynchronous case, leading, therefore, to identifying possible enhancements of the performances of asynchronous search techniques. This model can also be used in creating some educational software to be used in the study of asynchronous search techniques with agents by the students. For this purpose we have chosen the NetLogo environment, which is a programmable environment [8].

We will see the way one can simulate agents, how constraints can be implemented, how various measurement units for asynchronous techniques in the ABT and AWCS family can be implemented. Unfortunately, there is no distributed environment dedicated to modeling with distributed constraints, all the existent media are general ones, with more general targets. The implementation of agents and constraints implies a certain calculation effort, bigger or smaller, according to the performances of the given environment. The use of this support for educational software can ease the actual implementation of asynchronous techniques. This educational software ca be approached by students on the site [7]

THE IMPLEMENTATION OF APPLICATIONS WITH AGENTS IN NETLOGO

THE NETLOGO OBJECTS

The NetLogo world is made of agents. Each agent carries out a task, all the agents execute simultaneously and concurrently. The NetLogo language allows three types of agents: turtles, patches and the observer. The turtle type objects are agents that can move on in the NetLogo world, which is bidimensional and is divided in a grid of patches. Each patch is a square piece that represents the support on which turtle objects can move. The observer doesn't have a fixed location, it can be imagined as being situated above the world of turtles and patches objects. The observer can be regarded as a system agent that can initiate various operations for the other agents. NetLogo uses commands and reporters to tell the agents what to do (the commands and the reporters are NetLogo primitives). The commands are actions for the agents, but the reporters return certain values.

NetLogo allows the defining of different "types" of turtles, called breeds. Once a breed has been defined, we ca establish a different behavior for it. Those objects are used for simulating various objects existent in DCSP problems. For example, the agents from the n queens problem can be defined using breed type objects (a construction of type breeds [queens]). That thing allows the fixing of a special behavior for each agent-queen. When breed type objects are defined, automatically there is created an agentset for each breed.

A very important problem is related to the way of execution of an agent's attached procedures, agent simulated using breed type objects. The DCSP applications require the simultaneous and asynchronous execution of the code attached to each agent. That thing is possible in NetLogo *because the commands are executed asynchronously, each object of the "turtle" type or "patch" executes its list of commands as soon as possible. There are two ways of performing each agent's commands. The first one consists in "aligning" the commands executed by each turtle, through placing all the commands in the ask block. That way, the executed steps won't be synchronized. In exchange, using an ask command for each operation, a synchronization of all the operations performed by the agents will be obtained, each turtle will wait until the other turtle objects will finish their computations.*

MODELLING AND IMPLEMENTING THE PROCESS OF THE AGENTS' EXECUTION

In this paragraph there is presented a solution of modelling and implementation for the existing agents' process of execution in the case of the asynchronous search techniques. That modelling, applying a technique for detecting the algorithms' termination, allows us to obtain two multi-agent systems that can be applied for implementing and evaluating the most outstanding asynchronous search techniques. That modelling ca be used also for implementing most of the asynchronous search techniques, such as those from the AWCS family [3,4], ABT family [1], DisDB [1]. The modelling proposed in this paragraph allows the obtaining of implementations for asynchronous search techniques derived versions in which various situations that exist in reality are simulated: delays in supplying the messages, message management, etc. Implementation examples for those techniques can be found on the NetLogo site ([6] and in [5, 7]. Any implementation for the asynchronous search techniques supposes the following two steps:

- *programming the agents such as they run concurrently*
- *designing the user interface.*

The modelling of the agents' execution process will be structured on two levels, corresponding to the two stages of implementation. The definition of the way in which asynchronous techniques will be programmed such that the agents to run concurrently and asynchronous will be the internal level of the model. The second level refers to the way of representing the NetLogo application, and is the exterior level. The first aspect will be treated and represented using turtle type objects. The second aspect (that is connected with the problem to be solved) refers to the way of interacting with the user, the user interface. Regarding that aspect, NetLogo offers patches type objects de tip and various graphical controls. Anyway, patches type objects will allow the simulation of the application's interface.

AGENTS' SIMULATION AND INITIALIZATION

First of all, the agents are represented by the breed type objects (as we saw in the previous paragraph, those are of the turtles type). In there fig. 1 is presented the way the agents are defined together with the global data structures proprietary to the agents.

breeds *[agents]*
globals *[variables that simulate the memory shared by all the agents]*
agent-own *[message-queue current-view nogoods messages-received_ok messages-received_nogood]*
;message-queue contains the received messages.
;current-view is a list indexed on the agent's number, of the form [v_0 v_1 v_2...], v_i = -1 if we don't know the value o that agent.
;nogoods is the list of inconsistent positions [0 1 1 0 ...] where 0 is a good position, and 1 is inconsistent.
;messages-received_ok and messages-received_nogood are variables that count the number of ok and nogood messages received by an agent.

Figure 1. Agents' definition in the case of the asynchronous search techniques

The initialization of the agents supposes building the agents and initialization of the necessary data structures for the agents' operation. For initialization there is proposed an initialization procedure for each agent, procedure presented in figure 2 (the procedure will be called setup).

```
to setup-agenţii // the agents defined with the breeds [agenţi] are used
; the num-agents agents are created and are initialized
 create-custom-agenţi num-agents [
  set messages-received_ok 0
  set current-view get-list num-agents -1
  set nogoods get-list num-agents 0
  set message-queue []
  ...
  ]
end
```

Figure 2. The initialization procedure for each agent-setup

Typically the num-agents required for the running of the asynchronous search technique are built and the most important data structures are initialized.

REPRESENTATION AND MANIPULATION OF THE MESSAGES

Any asynchronous search technique is based on the use by the agents of some messages for communicating various information needed for obtaining the solution. The manipulation of the messages supposes first of all message representation. This thing can be achieved in Netlogo by using some indexed lists. To represent complex messages that contain many information, Netlogo allows the use of lists of lists. The way of representation of the main messages encountered at the asynchronous search techniques is presented as follows:

- ***(list** "ok" agent value agent_costs) – messages of the ok or info type;*
- ***(list** "nogood" agent current-view agent_costs) - messages of the nogood or back type;*
- ***(list** "addl" $agent_1$ $agent_2$ agent_costs)*
- ***(list** "removel" $agent_1$ $agent_2$ agent_costs)*

DEFINITION AND REPRESENTATION OF THE INTERFACE

As concerning the interface part, it can be used for the graphical representation of the DCSP problem's objects (queens or nodes) of the patch type. It is recommended to create an initialization procedure for the display surface where the agents' values will be displayed.

For the case of the graph coloring problem, the representation of nodes and links is done in the same way [5,6,7]. The two initialization procedures will be attached (using a setup procedure) to a start button of the application, as in the sequence in figure 3.

```
to setup
 ca
 setup-patches
 setup-nodes
 ask nodes [procedura_inițializare]
end
```

Figure 3. Setup procedure of the NetLogo application

IMPLEMENTATION AND EVALUATION METHODOLOGY FOR THE ASYNCHRONOUS TECHNIQUES

In this paragraph there is presented a methodology of implementation for the asynchronous search techniques in NetLogo, using the model presented in the previous paragraphs 2. That methodology supposes the identification of the application's objects, building the agents and of the working surface for the application. There are also built the communication channels between agents, routines for message handling and the main program of the application. The methodology contains more elements specific to NetLogo necessary for finalizing the implementation of the asynchronous search techniques. Any implementation based on the presented model, will require the following of the next steps.

P1. Defining the DCSP application's objects.

Starting from the type of problem that is implemented, it will be defined the objects of the DCSP application. In figure 4 is presented a solution of agents modelling and also for the working surface of th eapplication. As in the modeling examples are proposed breeds [queens] (for modeling the agents associated to the queens from the problem of the n queens) or breeds [vertices] (for modeling the agents associated to each node from the problem of graph coloring).

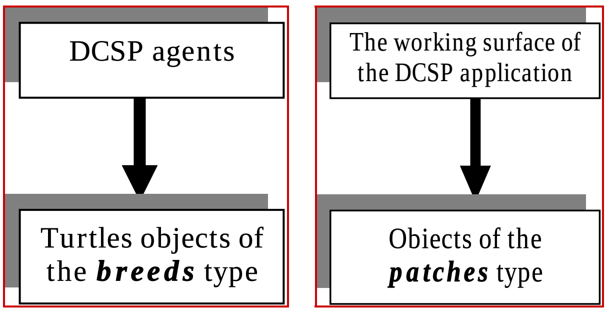
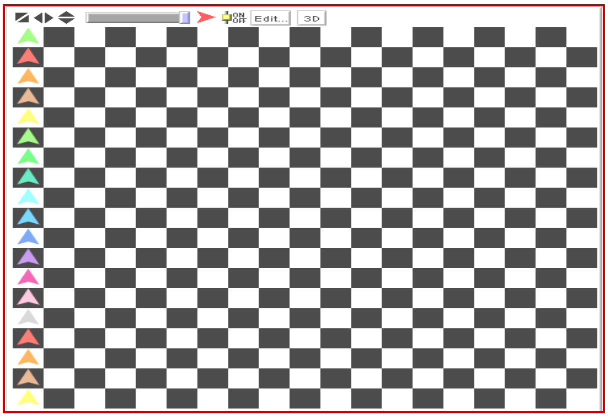
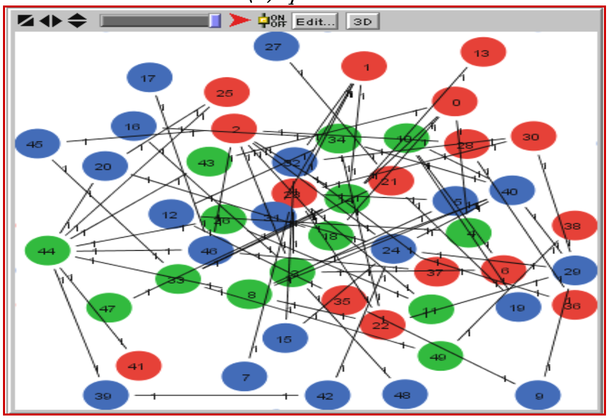


Figure 4. Identification of the objects of the DCSP application

In exchange, to model the surface of the application are used objects of the patches type. Depending on the significance of those agents, they are represented on the Netlogo surface. In figure 5 are presented two ways in NetLogo for representing the agents of the queens type, respectively noduri.



(a) queens

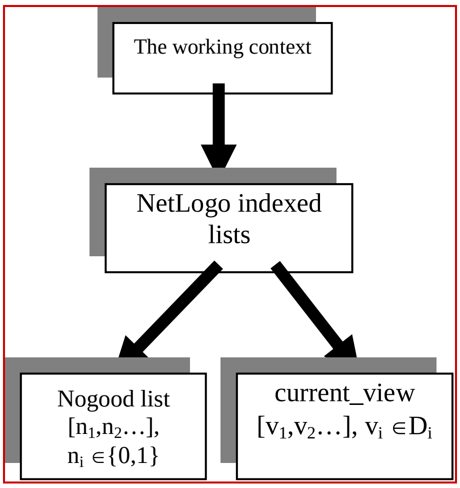


(b) nodes

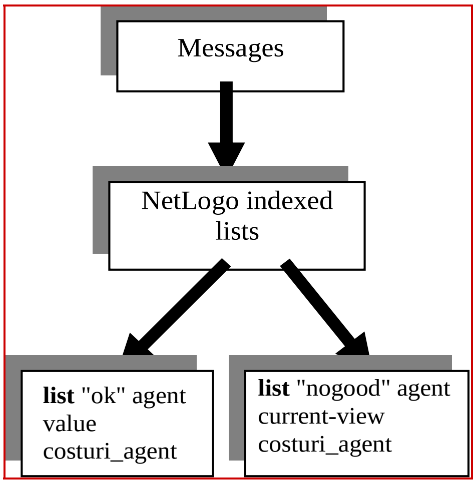
Figure 5. Examples of reprezentation of the agents on the NetLogo surface

P2. Message handling. The FIFO type message chanel.

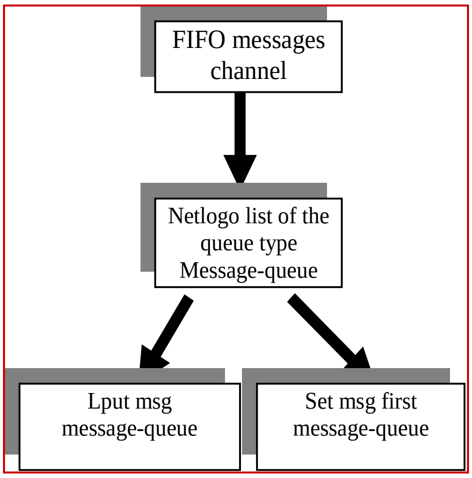
Any agent keeps its working context at least as two proprietary structures: current_view and its nogood list. That context is used to take decisions, inclusively for building messages. For the proposed model, the data structures that store the working context of each agent can be simulated with lists. A representation solution is presented in figure 6 (a)



(a)



(b)



(c

Figure 6. The necessary structures for message handling)

```
to receive-message [msg]
 without-interruption
[
  set message-queue
lput msg message-
queue]
```

```
to report retrieve-
message
  without-interruption [
   set msg first message-
queue
   set message-queue
butfirst message-queue]
  report msg
end
```

```
 to handle-message
  if (empty?
 message-queue)
 [stop]
  set msg retrieve-
 message
  if (first msg =
 "ok")[
   ok msg ]
```

Figure 7. Message handling

Message handlinf supposes first of all message representation. In figure 6.(b) is presented the way of representation of the main messages found at the asynchronous techniques. Simulareation of message queues for each agent can be done using Netlogo lists, for which are *defined routines of handling corresponding to FIFO principles (figure 6.(c)). These structures keep the messages received by each agent. Starting from NetLogo elements presented in figure 6, we can build three procedures for handling messages from the message queue, routines presented in figure 7. The first receive-message routine is used for receiving a new mesaage, the second routine retrieve-message has as its purpose the extraction of a message from the waiting queue, being called in the message treatment routine. The last routine handle-message identifies the message type, calling the appropriate message handling routine.*

P3. Application initialization an of each agent. "The main program" for application

The initialization of the application supposes the building of agents and of the working surface for them. When the agents are built the required initializations are also done. Usually, is initialized the working context of the agentul (current-view), the message queues, the variables that count the effort carried out by the agent. In figure 8 are presented the two routines of application initialization and of agents initialization.

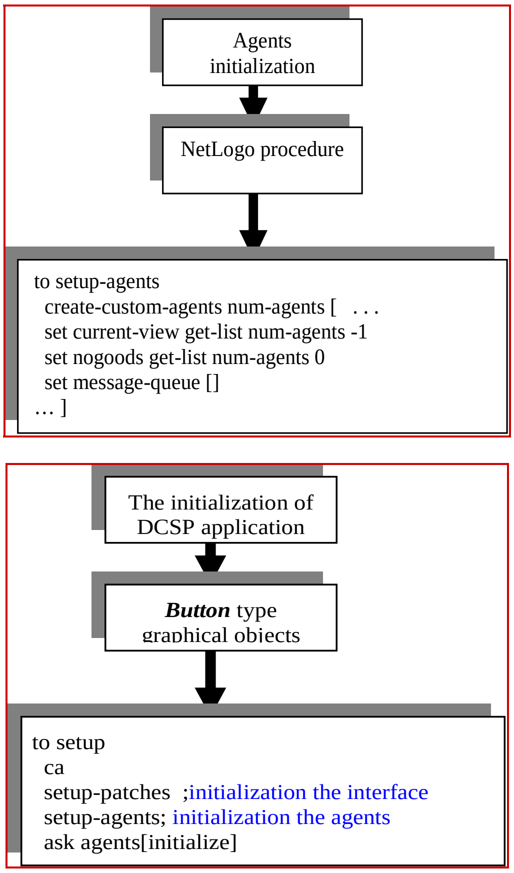


Figure 8. Initialization of the DisCSP application

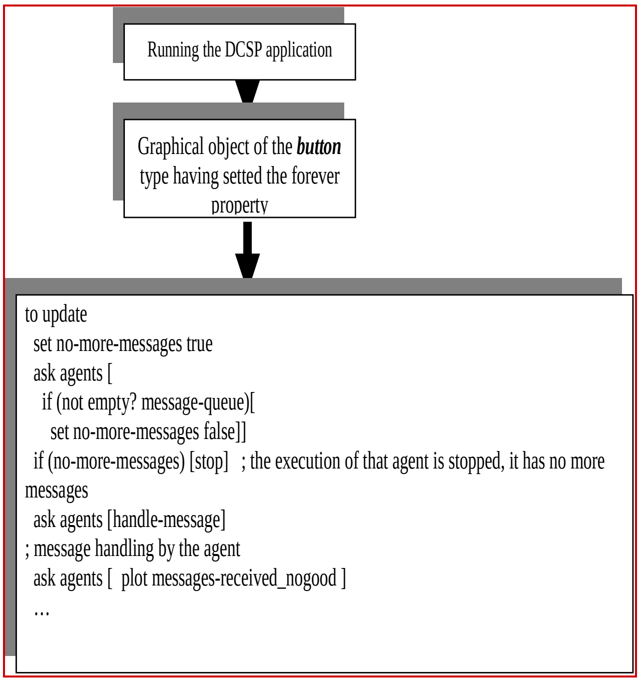


Figure 9. The procedure for running the DCSP application for the system SEIS

The working surface of the application should contain NetLogo objects through whom the parameters of each problem could be controlled: the number of agents, the density of the constraints graph, the number of colors. These objects allow the definition and monitorization of each problem parameters.

For the application running is proposed the introduction of a graphical object of the button type and setting the forever property. That way, the attached code, in the form of a NetLogo procedure (that is applied on each agent) that will run continuously, until emptying the message queues and reaching the Stop command (which in NetLogo stops the execution of an agent). The solution presented in figure 9 is based on the utilization of the ask command. That NetLogo command executes a synchronization of each agent execution.

Another important observation is tied to attaching the graphical button to the observer. The use of this solution allows obtaining a solution of implementation with synchronization of the agents' execution. In that case, the observer will be the one that will initiate the stoping of the DisCSP application execution. In figure 9 the update procedure is attached and handled by the observer. These elements lead to the multi-agent system with synchronization of the agents execution (SEIS). If it's desired to obtain a system with asynchronous operation

(SIEAS), will be used the second method of detection, which supposes another update routine. That new update routine will be attached to a graphical object of the buton type which is attached and handled by the turtle type agents.

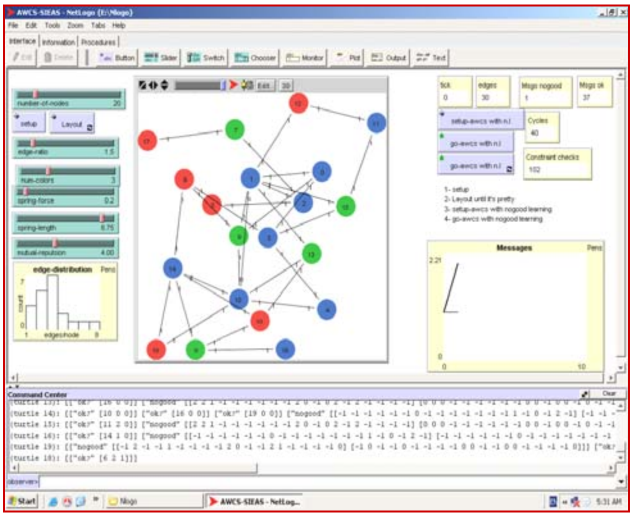


Figure 10. NetLogo implementation for AWCS technique- SEIAS

P4. Monitorization of the evaluation parameters

The model presented in this chapter allows storing the costs for obtaining the solution. That thing can be done using some variables attached to the agents. For counting the flow of messages it can be used a variable proprietary to each agent (messages-received_nogood,etc), variable that needs to be incremented in the moment of receiving a message. That variable is incremented in the routine of message manipulation handle-message. Also, for measuring the work effort carried out by the agents can be used two variables nr_constraintc and c-ccks. Those variables store the costs necesary for each agent. Thus, those costs should be measured.

Application of the methodology presented previously allows the implementation and evaluation of any asynchronous search technique. In figure 10 is captured an implementation for the AWCS technique that uses uses the multi-agent SIEAS system.

CONCLUSION

In this article was analysed the NetLogo environment with the purpose of building a general model of implementation and evaluation for the asynchronous techniques such as they could use the NetLogo environment as a basic simulator in the study of asynchronous search techniques.

In this article was proposed a general model of implementation and evaluation for the asynchronous search techniques. The proposed model supposed the identification of NetLogo objects necessary for implementing the asynchronous search technique (agents, messages, message queues, agents ordering) and of the interface of interaction with the user. In this article was proposed solutions for simulating the objects of any DisCSP application. Also, were proposed solutions for counting the costs for obtaining a solution using different measuring units. That thing will allow the evaluation of performances for asynchronous search techniques and eventual improvements for them Also, the model allows studying the behaviour of the agents for various techniques, studyind the costs for each agent.

As a general conclusion, we think that the model we achieved can be used for the study and analysis of the asynchronous techniques, the model allowing their complete evaluation. Students can use the models on the site [7] to study, to understand the functioning of the asynchronous search techniques and, perhaps, to extend them. Starting from those models, they can develop other versions of the asynchronous search techniques.

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STUDIES REGARDING OF SIDERITIC RESIDUE UTILIZATION FOR CEMENT PRODUCTION

Abstract:
The paper presents the experimentations made in the laboratories of Faculties of Engineering from Hunedoara and also in the frame of Carpatcement Holding Deva laboratories, looking at the introduction of the sideritic residue along with the clinker, for obtain of cement. For suggested recipe, were determinate the specific surfaces, setting time, compression strength. Result obtained in the laboratory condition proven as the proposal is viable as much from economic and ecologic point of view, through the recycling of manufactured residue existing in very big amounts in approach of Hunedoara area.

Keywords:
sideritic residue, clinker production, cement, polluted surface, recycling

INTRODUCTION

The Portland cement is the most used binding material into construction, due to its properties, which are depending upon the chemical and mineralogical composition, manufacturing conditions etc. Portland cement has, normally, the following chemical composition:

$CaO = 60 – 65$ %; $SiO_2 = 18 –24$ %;
$Al_2O_3 = 5 –10$ % ; $Fe_2O_3 = 1 – 4$ %; $MgO < 0$.

From the point of view of the formal constituted elements, the chemical composition is presenting as follows:

- tricalcic silicate ($3CaO{\cdot}SiO_2$) symbolized C_3S, in ratio of 47%;
- tricalcic silicate ($2CaO{\cdot}SiO_2$) symbolized C_2S, in ratio of 28%;
- tricalcic aluminates ($3CaOAl_2O_3$) symbolized C_3A, in ratio of 11%;
- ferialuminat tricalcic ($4CaO{\cdot}Al_2O_3{\cdot}\ Fe_2O_3$) symbolized C4AF, in ratio of 8%;
- $CaSO_4$ (3%); MgO (2%); CaO_{liber} (0,5%); Na_2O (0,5%).[2]

The cement is obtained by raw material burning and smelting into the special installation: by dried, semi-dried, semi-wet and wet proceedings.

The raw material that is used for Portland cement manufacturing is composed by:

- calcareous rocs, with an calcite content of 75- 80%;
- clay, with content of SiO_2, Al_2O_3 , Fe_2O_3;
- adjustment adding, like:
  - bauxite, for increasing Al_2O_3 content;
  - diatomite, for increasing SiO_2 content;
  - ferric disulphide ashes, witch bring Fe_2O_3 and decreasing temperature of clinkerization process;

- *metallurgical slag, witch bring Fe_2O_3, thermo-central ashes and*
- *others wastes.*

We are considering with a fundamental base technological solution of recycling the sideritic waste material, resulted on the cement producing.

THE STUDY

Aspects concerning the sideritic residue sludge beds are presented in figure 1.

The sideritic residue granulometric composition is presented in table 1. The simple granulometric curve is presented in figure 2 and the cumulate granulometric curves are presented in figure 3.

Figure 1. a. Aspects concerning the sideritic residue sludge beds: sludge bed 1

Figure 1. b. Aspects concerning the sideritic residue sludge beds: sludge bed 2

Figure 1. c. Aspects concerning the sideritic residue sludge beds: sludge bed 3.

Tab.1. The sideritic residue granulometric composition

Material	Granulometric classes, [μm]						
	< 25	25-56	56-90	90-180	180-315	315-500	> 500
Sideritic residue	2,19	3,30	6,42	32,79	50,72	3,97	0,61

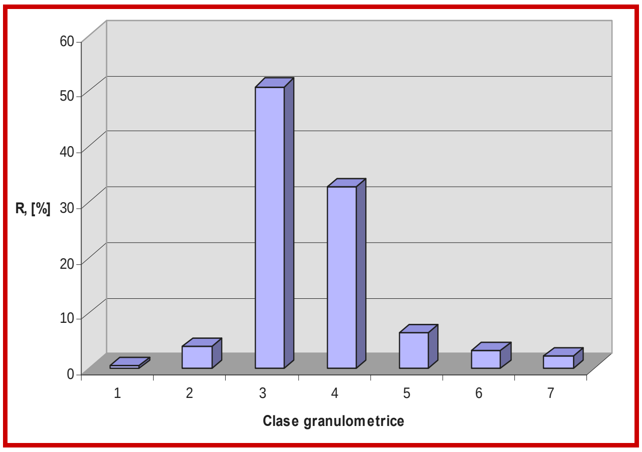

Figure 2. The simple granulometric curve

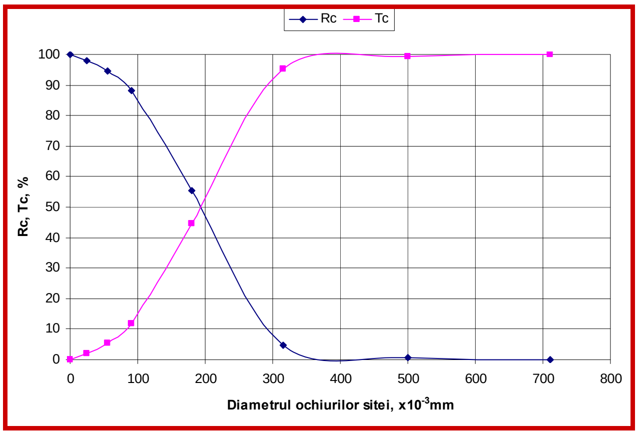

Figure 3. The cumulate granulometric curves

Figure 4.a. The raw materials: clinker

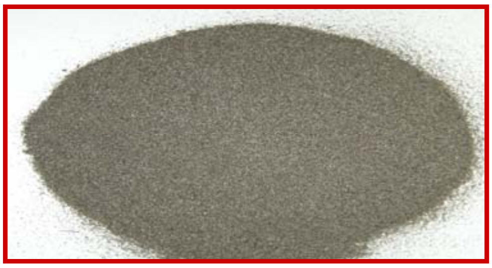

Figure 4.b. The raw materials: sideritic waste

Figure 4.c. The raw materials: calcined gypsum

For experimentations, in order to obtained cement, we elaborated 7 cement recipes, introducing various quantities of clinker and sideritic waste, as well as 5% burnt plaster (fig.4). The details are shown in tab.2 and graphically in fig.5.

Tab.2. The experimented cement recipes components

Component, [%]	Recipe no.						
	1	2	3	4	5	6	7
Clinker	90	85	80	75	70	65	60
Sideritic residue	5	10	15	20	25	30	35
Calcined gypsum	5	5	5	5	5	5	5
Total	100	100	100	100	100	100	100

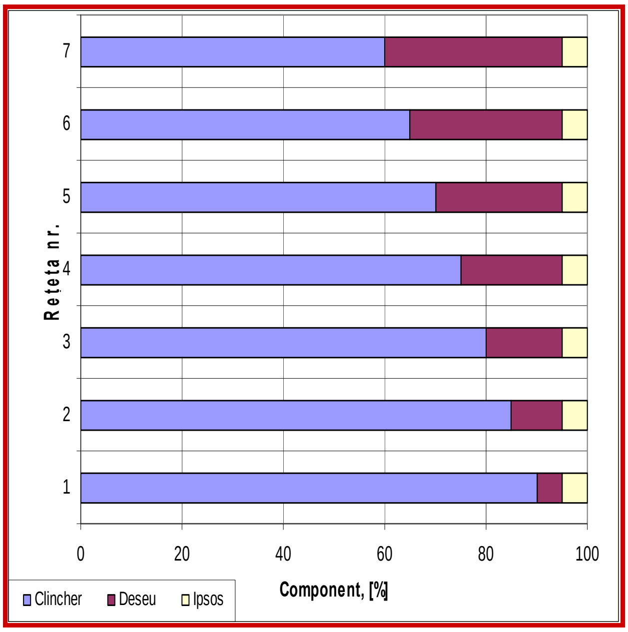

Figure 5. Used recipes

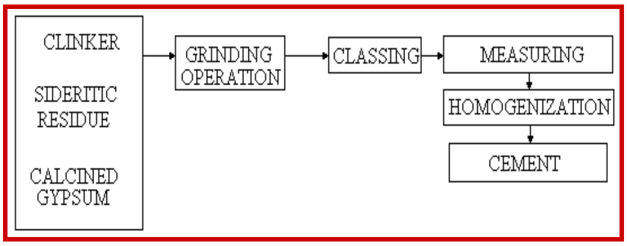

Figure 6. Cement technological flux in laboratory condition

In order to determine the quality of our recipes we elaborated a 1 kg sample for each of them, according to the procedures shown in fig.6. We used in this scope the installations existing in the laboratories of our Faculty [3].

ANALISES, DISCUSIONS, APPROACHES, INTERPRETATIONS

The determination of quality has been done as follows:

- we performed the chemical analysis of the samples, the results being given in tab.3;
- we determined the specific surface of the cement mixture, tab.4;
- we carried out cement specific tests and determinations such as: the determination of water for the normal consistence paste, the binding time, resistance to pressure after 1, 2 and 7 days from binding – tab.5.

The tests have been done both in our laboratories and with the help and participation of our contract partner: CARPATCEMENT HOLDING, Deva branch. The chemical structure varied as shown in tab.3.

Tab.3. Chemical composition for our cement recipes

Recipe no.	Chemical composition, [%]			
	CaO	SiO_2	Al_2O_3	Fe_2O_3
1	60,53	20,78	5,00	3,64
2	58,04	21,44	4,88	3,85
3	55,54	22,10	4,75	4,06
4	53,04	22,76	4,62	4,28
5	50,54	23,42	4,50	4,49
6	48,04	24,08	4,37	4,70
7	45,55	24,74	4,24	4,91

Recipe no.	Chemical composition, [%]		
	Others oxides	P.C.	$CaSO_4$*0,5H_2O
1	3,97	1,17	4,90
2	4,54	2,35	4,90
3	5,12	3,52	4,90
4	5,70	4,69	4,90
5	6,28	5,87	4,90
6	6,86	7,04	4,90
7	7,44	8,21	4,90

In order to determine the specific surface, we used the Blaine permeability meter shown in fig.7 – from the laboratories of CARPATCEMENT HOLDING, Deva branch. The data we obtained are given in tab.4 and in figure 8.

Figure 7. The Blaine Permeability-meter

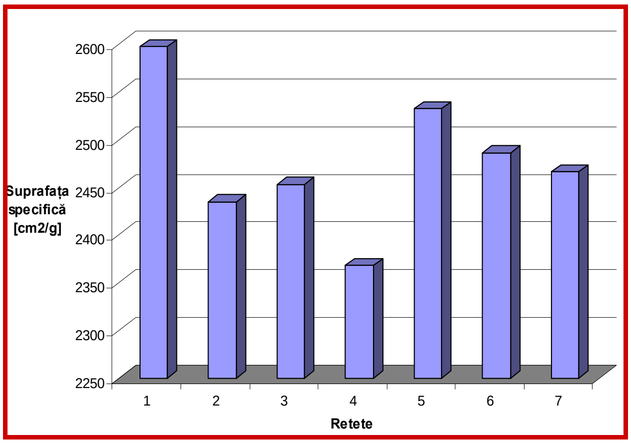

Figure 8 Specific surface for our cement recipe

Tab.4. Resulting data for specific surface

Specific surface [cm²/g]	Recipe no.						
	1	2	3	4	5	6	7
	2597	2435	2453	2368	2532	2486	2466

Figure 9. Vicat apparatus for determination of water for the normal consistence paste

Figure 10. The resulting proofs

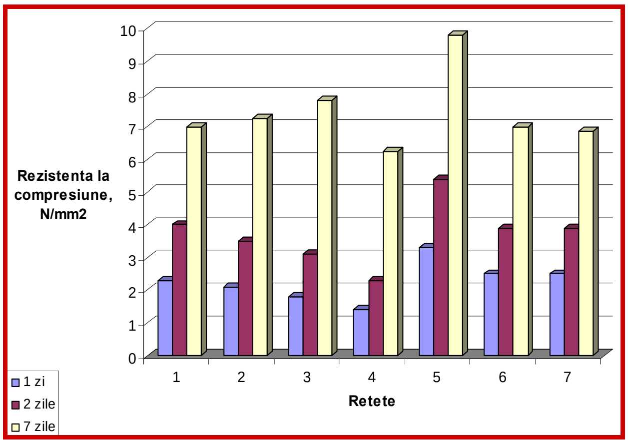

Figure 11. The resistance to pressure variation of cement proofs

Tab.6. The quality characteristics for our cement recipes

Characteristics		Recipe no.						
		1	2	3	4	5	6	7
Water for the normal consistence paste, [cm³]		75	74	73	65	67,5	67	66
The binding time, [min]		16	19	14	13	15	18	18
Resistance to pressure, [N/mm²]	1 day	2,30	2,10	1,80	1,40	3,30	2,50	2,50
	2 days	4,00	3,50	3,10	2,30	5,40	3,90	3,90
	7 days	7,00	7,25	7,81	6,25	9,80	7,00	6,87

The experiments meant to determine the amount of water in the normal consistency paste and of the binding start time have been done in the laboratories of the Faculty of Engineering of Hunedoara, using a Vicat apparatus, shown in *fig.9 and fig.10. We mention that the determinations were done according to all the norms in force. The data we obtained are given in tab.6 and in fig. 11.*

The resistance to compression has been tested by means of the device shown in fig.12, existing in the testing laboratories of CARPATCEMENT HOLDING Deva branch.

Figure 12. Compressing testing machine for cement sample. 1 – machine bench; 2 – test specimen; 3 - panel.

CONCLUSION

The resulting experimental data have lead to the following obvious conclusions:

- *the resistance to pressure of the cement test samples, where part of the clinker has been replaced by siderite waste, is comparable to that of regular cements;*
- *the specific surface has a high influence upon the resistance to pressure and one can see that the larger the specific surface, the larger the resistance to pressure.*
- *the resistance to pressure of experimental cements increases with time, so that one can notice that, after 7 days, resistance is 3 times higher than the resistance determined after 1 day;*
- *the highest resistance to pressure after 7 days was obtained for recipe no. 5, to which we added 25% siderite waste;*
- *particular attention should be paid in further researches to the fine grinding of cement, so as to obtain a specific surface above 3000 cm^2/g;*
- *the quantity of water for the normal consistency paste is smaller than the one usually recommended for cement: 70-90 cm^3;*
- *the binding start time obtained in laboratory conditions recommends the use of experimental cements for road leveling layers, as they harden fast (with a higher addition of water).*

At present, the acquisition price of cement is about 115€/t, out of which 22€/t represents the value of raw materials. The partial replacement of clinker by siderite waste leads to about 21% cut down on raw materials (the calculation referring to recipe 5, which has the best characteristics), respectively 4% of the price of cement.

Moreover, one has to consider the ecological impact, resulted from the removal of the waste ponds.

ACKNOWLEDGMENT

This works is based on experiments made in the PROJECT no.46/2008, entitled: "DECREASING OF ENVIRONMENT POLLUTION DEGREE THROUGH THE SIDERITE WASTE CAPITALIZATION FOR PRODUCTION OF CEMENT" Beneficiary: BALKAN ENVIRONMENTAL ASSOCIATION (B.EN.A.) – TUBORG, Project manager: Teodor HEPUT.

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Beneficiary: Balkan Environmental Association (B.EN.A.) – TUBORG,

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ACTA TECHNICA CORVINIENSIS
– BULLETIN of ENGINEERING

Scientific supplement of
ANNALS of FACULTY
ENGINEERING HUNEDOARA
– INTERNATIONAL
JOURNAL of ENGINEERING
ISSN: 1584-2665 [print]
ISSN: 1584-2673 [CD-Rom]

ACTA TECHNICA CORVINIENSIS – BULLETIN of ENGINEERING

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CALCULUS METHOD OF THE TECHNOLOGICAL LOADS TRANSMITTED TO THE EXTRACTING TOWERS WITH THE HOISTING INSTALLATIONS OF WINDING MACHINES WITH MULTICABLE DRIVING WHEELS ON

Abstract:
In the paper there are presented certain aspects concerning the calculus of technological loads transmitted through the bearings of the extracting pulleys of the structure of the towers of the extracting installations in the case of functioning loads.
In the case of the extracting installations which have the extracting machine on the ground, having as a wrapping organ of the cables friction driving wheels, or a moving wheel the variation of the loads is determined not only by the kinematics of the installation (kinematics parameters), the dynamic (friction and inertia forces), but also by certain geometrical elements which define the position of the extracting machine towards the well geometrical elements that refer only to these type of installations.
These geometrical elements are the incline angles of the extracting cable chords. These aspects were showed on the installation „Skip Shaft" belonging to Mining Plant Lonea.

Keywords:
calculus method, technological loads, extracting tower

INTRODUCTION

In the case of the extracting installations which have the extracting machine on the ground, having as a wrapping organ of the cables double cylindrical wheels, or a moving wheel the variation of the loads is determined not only by the kinematics of the installation (kinematics parameters), ther dynamic (friction and inertia forces), but also by certain geometrical elements which define the position of the extracting machine towards the well geometrical elements that refer only to these type of installations.
These aspects were showed on the installation „ Skip well " Lonea Mining Plant (Fig.1). The installation taken into study has benn described as follows.

Figure 1. Extracting installation

THE INSTALLATION TAKEN INTO STUDY

The extracting installation that operates on the new skip well from Lonea Mining Plant, is destined [7] for the extraction from the underground of minerals. The extraction is done from the horizons +169,40; +203,3 and 403,45 to the surface (the surface level is +704,5m; and the skip unloading level is +715,5m).

The installation (Fig.1) is ballanced and has an extracting machine type MK 5x2 (Fig.2) equipped with two motors type M2M-1000-213-4YXP/1986, of 1000 kW power and a nominal rpm of 54 rot/min (Fig.3). he cables are wrapped around a moving wheel of ф 5000 mm (Fig.4).

The extracting cables with diameters of ф 46,5 mm and a mass (on a linear meter) of 8,049 kg/m are wrapped around the two extracting pulleys of ф 5000 mm with a mass (the pulley, the axel of the pulley and the bearing of the axel) of 12.108,83 kg (Fig.5), laying on the tower at a height of 51 m (pulley axel).

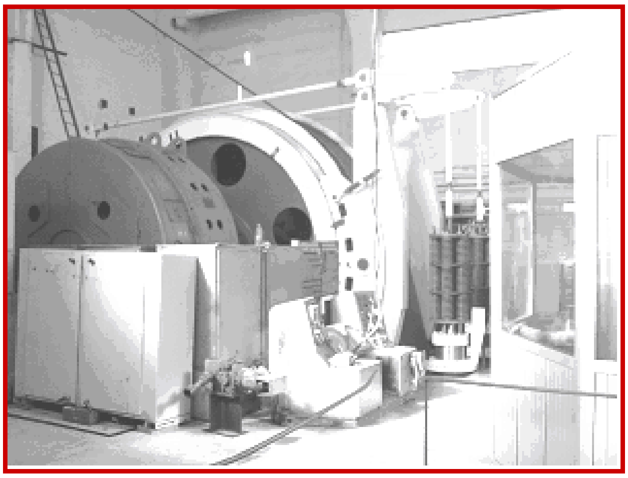

Figure 2. Extracting machine

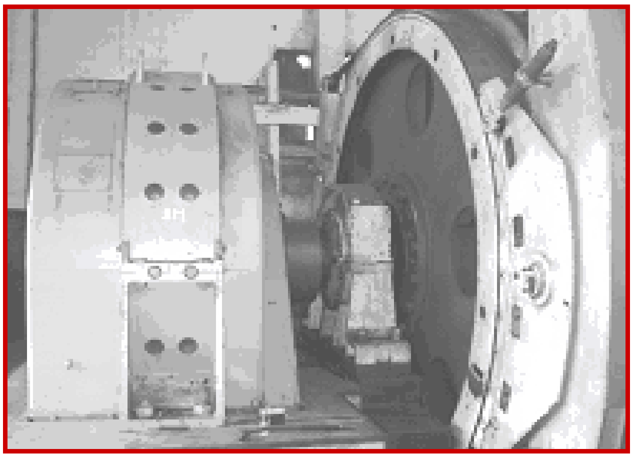

Figure 3. The motor

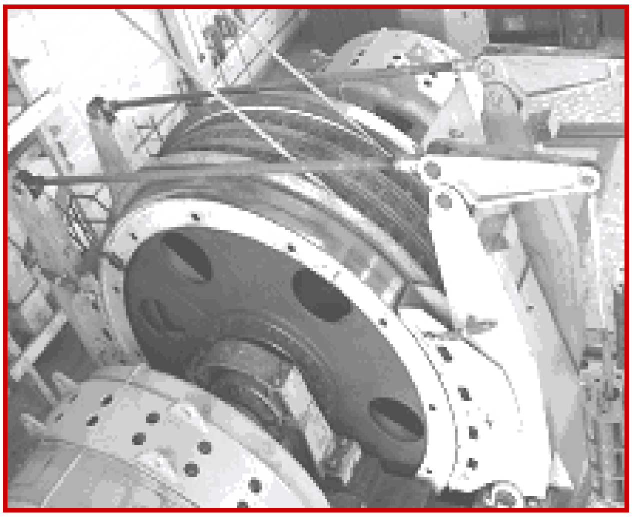

Figure 4. Wrapping organ

Figure 5. Extracting pulleys

Figure 6. Metallic tower

The ballanced cables have a section of 135x20 mm and a mass (on a linear meter) of 9,062 kg. The extracting vessels are skips having a mass (own mass, plus D.L.C., plus D.E.C. and suplimentary mass) of 21600 kg and the effective load is 7000-8000 kg/skip. Another main component of the extracting installation is the metallic tower (fig.6) with a height until the pulley axel of 51 m. The structure of the tower is composed of the extracting pulley platform sustained by the leading component and the one abutment set up as a frustum pyramid The extracting machine lies on the ground (at a height of 7,5 m to the 0 level of the well (well collar), sideways from the tower (well tower), at a distance (of the wheel axel), towards the vertical portion of the extracting cables which enter the well of 44m. The length of the cable chord (the distance between the tangent points of the cable to the deviating pulley from the tower and the wheel of the extracting machine, in the central position of the chord (perpendicular on the wheel axel)), is for the bottom branch Lci=52,78253595m, and Lcs=58,78482883m for the top branch. The incline angles of the cables chords are βi = 48^0 43' 37" for the bottom branch and βs = 44^0 37' 07", for the top branch [7].

LOADS TRANSMITED TO THE TOWER

For the determination of the loads (efforts) which act upon the installation taken into consideration it has been taken into study the case when one of the skips is descending (ascending) on one of the branches.

On the calculation of loads it has been considered the fact that their variation is determined not only by the kinematics of the installation (kinematical parameters) but also by certain geometrical elements which define the position of the extracting machine towards the well geometrical elements regarding only the installations where the extracting machine lies on the ground.([1],[3],[4],[5],[6]).

For this purpose it has been taken into analysis the case when the skip is descending on the top branch (case 1, the skip of the bottom branch is climbing and the top one is descending) and the case when the skip is descending on the bottom branch (case 2, the skip of the bottom branch is descending and the top one is climbing). The diagrams for the space, speed, and acceleration for the two cases taken into analysis are presented into Fig 7 case 1 and in Fig 8 case 2. The variations of acceleration and space have been used for the calculation of the loads applied to the tower. The determination of the loads acting upon the tower through the deviating pulleys has been done using the d'Alembert principle (the kinetics-static method [2]) taking into consideration the static forces (the weight of the extracting cable, the cage the trolley the pulley and the load), the friction forces (multiple friction and aero-dynamic resistances which for installations with cages is approximated with a coefficient of k'=0,2 from the useful load [1]) and the dynamic forces (which intervene only in the acceleration and deceleration periods, Fig. 7 and Fig. 8).

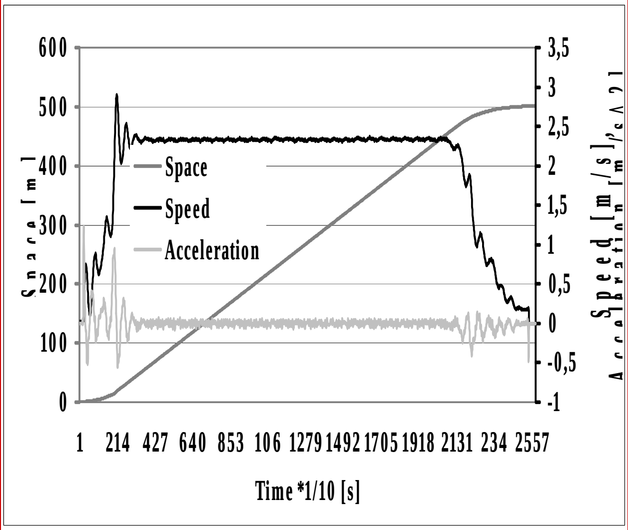

Figure 7. Speed acceleration and space for case 1

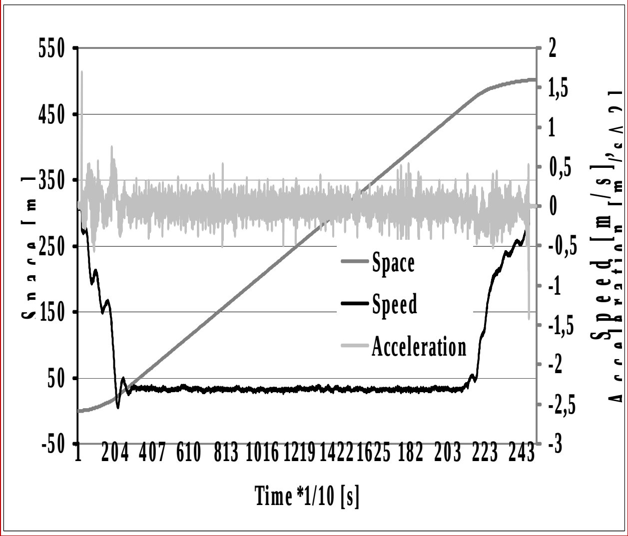

Figure 8. Speed acceleration and space for case 2

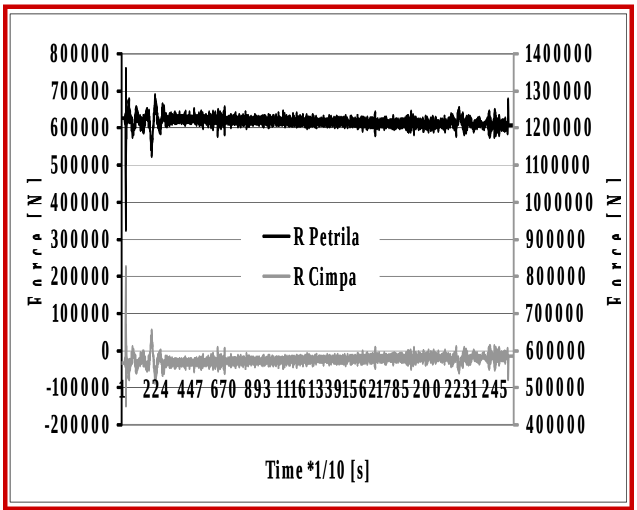

Figure 9. Reactions from the bearing of the top and bottom pulley when the top cage descends and the bottom one climbs, case 1

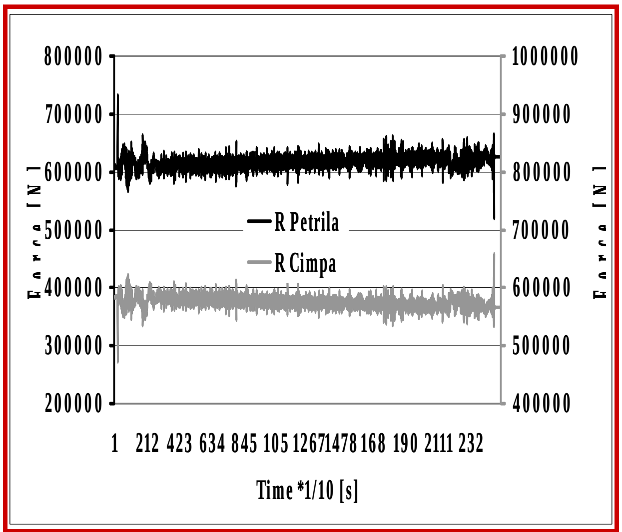

Figure 10. Reactions from the bearing of the top and bottom pulley when the top cage climbs and the bottom one descends, case 2

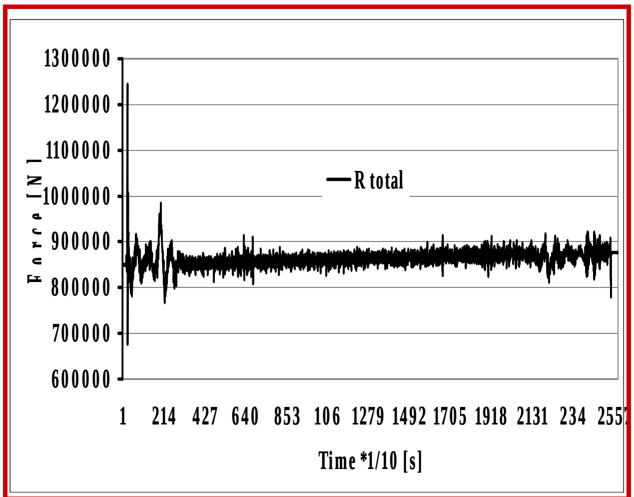

Figure 11. Total loads when the top cage descends and the bottom one climbs case 1

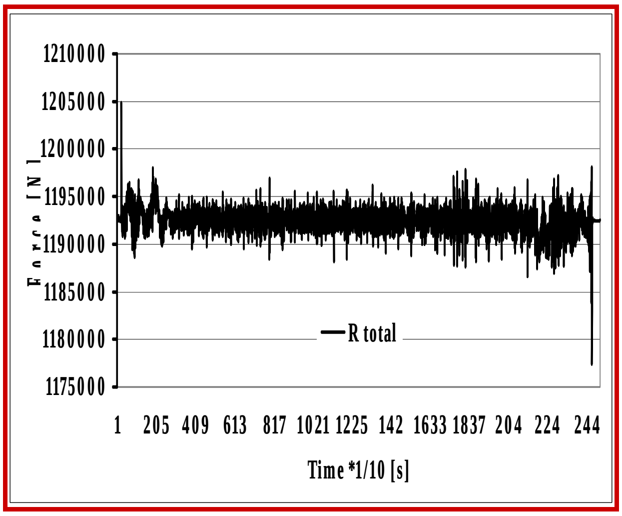

Fig. 12. Total loads when the top cage climbs and the bottom one descends case 2

The variation of the resultant forces from the bearings of the extracting pulleys for the two cases taken into consideration is presented in Fig 9, for case 1, for the top and bottom pulley and Fig 10, for case 2, also for the top and bottom pulley.

CONCLUSION

The calculation the structure of the mining extracting towers is done taking into consideration all the unfavourable combinations practically possible of the different loads called groups of loads.

Following the classification and grouping of the loads transmitted to the extracting mining towers in the paper there are presented certain aspects concerning the establishing of the exceptional short term loads due to the extracting cycle in the case of the appliance of the safety brake which are transmitted to the structure skip and the wrapping organ of the extracting machine is moving wheel.

The loads transmitted to the tower through the bearings of the extracting pulleys from the tower due to the efforts from the extracting cables have been considered in the case when the emergency brake is applied due to an overcome of the max speed allowed when the skip are climbing and descending on one of the two extracting branches.

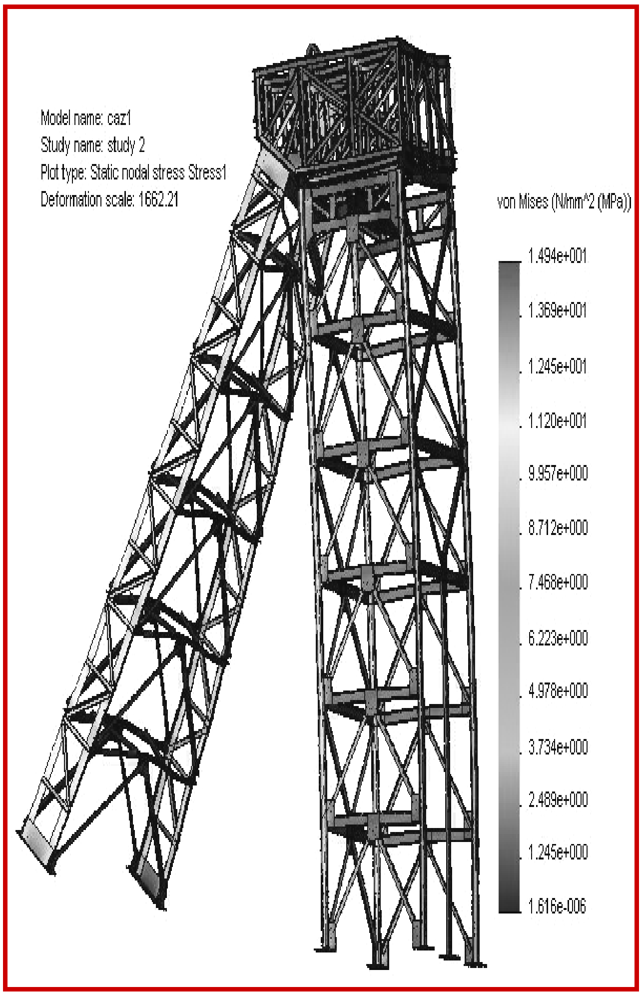

Figure 13. Stress on the tower

The variation of loads is due both for the cinematic parameters as well as for the geometric parameters of the extracting installation.

As noticed from the variation of the total loads which act upon the tower during an extracting cycle the maximum values are in case 1 of the cycle and in case 2 at the beginning of the cycle (Fig 11 and Fig 12).

The maximum values of the loads determined are further used to determine the values of mechanical stress and strain from the elements of the structure of the metallic tower of the installation in order to verify its resistance, like in Valea Arsului tower case, from Lonea Mining Plant. (Fig. 13).

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Scientific supplement of
ANNALS of FACULTY
ENGINEERING HUNEDOARA
– INTERNATIONAL
JOURNAL of ENGINEERING
ISSN: 1584-2665 [print]
ISSN: 1584-2673 [CD-Rom]

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ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

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THE MACHINING ERROR DUE TO CONTACT DEFORMATION OF WORKPIECE-FIXTURE SYSTEM

Abstract:
In this paper work there are described the error's sources due to workpiece-fixture compliance which appear while the workpieces are clamped, is presented the analytic models of calculus of the errors due to contact deformation between locators and workpiece and an example of using the finite element method in order to determine the contact deformation for a practical example. The differences between the results obtained using the finite element method and the results obtained using analytical relations are very small, which demonstrates that the finite element method can be used for determining the machining error due to contact deformation.

Keywords:
workpiece, fixture, deformation, machining error

INTRODUCTION

In the machining process the fixtures are used for the orientation and clamping, for the workpiece to be machined through various methods, assembling and controlling. Once the workpiece is orientated and clamped with locators and clamping devices the workpiece can be machined in order to accomplish the imposed accuracy conditions.

The errors due to fixtures are major ones and influence the workpiece's machining accuracy; the errors can amount to 20-60% of the overall machining error. Therefore, performance evaluations of the workpiece-fixture system constitute a significant task for fixture design optimization and control of the machining error before manufacturing and the application in production.

The errors due to the workpiece-fixture system can be classified in two categories: errors due to orientation of the workpiece in the fixture and errors due to deformations of the workpiece-fixture system during clamping and machining.

During clamping and machining the workpiece, for a point P situated on the machined feature, the force assembly which acts on the workpiece-fixture system determines the appearance of three types of errors: errors due to contact deformation, errors due to locator's deformation and errors due to workpiece deformation.

ANALYTIC CALCULUS OF THE ERRORS DUE TO CONTACT DEFORMATION

In many different situations, in device design practice, the contact geometry between surfaces of workpieces and locators or clamping elements of fixture can be a point (sphere–sphere contact), a line (cylinder - plane contact) and a plane surface (plane – plane contact).

The contact deformation between workpiece and locators and clamping elements of fixtures can be characterized with Hertz's model of *contact stress. The hertzian theory of contact is based on the following simplifying assumptions [1]:*

- *the materials in contact are homogeneous and the yield stress is not exceeded;*
- *contact stress is caused by the load which is normal to the contact tangent plane which effectively means that there are no tangential forces acting between the solids;*
- *the contact area is very small compared with the dimensions of the contacting solids;*
- *the contacting solids are at rest and in equilibrium;*
- *the effect of surface roughness is negligible.*

CONTACT BETWEEN A SPHERE AND A PLANE SURFACE

The contact area between a sphere and a plane surface, as shown in Figure 1, is circular.

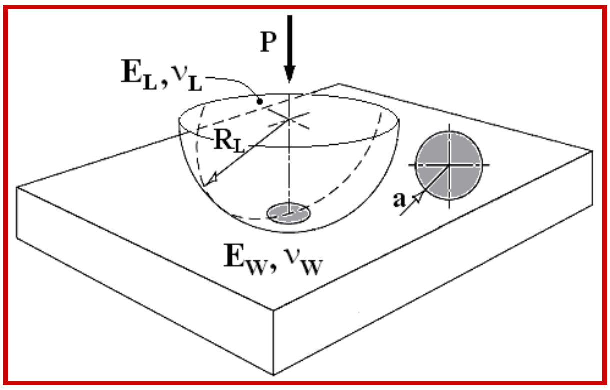

Figure 1. Contact between a sphere and a flat surface

The contact parameters for this configuration can be calculated according to the next formulae:

- *contact area dimensions:* $a = \left(\frac{3PR'}{E'}\right)^{1/3}$ (1)
- *maximum contact pressure:* $p_{\max} = \frac{3P}{2\pi a^2}$ (2)
- *average contact pressure:* $p_m = \frac{P}{\pi a^2}$ (3)
- *maximum contact deformation:*

$$\delta = 1.0397\left(\frac{P^2}{E'^2 R'}\right)^{1/3} \qquad (4)$$

- *maximum shear stress:* $\tau_{\max} = \frac{1}{3} p_{\max}$ *at a depth of* $z = 0.638a$ (5)

where a is the radius of the contact area [m]; P is the normal load [N]; p is the contact pressure (Hertzian stress) [Pa]; δ *is the contact deformation (total deflection at the centre of the contact* $\delta = \delta_A + \delta_B$*, where* δ_A *and* δ_B *are the maximum deflections of body A and B respectively) [m];* τ_{max} *is the shear stress [Pa]; z is the depth under the surface where the maximum shear stress acts [m]; E' is the reduced Young's modulus [Pa] and R' is the reduced radius of curvature [m] (*$R' = R_L$*).*

The reduced Young's modulus is defined as:

$$\frac{1}{E'} = \frac{1}{2}\left(\frac{1-\upsilon_L^2}{E_L} + \frac{1-\upsilon_W^2}{E_W}\right) \qquad (6)$$

where ν_L *and* ν_W *are the Poisson's ratios of the locator and workpiece, respectively and* E_L *and* E_W *are the Young's moduli of the locator and workpiece, respectively.*

CONTACT BETWEEN A CYLINDER AND A PLANE SURFACE

According to the Hertz theory for the contact of cylindrical locator, when one of the contact bodies roughly takes the form of a rectangular block of thickness t, as shown in figure 2, then the deformation of the block through its thickness may be obtained with reasonable approximation, provided that the thickness of the block is large compared with the contact width (t>>a), then the deformation of the block through its thickness is

$$\delta = P\frac{1-\nu_L^2}{\pi E_L}\left[2\ln\left(\frac{2t}{a}\right) - \frac{\nu_L}{1-\nu_L}\right], \qquad (7)$$

where t is the thickness of the block; ν_L *is Poisson's ratio of the cylindrical locator;* E_L *is Young's modulus of the cylindrical locator;*

$a = \left(\frac{4PR_L}{\pi E'}\right)^{1/2}$ *(8) is the contact width.*

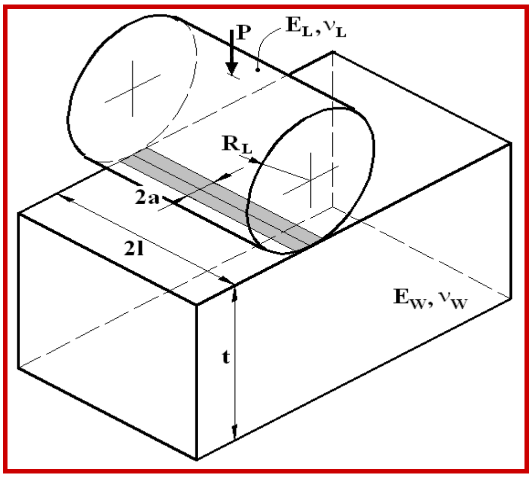

Figure 2. Contact between a cylindrical locator and a rectangular workpiece

EVALUATION OF THE MACHINING ERROR DUE TO CONTACT DEFORMATION WITH THE FINITE ELEMENT METHOD

A quick and efficient evaluation of the machining errors due to contact deformation which appear during clamping of workpieces can be realized with the finite element method. Forwards it is presented an example of application of this method for contact between a cylindrical locator and a rectangular workpiece.

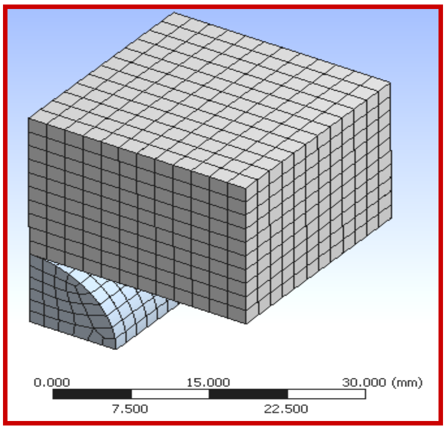

Figure 3. a. FEA analysis of the workpiece-locator system

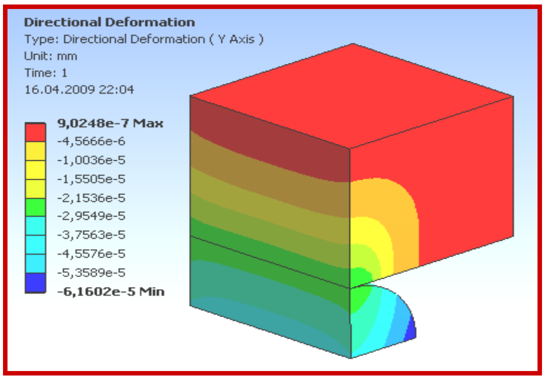

Figure 3. b. FEA analysis of the workpiece-locator system.

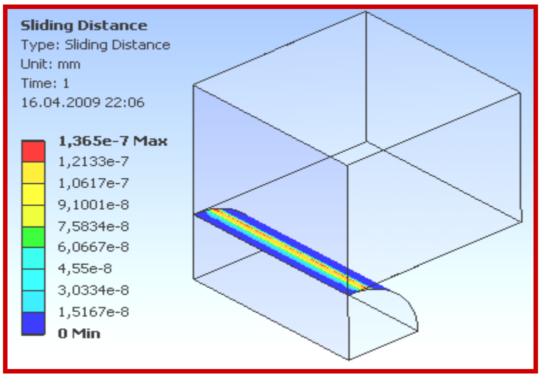

Figure 3. c. FEA analysis of the workpiece-locator system.

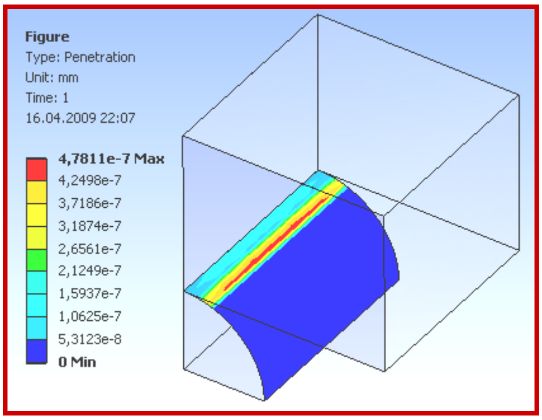

Figure 3.d. FEA analysis of the workpiece-locator system

An elastic cylindrical locator of steel with a radius of R=10 mm pressed against a flat surface of a workpiece of the same material by a pressure P=0,20 MPa. Geometry of the rectangular workpiece: length 25 mm, width 25 mm and height 20 mm. Materials for cylindrical locator and rectangular workpiece: steel having Young's modulus E =205 GPa and Poisson's ratio ν =0.29. The clamp–workpiece contact was modeled using surface to surface contact elements.
The results are presented in figure 3. The contact deformation in contact zone are evaluated in figure 3, b.

CONCLUSION

The maximum contact deformation calculated with relation (7) is 0,388 μm. The contact deformation evaluated with the finite element method in middle point of contact line is 0,357 μm. These results demonstrate that the finite elements method permits a quick and efficient evaluation of the contact deformation due to workpiece-fixture system and the machining error due the contact deformation.

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ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

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ON THE STATIC AND DYNAMIC CHARACTERISTICS OF THE SHOCK INSULATORS EQUIPPING RAILWAY VEHICLES

Abstract:
The paper presents theoretical notions regarding the shock due to collisions of railway vehicles as well as a study on the applied methodology used to experimentally determine the static and dynamic characteristics of the bumpers that equip railway vehicles. The experimental stand, the transductors, the measurement, recording and data processing apparatus are also presented.
The experimental force as a function of displacement (contraction) diagrams are presented for the shock insulators as well as the characteristics obtained during the static testing, both for normal temperature and extreme temperatures (+50°C and -40°C). Furthermore, the paper contains a study on the dynamic characteristics obtained for collision velocities between 6,15 km/h and 14,7 km/h with the appropriate conclusions regarding the category of classification of the elastic element that equips the studied bumpers (shock insulators) in order to categorize them in one of the A, B or C categories according to the international norms of the European railways, UIC 526-1.

Keywords:
shock insulators, static characteristics, dynamic characteristics

EXPERIMENTAL DETERMINATIONS

The testing for shock insulators [6], [8], [9], [10], [11] was conducted according to the prescription of the UIC 526-1 document. From the testing program presented in UIC 526 - 1 file the following tests were conducted:

1. Testing in order to determine the static characteristics;
2. Testing in order to determine the static characteristics at extreme temperatures -40°C and +50°C;

Testing in order to determine the dynamic characteristics.

STATIC CHARACTERISTICS

Test at +15°C. For the static test, a number of 2 shock insulators were studied (fig. 1) [4], [7]. The characteristic parameters of the category C shock insulators are imposed by the UIC 526-1 file and are the following:

- Precompression force 10 ÷ 50 KN;
- Force after 25mm compression 30 ÷ 130 KN;
- Force after 60mm compression 100÷400 KN;
- Force after 100mm compression 400÷1000 KN;
- stored energy (W_e) ≥ 12.500 J;
- absorbed energy (W_a) ≥ 0,5 W_e.

The experimentally determined characteristic diagrams of the shock insulators are shown in figures 2 and 3.

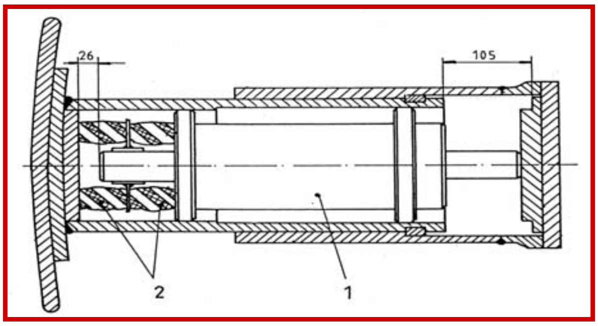

Fig.1 Shock insulator (1. Silicone dampener; 2. Rubber elastic elements)

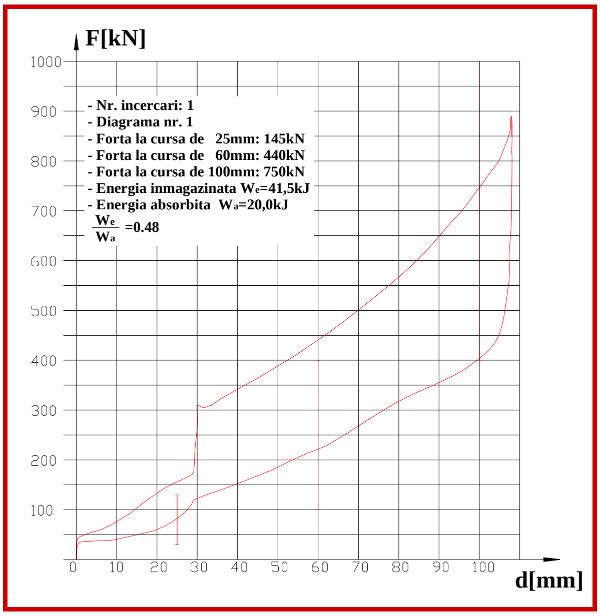

Fig. 2. Experimentally determined characteristic diagrams of the shock insulators

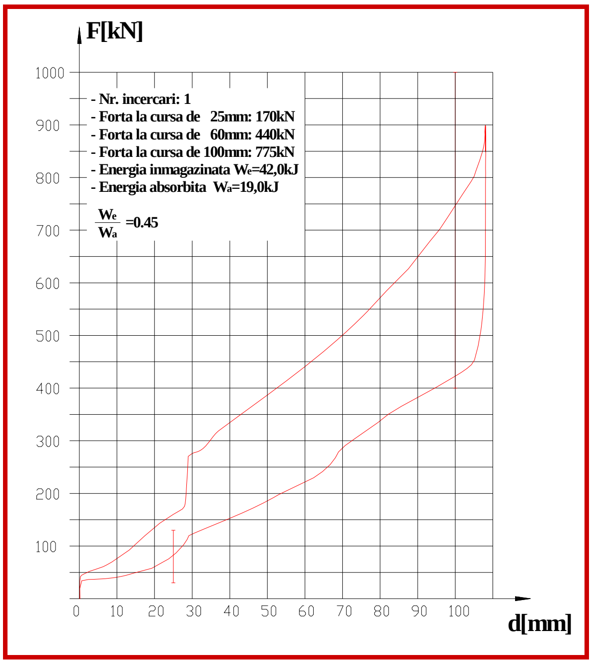

Fig. 3. Experimentally determined characteristic diagrams of the shock insulators

From the analysis of the experimental results it is observed that for the two shock insulators tested, the force characteristics for the 25mm and 60mm compressions and the $\eta = \frac{W_a}{W_e}$ *factor do not fall within the limits imposed by the UIC 526-1 file, while the other characteristics fit within the prescribed limits.*

Test at +50°C*. The test was conducted in a sealed climate controlled chamber where the shock insulators were introduced for a period of 8 hours.*

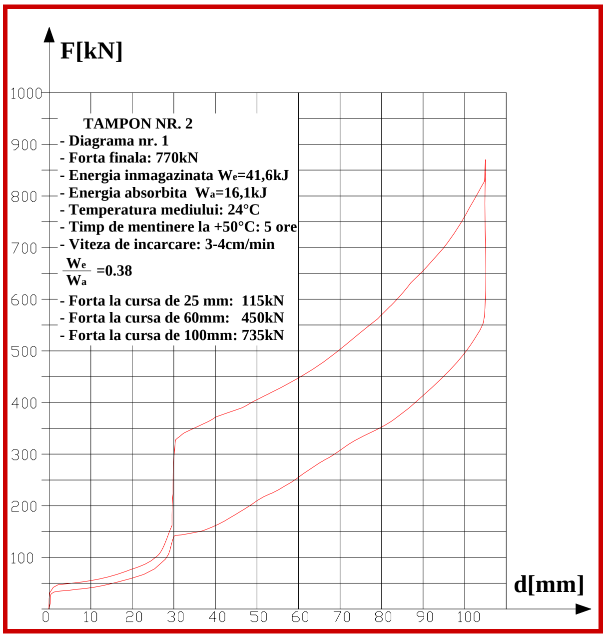

Fig. 4. Experimentally determined characteristic diagrams

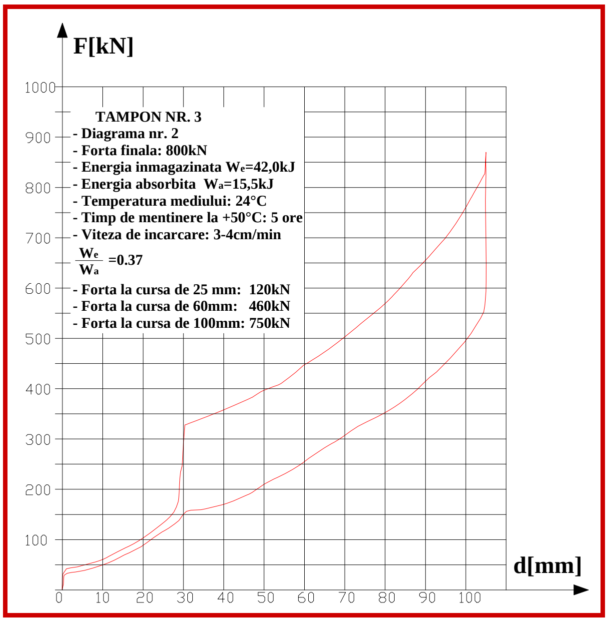

Fig. 5. Experimentally determined characteristic diagrams

The heating was done with an air heater and the temperature control was done with a thermometer.

The results of the tests with the obtained parameter values are shown in figures 4 and 5.

Comparing the results from figures 2 and 4 for the first shock insulator, and from figures 3 and 5 for the second one, the following procentual differences are observed:

Shock insulator 1	Shock insulator 2
$\Delta F_{25} = 21\,\%$	$\Delta F_{25} = 29{,}4\,\%$
$\Delta F_{60} = 2{,}2\,\%$	$\Delta F_{60} = 4{,}5\,\%$
$\Delta F_{100} = 2\,\%$	$\Delta F_{100} = 3{,}3\,\%$
$\Delta W_e = 0{,}2\,\%$	$\Delta W_e = 0\,\%$
$\Delta W_a = 20\,\%$	$\Delta W_a = 19{,}4\,\%$

From the analysis of the above results it is observed that the shock insulators fit (with the exception of ΔF_{25} and the η factor) within the 20 % tolerance admissible by the UIC 526-1.

***Test at -40°C**. In order to conduct this test, shock insulator 2 was dismantled, the elastomer capsule together with the rubber elements were inserted into feutron where they were kept at -40°C for 16 hours. After the cooling time was done, the shock insulator was reconstructed and then the experimental determinations were carried out.*

The results of the tests together with the obtained parameter values are shown in fig. 6.

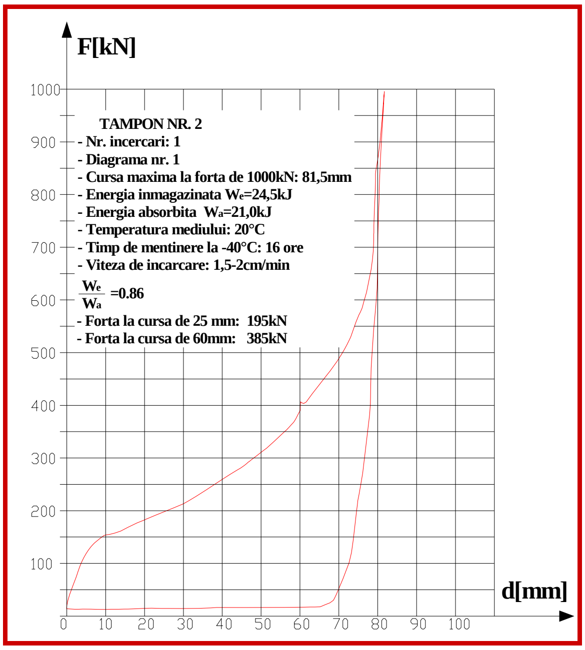

Fig. 6. Experimentally determined characteristic diagrams

Comparing the results from figures 3 and 6, the following procentual differences are observed:

- $\Delta F_{25} = 34{,}4\,\%$;
- $\Delta F_{60} = 22{,}5\,\%$;
- $\Delta W_e = 41\,\%$;
- $\Delta W_a = 5\,\%$.

From the analysis of the results it is observed that during the -40°C testing the buffer no longer complies with the requirements of UIC 526-1. Furthermore, the buffer only underwent a compression of 81mm.

COLLISION TESTING IN ORDER TO DETERMINE THE DYNAMIC CHARACTERISTICS OF THE SHOCK INSULATORS

Collision testing was conducted according to the prescriptions of UIC 526-1. The testing was done with two cars with masses of 80t (figure 7), the collided car being equipped with category C shock insulators [1], [5]. The colliding car was equipped with category A shock insulators with rubber elastic elements.

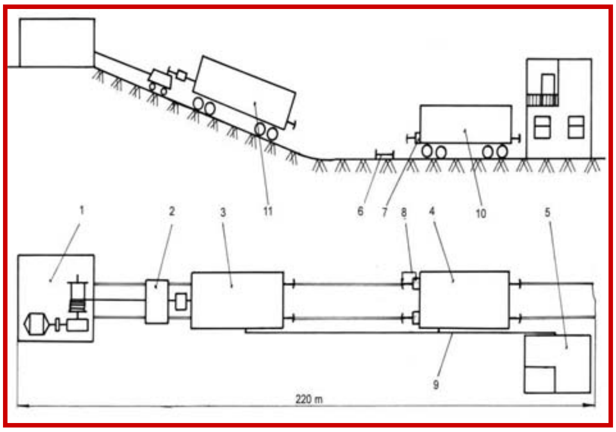

Fig. 7 Collision testing stand (1. whinch ; 2. Releasing cart ; 3. Colliding car ; 4. Collided car ; 5. Stand building ; 6. Velocity transductor ; 7. Force transductor ; 8. Displacement transductor ; 9. Connection cables ; 10. Acceleration transductors)

The transductors and the measurement apparata used, as well as their placement are shown in fig. 8 [2]. The colliding car was launch at increasing velocities, up to 15 km/h towards the collided car. During the impact, the time evolutions of the following parameters were measured (table 1):

- *force transmitted throufh the buffers F_1 and F_2;*
- *buffer compression D_1 and D_2;*
- *acceleration of the collided car „a”.*

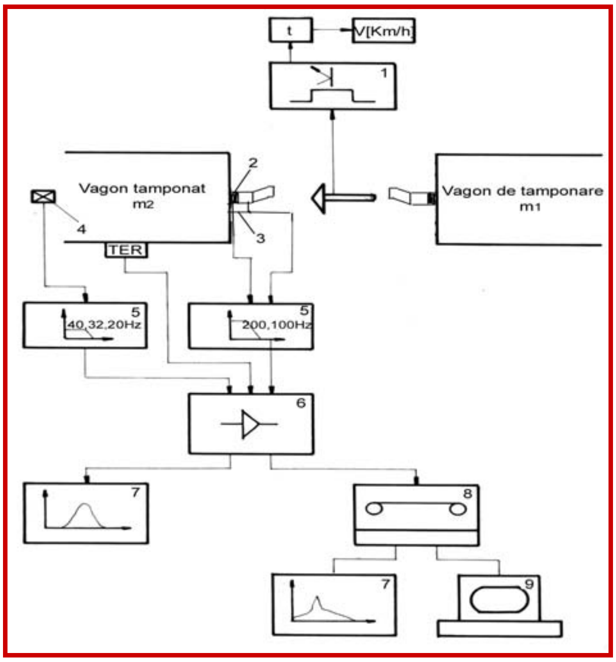

Fig. 8 Transductors, experimental data measurement, recording and analysis apparata (1. Velocity transductor; 2. Force transductor; 3. Displacement transductor; 4. Acceleration transductor; TER. Resistive tensometric transductor; 5. Low-pass frequency filters; 6. Measurement amplifier; 7. Ultraviolet recorder; 8. Magnetic recorder; 9. Computer)

Table 1

No.	Velocity [km/h]	W_{e1} [kJ]	W_{e2} [kJ]	$W_{e\,MEDIU}$ [kJ]
1.	6,15	7,5	9,0	8,25
2.	8,20	18,0	13,9	15,95
3.	10,14	30,5	22,1	26,30
4.	11,84	47,7	35,4	41,55
5.	13,84	57,3	38,2	47,75
6.	14,70	61,3	42,8	52,05
No.	F_1 [MN]	F_2 [MN]	F_{MEDIU} [MN]	a (0-20Hz) [g]
1.	0,381	0,297	0,340	1,41
2.	0,559	0,348	0,454	1,79
3.	0,725	0,478	0,601	2,27
4.	1,031	0,620	0,825	3,14
5.	1,297	0,930	1,113	4,48
6.	1,514	1,059	1,286	5,31

By eliminating time from the variations of force F = f (t) and compression D = f (t) the diagrams F = f (D) were obtained. From these diagrams, the following parameters were determined: W_e - stored energy; W_a - absorbed energy and $\eta = \dfrac{W_a}{W_e}$ [3].

The F = f (D) diagrams are shown in figures 9 and 10.

The variations of the average stored energy of the two shock insulators were represented as a function of the velocity of the collided car (figure 11), and of the average transmitted force through the two shock insulators (figure 12).

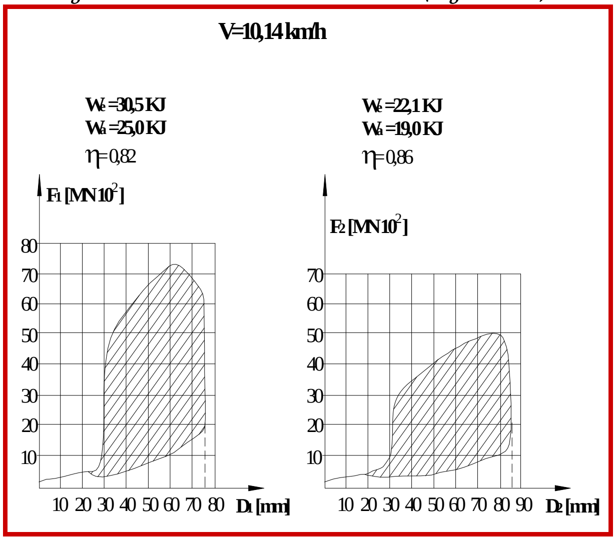

Fig. 9. The F = f (D) diagram

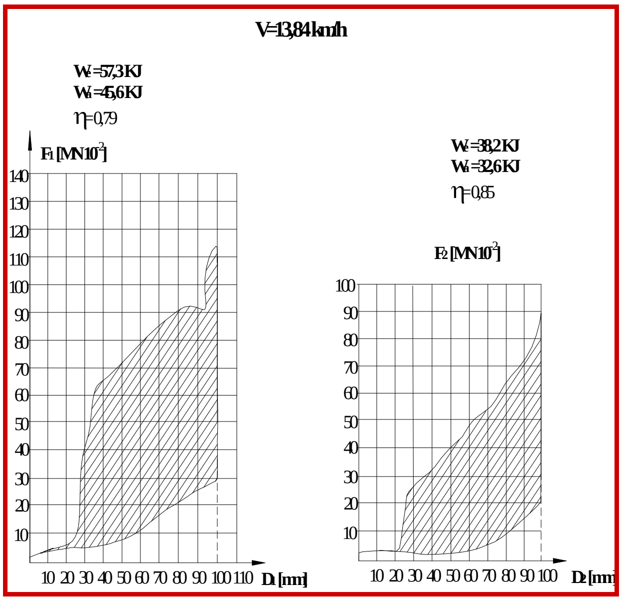

Fig. 10. The F = f (D) diagram

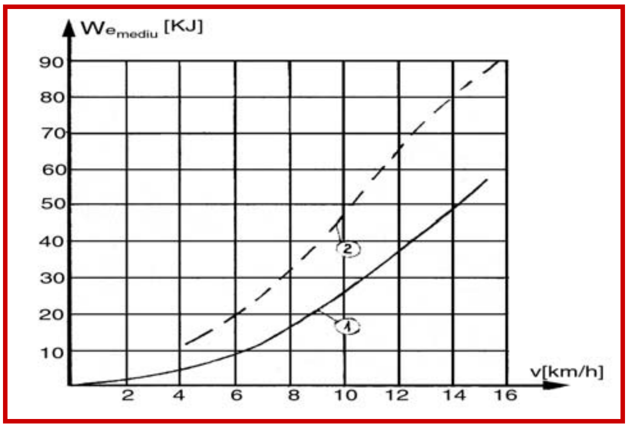

Fig. 11
1. Cat. C buffer with elastomers
2. Cat. C buffer ICPVA

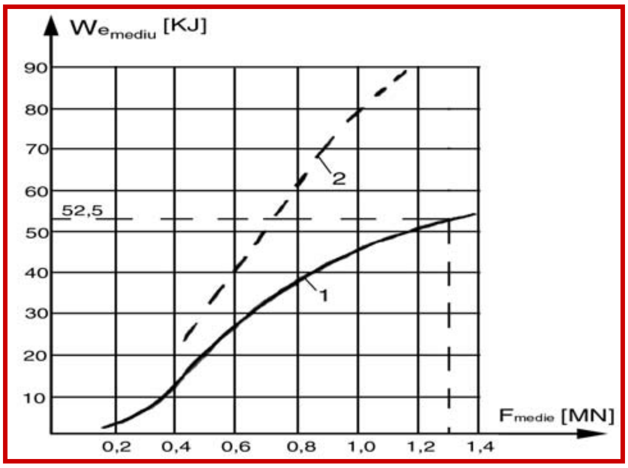

Fig. 12
1. Cat. C buffer with elastomers
2. Cat. C buffer ICPVA

According to the diagram in figure 12, the average stored energy on the two studied shock insulators, $W_{e\ MEDIU}$, at the average force transmitted through the buffers of 1,3 MN is $W_{e\ MEDIU} = 52{,}5\ kJ$. According to the requirements of the UIC 526-1, for category C buffers it is necessary for a value in excess of 70 kJ to be reached.

CONCLUSION

After the analysis of the experimental results, the following conclusions can be drawn:

- In regard to the static characteristics, the buffers do not correspond to the requirements of the UIC 526-1, the values of the absorbtion coefficient η corresponding to the force at 25 mm and 60 mm does not fit within the admissible limits.
- For the extreme temperature tests, the studied buffers do not correspond to the UIC 526-1 norms. We point out that at -40°C the buffer only underwent a compression of 81 mm and it did not return to the initial displacement, by 31mm, which, in use, determines the altering of the clearance between car buffers.
- In regard to the dynamic characteristics, the tested buffers do not correspond to the requirements imposed by the UIC 526-1 for category C buffers. The buffers fit within the limits imposed by category B buffers.

In conclusion, the tested buffers correspond to the norms of cateory B buffers in regards to the dynamic characteristics without fulfilling the requirements for the static characteristics at extreme temperatures.

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ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

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BOUNDARY ADAPTED SPECTRAL APPROXIMATION FOR SPATIAL STABILITY OF BATCHELOR VORTEX

Abstract:
The main goal of this paper is to develop a methodology for analyzing the non-axisymmetrical swirling flows with helical vortex breakdown by means of linear stability analysis. For the case of high Reynolds numbers the eigen value problem governing the linear stability analysis of the Batchelor vortex is investigated using a boundary adapted spectral collocation technique. A symmmetrization is performed eliminating all geometric singularities on the left-hand sides of the governing equations set. The method provides a fairly accurate approximation of the spectrum without any scale resolution restriction.

Keywords:
swirling flow, Batchelor vortex, spectral collocation

INTRODUCTION

Most of the vortex stability analyses concerned axisymmetrical vortices with axial flow [1] in order to explain the vortex breakdown phenomenon observed experimentally for the first time on delta wings [2], in pipes [3] and in cylinders with rotating ends [4]. Obviously, the axial symmetry hypothesis is a major simplification having the main benefit of dramatically reducing the computational cost [5]. On the other hand, it introduces important limitations as far as the three-dimensionality and unsteadiness of the flow are concerned.

The present paper focused on developing an analytical and numerical technique for analyzing the eigenvalue problem governing the linear stability of an inviscid swirling fluid flow under small perturbations. This problem is characterized by a system of ordinary differential equations with variable coefficients.

In most cases, the spatially or temporal stability (classified for open flows as in [6]) under infinitesimal perturbations is reduced to the study of an algebraic eigenvalue problem of this type. The study leads to a dispersion relation connecting in fact the growth rate ω and the axial wavenumber k as a consequence of the condition that nontrivial eigenvalues to exist. Most of the investigations [1], [7] concerned the values of these nondimenional parameters for which the vortex become unstable in the case of either a spatial stability or temporal stability investigation. Since the investigation of this aspect may imply a large amount of measurement, one must resort also to numerical techniques. Although a spatial stability analysis implies the investigation of a nonlinear eigenvalue problem this type of analysis directly provides the frequency ranges of the most unstable modes. In this paper we consider a more general mathematical model for swirling flow stability analysis, starting with the unsteady Euler equations in cylindrical coordinates. In doing so, we can examine both unsteady and circumferentially variable perturbations.

The paper is organized as follows. The eigenvalue problem governing the linear stability analysis for inviscid swirling flows against normal mode perturbations is defined in Section 2. The third section a new radial spectral approximation is proposed and in Section 4 the method is applied for the Batchelor vortex case and the actual numerical procedure is presented. The main advantages of the proposed methods are pointed out in Section 5.

PROBLEM FORMULATION

The governing equations in the case of incompressible and inviscid flow are the Euler equations

$$\nabla \cdot \underline{V} = 0,\ \frac{\partial \underline{V}}{\partial t} + (\underline{V} \cdot \nabla)\underline{V} = -\frac{1}{\rho}\nabla p \qquad (1)$$

The following flow fields decomposition are used: velocity $\underline{V} + \underline{v}$, *pressure* $p + \pi$ *where* $(\underline{V}, p)$ *is the base flow, and* $(\underline{v}, \pi)$ *is the perturbation considered small.*
Since the base flow obey the Euler equations (1) the evolution of such small perturbations of the basic flow is governed by the linearized Euler equations

$$\nabla \cdot \underline{v} = 0,\ \frac{\partial \underline{v}}{\partial t} + (\underline{V} \cdot \nabla)\underline{v} + (\underline{v} \cdot \nabla)\underline{V} = -\frac{1}{\rho}\nabla \pi \qquad (2)$$

In the linearization process the second order terms in the small perturbations were neglected. Assuming a steady columnar flow the velocity profile is written

$$\underline{V}(r) = [U(r), 0, W(r)] \qquad (3)$$

where U *represents the axial velocity component* W *the azimuthal component of the velocity both depending only on radius. Next, we consider the following factorization of the small perturbations*

$$[\underline{v}(t,z,r,\theta), \pi(t,z,r,\theta)] = [F(r), iG(r), H(r), P(r)] \exp[i(kz + m\theta - \omega t)] \qquad (4)$$

Introducing the factorization form (4) into the linearized Euler equations (2) we obtain the following system of first order differential equations

$$k r F + G + r G' + m H = 0 \qquad (5a)$$

$$kUG - \omega G + \frac{mWG}{r} + \frac{2WH}{r} - P' = 0 \qquad (5b)$$

$$rHkU - rH\omega + m(HW + P) + WG + rGW' = 0 \qquad (5c)$$

$$FkU - F\omega + \frac{FmW}{r} + U'G + kP = 0 \qquad (5d)$$

where prime denotes differentiation with respect to the radius. This homogenous first order differential system is completed with the following boundary conditions at axis and the far field

$$\begin{cases} G(0) = H(0) = 0, F(0), P(0)\ \text{finite}, (m = 0), \\ H(0) \pm G(0) = 0, F(0) = P(0) = 0, (m = \pm 1), \\ F(0) = G(0) = H(0) = P(0) = 0, (|m| > 1), \\ F, G, H, P \to 0, (r \to \infty) \end{cases} \qquad (6)$$

Equations (5) and (6) represent an eigenvalue problem.

BOUNDARY ADAPTED RADIAL SPECTRAL APPROXIMATION

The pseudospectral - collocation method is one of the most used technique for the numerical investigations in hydrodynamic stability problems. Many researchers have demonstrated the applicability of this method with high degree of accuracy to eigenvalue problems governing the linear stability of swirling flows [9-11].
The difference between the classical method and the modified version proposed here is given by the selected spaces involved in the discretization process motivated by the need to adapt the grid points to the singularities of the underlying solution.
In fact the boundary conditions (6) at infinity are applied at a truncated radius distance r_{max} *selected large enough such that the numerical results do not depend on this truncated distance.*
Following [9] we define the boundary-adapted functions $\{\phi_k\}, k = 1\ldots,N$ *of modal type, i. e. each function provides one particular pattern of oscillation*

$$\phi_k(r) = \left(1 - \frac{r}{r_{max}}\right) \cdot r \cdot T_k^*(r), \quad \{\phi_k\}, k = 1\ldots,N \qquad (7)$$

with T_k^* the shifted Chebyshev polynomials on $[0, r_{\max}]$. These type of polynomials defined on the physical space are used in order to optimize the interpolative procedure. The choice is based on the condition that the values of the grid points are given by the same elementary analytic expression for all values of N and they did not have to be computed numerically for every N.
The linear transformation that mapps the standard interval $\xi \in [-1,1]$ into the physical range of our problem $r \in [0, r_{\max}]$ and preserves the clustering rate of collocation nodes is defined by the linear transformation

$$r(\xi) = \frac{r_{max}}{2}\xi + \frac{r_{max}}{2} \quad (8)$$

while the inverse transformation is defined

$$\xi(r) = 2\frac{r}{r_{max}} - 1 \quad (9)$$

The proposed method allowed us to discard the first and last collocation nodes, expansion functions satisfying the boundary conditions from the construction of our modal boundary-adapted basis. In this way the critical singularities which occurred in evaluating terms like 1/r for the numerical treatment of the eigenvalue problem were eliminated. Then the solution is approximated with respect to this expansion set of functions,

$$(F,G,H,P) = \sum_{k=1}^{N}(u_k, v_k, w_k\, p_k)\phi_k(r) \quad (10)$$

A modified Chebyshev Gauss grid $\Xi = (\xi_j)_{0 \le j \le N-1}$ in $[-1,1]$ was constructed

$$\xi_j = \cos\left(\pi + \frac{2j\pi}{2N-2}\right),\ \xi_j \in [-1,1],\ j = 0..N-1 \quad (11)$$

In our case the collocation nodes clustered near the boundaries diminishing the negative effects of the Runge phenomenon. Another aspect is that the convergence of the interpolant on the clustered grid towards unknown function is extremely fast.
Each of the basis functions from (7) meet the relations

$$\phi_k(r_1 = 0) = \phi_k(r_N = r_{\max}) = 0,$$
$$\phi_k(r_j) \ne 0,\ j = 1..N,\ k = 2..N-1 \quad (12)$$

which implies that each functions F, G, H, P satisfy the boundary conditions (6).
With (10) the mathematical model takes the form

$$kr\sum_{k=1}^{N}u_k\Phi_k(r) + \sum_{k=1}^{N}v_k\Phi_k(r) + rG' + m\sum_{k=1}^{N}w_k\Phi_k(r) = 0 \quad (13a)$$

$$\left(ku_z - \omega + \frac{mu_\theta}{r}\right)\sum_{k=1}^{N}v_k\Phi_k(r) + \frac{2u_\theta}{r}\sum_{k=1}^{N}w_k\Phi_k(r) - P' = 0 \quad (13b)$$

$$(rku_z - r\omega)\sum_{k=1}^{N}w_k\Phi_k(r) + m\left(u_\theta\sum_{k=1}^{N}w_k\Phi_k(r) + \sum_{k=1}^{N}p_k\Phi_k(r)\right)$$
$$+(u_\theta + ru_\theta')\sum_{k=1}^{N}v_k\Phi_k(r) = 0 \quad (13c)$$

$$\left(ku_z - \omega + \frac{mu_\theta}{r}\right)\sum_{k=1}^{N}u_k\Phi_k(r)$$
$$+ u_z'\sum_{k=1}^{N}v_k\Phi_k(r) + k\sum_{k=1}^{N}p_k\Phi_k(r) = 0 \quad (13d)$$

Let us denote by $[r] = diag(r_i)$, r_i given by (8), $i = 0,\dots,N-1$, $[\phi] = (\phi_{ij})_{1\le i\le N,\ 1\le j\le N}$, $\phi_{ij} = \phi_j(r_i)$, $[U] = diag(U(r_i))$, $[W] = diag(W(r_i))$, $1 \le i \le N$. The system (13) can be written $(kM_k + \omega M_\omega + mM_m + M_0)\bar{s} = 0$ with $\bar{s} = (\bar{f}\ \ \bar{g}\ \ \bar{h}\ \ \bar{p})^T$ and the matrices M_k, M_ω, M_m and M_0 having the following explicit forms

$$M_k = \begin{pmatrix} [r][\phi] & 0 & 0 & 0 \\ 0 & [U][\phi] & 0 & 0 \\ 0 & 0 & [rU][\phi] & 0 \\ [U][\phi] & 0 & 0 & [\phi] \end{pmatrix} \quad (14);$$

$$M_\omega = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & -[\phi] & 0 & 0 \\ 0 & 0 & -[r][\phi] & 0 \\ -[\phi] & 0 & 0 & 0 \end{pmatrix} \quad (15)$$

$$M_m = \begin{pmatrix} 0 & 0 & [\phi] & 0 \\ 0 & \left[\frac{W}{r}\right][\phi] & 0 & 0 \\ 0 & 0 & [W][\phi] & [\phi] \\ \left[\frac{W}{r}\right][\phi] & 0 & 0 & 0 \end{pmatrix} \quad (16);$$

$$M_0 = \begin{pmatrix} 0 & [\phi]+[r]D & 0 & 0 \\ 0 & 0 & 2\left[\frac{W}{r}\right][\phi] & -D \\ 0 & [W][\phi]+[rW'][\phi] & 0 & 0 \\ 0 & [U'][\phi] & 0 & 0 \end{pmatrix} \quad (17)$$

By differentiating (10) results

$$F'(r) = \sum_{k=1}^{N} \left\{ \begin{aligned} &\left(1-\frac{2r}{r_{\max}}\right) u_k T_k^*(r) \\ &+ \left(1-\frac{r}{r_{\max}}\right) r u_k T_k^{*\prime}(r) \end{aligned} \right\} \quad (18)$$

For $k = 1$ we have $T_1^{*\prime}(r) = 0$ and rewriting (18) we have

$$F'(r) = \left(1-\frac{2r}{r_{\max}}\right) u_1 T_1^*(r) + \sum_{k=2}^{N} \left\{ \left(1-\frac{2r}{r_{\max}}\right) u_k T_k^*(r) + \left(1-\frac{r}{r_{\max}}\right) r u_k T_k^{*\prime}(r) \right\} \quad (19)$$

The shifted Chebyshev polynomials meet the recurrence relation

$$T_n^{*\prime}(r) = \frac{r_{\max}}{4} \frac{(n-1)}{r(r_{\max}-r)} \left[T_{n-1}^*(r) - T_{n+1}^*(r)\right], \ n \geq 2 \quad (20)$$

thus

$$F'(r) = \left(1-\frac{2r}{r_{\max}}\right) u_1 T_1^*(r) + \sum_{k=2}^{N} u_k \left\{ \left(1-\frac{2r}{r_{\max}}\right) T_k^*(r) + \left(1-\frac{r}{r_{\max}}\right) r \frac{r_{\max}}{4} \frac{(k-1)}{r(r_{\max}-r)} \left[T_{k-1}^*(r) - T_{k+1}^*(r)\right] \right\} \quad (21)$$

The interpolant derivative matrix D from (17) was evaluated by

$$D = \begin{pmatrix} \left(1-\frac{2r_1}{r_{max}}\right) T_1^*(r_1) & E_2(r_1) & E_3(r_1) & \ldots & E_N(r_1) \\ \left(1-\frac{2r_2}{r_{max}}\right) T_1^*(r_2) & E_2(r_2) & E_3(r_2) & \ldots & E_N(r_2) \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ \left(1-\frac{2r_N}{r_{max}}\right) T_1^*(r_N) & E_2(r_N) & E_3(r_N) & \ldots & E_N(r_N) \end{pmatrix} \quad (22)$$

where

$$E_k(r) = \left(1-\frac{2r}{r_{\max}}\right) T_k^*(r) + \frac{k-1}{4}\left[T_{k-1}^*(r) - T_{k+1}^*(r)\right], \quad k \geq 2 \quad (23)$$

This algorithm allows us to obtain the eigenvalue, the eigenvector, the index of the most unstable mode, the maximum amplitude of the most unstable mode and the critical distance where the perturbation is the most amplified.

The main advantages of the proposed method consist in reducing the computational time by reducing the matrices order to $(4N-8)^2$ and for a certain spectral parameter N we obtain an exponential decreasing error.

NUMERICAL RESULTS FOR BATCHELOR VORTEX

The above presented method was tested on a particular benchmark model: the Batchelor or q-vortex [7].

The flow field is characterized by the velocity field $\underline{V}(r) = [U(r), 0, W(r)]$ [4],

$$U(r) = a + e^{-r^2}, \ W(r) = \frac{q}{r}(1-e^{-r^2}) \quad (24)$$

where q represents the swirl number defined as the angular momentum flux divided by the axial momentum flux times the equivalent nozzle radius and a provides a measure of free-stream axial velocity.

In [7] the numerical investigation of the two-point boundary value problem was based on a shooting method. The properties of the Batchelor vortex are pointed out by considering them as functions of the swirl ratio q and the external flow parameter a.

The computed spectrum of the eigenvalue problem is depicted in Figure 1. Graphical representations of the spatial eigenfunction amplitudes of the most unstable mode are given *in the Figure 2. For a stabilization of the Gibbs phenomenon a Lanczos type σ factor [10] was used,*

$$\sigma_k = \frac{\sin\frac{2\pi k}{N}}{\frac{2\pi k}{N}}, \quad 1 \le k \le N \qquad (25)$$

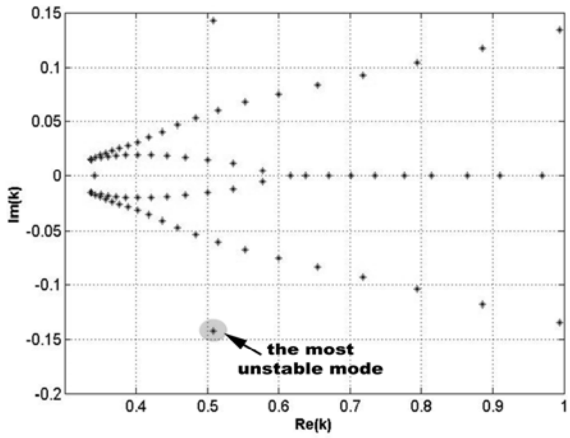

Figure 1. Spectra of the hydrodinamic eigenvalue problem computed at $\omega = 0.01$, $m=-3$, $a = 0$, $q = 0.1$, $N = 150$.

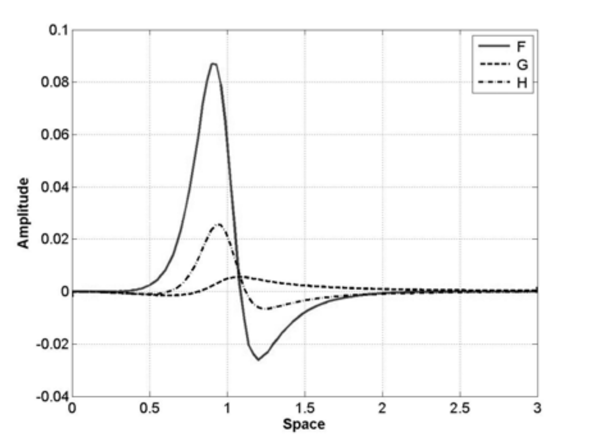

Figure 2. Values of eigenfunction amplitudes of the most unstable mode $\omega = 0.01$, $m = -3$, $a = 0$, $q = 0.1$, $N = 150$, $k = 0.50842-0.14243i$.

Table 1. Convergence behaviour of the critical distance for the most unstable mode with $\omega = 0.01$, $a = 0$, $q = 0.1$ and $m = -3$.

N	Axial wavenumber k	Critical distance r_c
100	0.64887-3.7433i	0.00302
150	0.50842-0.14243i	0.90051
180	0.50847-0.14232i	0.92294
250	0.50854-0.14216i	0.95451
300	0.50857-0.14209i	0.93874

CONCLUSION

In this paper we developed a spectral numerical procedure to investigate the spatial stability of a swirling flow subject to infinitesimal perturbations. Using a spectral collocation technique our numerical procedures directly provided relevant information on perturbation amplitude for stable or unstable induced modes, the maximum amplitude of the most unstable mode and the critical distance where the perturbation is the most amplified.

The accuracy of the methods is assessed underlying the necessity for the construction of a certain class of orthogonal expansions functions satisfying the boundary conditions. The key issue was the choice of the grid and the choice of the modal trial basis, the scheme based on shifted Chebyshev polynomials provided good results.

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ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

OCTAVIAN LIPOVAN

SOME GENERALISATION OF THE BARTLE, DUNFORD AND SCHWARTZ INTEGRABILITY MODEL

Abstract:
In [4] the author introduces the notion of pseudosubmeasure as generalization of the submeasure concept [2], and studies some proprieties of the pseudosubmeasure functions with values in a pseudometric space.
The purpose of this paper is to develop an integration theory for these functions, with respect to a semigroup valued measure, using families of pseudosubmeasure and the associated topological rings.
AMS Subject Classification Code (2000):28A20, 28B15

Keywords:
Bartle, Dunford and Schwartz integrability model, generalisation, theory

PRELIMINARIES

The notions and the notations used here follow the paper [4].

Let D be an ordered set with the smallest element d_0 .On this set we define a mapping: $(d_1, d_2) \to d_1 + d_2$ *with the following properties:*

(P1) $d_o + d = d + d_0; \forall d \in D$

(P2) $d_1 + d_2 = d_2 + d_1; \forall d_1, d_2 \in D$

(P3) $d_1 \le d_2 \Rightarrow d + d_1 \le d + d_2; \forall d \in D$

There exists a subset $D_1 \subseteq D$ *left directed such that*

(P4) $\forall d \in D_1, \exists d_1 \in D$

so that $d_1 + d_1 \le d$.

Definition 1.1. *A pseudometric on a set X is a D-valued function* $p : X \times X \to D$ *so that:*

(i) $p(x, y) = d_0 \Leftrightarrow x = y$

(ii) $p(x, y) = p(y, x), x, y, z \in X$

(iii) $p(x, y) \le p(x, z) + p(z, y); x, y, z \in X$.

A set X together with a pseudometric ρ *is called a pseudometric space and is denoted by* (X, ρ, D).

Remark 1.2. *Every uniform space (X,* $\mathcal{U}$ *) is pseudosemimetrizable, [4]. Let* $\mathcal{S}$ *be a ring (or algebra) of subsets of fixed set S.*

Definition 1.3. *A pseudosubmeasure on a ring* $\mathcal{S} \subset \mathcal{P}(S)$ *is a mapping* $\gamma : \mathcal{S} \to D$ *such that:*

(S_1) $\gamma(\varnothing) = d_0$

(S_2) $E \subseteq F \Rightarrow \gamma(E) \le \gamma(F), E, F \in \mathcal{S}$

(S_3) $\gamma(E \cup F) \le \gamma(E) + \gamma(F), E, F \in \mathcal{S}$

If γ *has the propert that* $\gamma(A) = d_0 \Rightarrow A = \varnothing$, *then mapping* $p : \mathcal{S} \times \mathcal{S} \to D$; $\rho(A, B) = \rho(A \Delta B)$ *is a pseudometric on* $\mathcal{S}$ *invariant to translation* Δ *(symmetric difference).*

Let $\Gamma = \{\gamma_i : \mathcal{S} \to D\}_{i \in I}$ *be a family of pseudosubmeasure on* $\mathcal{S} \subset P(S)$ *and consider the family* $\Omega_\Gamma = \{v_{K,d} : K = \text{finite} \subseteq I, d \in D_1\}$, *where* $v_{K,d} = (A \in \mathcal{S} : \gamma_i(A) \le d, a \in K\}$.

Then there exist a FN-topology $\tau(\Gamma)$ *on* $\mathcal{S}$ *so that* $\mathcal{S}(\Gamma) = (\mathcal{S}, \Delta, \cap, \tau(\Gamma)$ *) is a topical ring. Let* (X, ρ, D) *be a pseudometric space.*

By generalizing the model established in [3], we introduce an uniform structure on X^S in the following way: To every K = finite $\subset I, d \in D$, we associate the set:

$$W_k(D)=\{(f,g)\in X^S\times X^S;\gamma_i\{s\in S;\rho(f(s),g(s))\geq d\}<d, i\in K\}$$

Then, the family $\{W_k(d); d\in D_1, K = \text{finite}\subset I\}$ *forms a base for an uniform structure* $\mathcal{U}_\Gamma$ *on* X^S. *We denote* $X^S(\Gamma) = (X^S, \mathcal{U}_\Gamma)$. *The map* $f \in X^S$ *is a* $\mathcal{S}$*-step function if there exists* $x_i \in X, E_i \in \mathcal{S}, i = 1,2,...,n$

$x_i \neq x_j, E_i \cap E_j = \emptyset, i \neq j, S = \bigcup_{i=1}^{n} E_i$ *so that* $\forall s \in E_i$ *imply* $f(s) = x_i, i = 1,2,...,n$.

The space of $\mathcal{S}$*-step functions will be denoted by* $\mathcal{E}(\mathcal{S}, X)$.

Definition 1.4. *The function* $f \in X^S$ *is* Γ*-pseudosubmeasurable if f belongs to the closure of* $\mathcal{E}(\mathcal{S}, X)$ *in* $X^S(\Gamma)$.

We denote by $\mathcal{M}[\mathcal{S}, \Gamma, X]$ *the set of these functions.*

Definition 1.5. *Let* $\{f_a\}$ *be a generalized sequence in* $\mathcal{M}[\mathcal{S}, \Gamma, X]$ *and* $f \in \mathcal{M}[\mathcal{S}, \Gamma, X]$. *If* $f_a \to f$ *in* $X^S(\Gamma)$, *then* $\{f_a\}$ *converges to f in* Γ*-pseudomeasures and we denote* $f_a \xrightarrow{r} f$.

BASIC ASSUMPTIONS

Let S *be a nonempty set,* $\mathcal{S} \subset P(S)$ *be an algebra of subsets of S and consider a family of pseudosubmeasures* $\Gamma = \{\gamma_i : \mathcal{S} \to D\}_{i\in I}$.

Let $(X_i, \rho_i, D^i), i = 1,2,3$ *be three pseudometric abelian semigroups for which the addition is uniformly continous with respect to the pseudometric* ρ_i).

In the sequel we consider an additive set function $\mu : \mathcal{S} \to X_2, \mu(\emptyset) = 0$, *and we will choose a family of pseudosubmeasures as it will be specified.*

The maps which are to be integrated with respect to μ *will belong to* X_1^S *and the integral with take values in* X_3 *or its completion* $\hat{X}_3$.

Suppose that a separate continuous bilinear map exists $X_1 \times X_2 \to X_3; (x, y) \mapsto x\cdot y$ *so that:*

i) $x\cdot 0 = 0\cdot y = 0, (x \in X_1, y \in X_2)$

ii) $(x_1 + x_2)\cdot(y_1 + y_2) = x_1\cdot y_1 + x_1\cdot y_2 + x_2\cdot y_1 + x_2\cdot y_2, (x_1, y_1 \in X_1, x_2, y_2 \in X_2)$.

Finally we suppose that Γ_μ, μ *and the above bilinear map are chosen so that the following continuity axioms are satisfied:*

C1) For avery $F \in \mathcal{S}$ *and every* $d' \in D_1^3$ *there exists* $d' \in D_1^1$ *with the following property: for any* $n \in N$, *if* $\rho_1(x_i, y_i) < d', i = 1,2,...,n$ *and* $\{E_i\}$ *is sequence of pairwise disjoint set from* $\mathcal{S}$ *then:* $\rho_3\left(\sum_{i=1}^{n} x_i\mu(E_i \cap F), \sum_{i=1}^{n} y_i\mu(E_i \cap F)\right) < d$.

C2) For any $x \in X_1$, $\lim_{\substack{E\to\emptyset \\ E\in\mathcal{S}}} x\mu(E) = 0$.

INTEGRABLE FUNCTIONS

Let $f \in \mathcal{E}(\mathcal{S}, X)$ *be a* $\mathcal{S}$*-step function.*

Definition 3.1. *For* $E \in \mathcal{S}$, *the integral of f on E is by definition* $\int_E f d\mu = \sum_{i=1}^{n} x_i\mu(E_i \cap E)$.

We denote by $\mathcal{E}(\mathcal{S}, \Gamma_\mu, X_1, X_3)$ *the set of* Γ_μ*-integrable step functions.*

Theorem 3.2. *(i) Relatively to the operation* $(f + g)(s) = f(s) + g(s)$, *the space* $\mathcal{E}(\mathcal{S}, \Gamma_\mu, X_1, X_3)$ *is a subsemigroup of* X_1^3.

(ii) For $E \in S$, *the map* $f \to \int_E f d\mu$ *from* $\mathcal{E}(\mathcal{S}, \Gamma_\mu, X_1, X_3)$ *to* X_3 *is additive.*

(iii) For $f \in \mathcal{E}(\mathcal{S}, \Gamma_\mu, X_1, X_3)$ *the map* $E \to v(E), v(E) = \int_E f d\mu, E \in \mathcal{S}$ *is an additive function.*

(iv) For $f \in \mathcal{E}(\mathcal{S}, \Gamma_\mu, X_1, X_3)$;

$$\lim_{E \xrightarrow{\Gamma_\mu} 0} v(E) = \lim_{E \xrightarrow{\Gamma_\mu} 0} \int_E f d\mu = 0$$

The proof follows from definition 3.1 and axioms C_1 *and* C_2. *The extension of the integral from step functions to the arbitrary functions in* X_1^S *is based on the following result:*

Lemma 3.3. *Let* $\{f_a\}$ *be a generalized sequence from* $f \in \mathcal{E}(\mathcal{S},\Gamma_\mu, X_1, X_3)$, *which is Cauchy in* $X_1^S(\Gamma_\mu)$. *For* $\left\{\int_E f_\alpha d\mu\right\}$ *to be a Cauchy sequence in* X_3 *uniform with respect to* $E \in \mathcal{S}$ *it is necessary and sufficient that:*

a) For any neightbourhood V of 0 in X_3 *there exists an index* $\alpha_0, K =$ *finite* $\subset I$ *and* $d \in D$, *so that :*$\alpha \geq \alpha_0$ *and* $\gamma_i(E) < d, i \in K$ *imply* $\int_E f_\alpha d\mu \in V$

b) For sny neighbourhood V of 0 in X_3 *there exists and index* α_0 *and* $F \in \mathcal{S}$ *so that* $\int_E f_\alpha d\mu \in V$ *if* $\alpha \geq \alpha_0$ *and* $E \in \mathcal{S}, E \subset S - F$.

Proof. Necessity. *For any neighbourhood V of 0 in* X_3 *there exists a symmetric entourage W of the uniform structure from* X_3 *so that* $W^2(0) \subseteq V$.

Let α_0 *be so that* $\left(\int_E f_\alpha d\mu, \int_E f_{\alpha_0} d\mu\right) \in W$ *for any* $E \in \mathcal{S}$ *if* $\alpha \geq \alpha_0$.

From Theorem 3.2., IV, it results that exists $d \in D_1, K =$ *finite* $\subset I$ *so that we have:* $\int_E f_{\alpha_0} d\mu \in W(0)$ *if* $\gamma_i(E) < d, i \in K$.

Therefore $\int_E f_\alpha d\mu \in V$ *if* $\alpha \geq \alpha_0$ *and* $\gamma_i(E) < d, i \in K$, *that is the condition a).*

The condition b) is obtained by taking $E = \{s \in S : f_{\alpha_0}(s) \neq 0\}$. *We have* $F \in \mathcal{S}$*, and* $\int_E f_{\alpha_0} d\mu = 0$ *for all* $E \in \mathcal{S}$ *with* $E \subset S - F$.

Sufficiency. *Let W be a symmetric entourage for* X_3 *and let* $\alpha_0, K =$ *finite* $\subset I$, $d \in D_1$ *and F be chosen depending on the neighbourhood W(0) according to the conditions a) and b) simultaneously. For F and W, let entourage U from* X_1 *be chosen according to axiom* C_1.

We write

$$F_{\alpha\alpha'} = \{s \in S; (f_\alpha(s), f_{\alpha'}(s)) \notin U\}, F_{\alpha\alpha'} \in S.$$

Since $\{f_\alpha$ *is Cauchy in* $X_1^S(\Gamma_\mu)$ *there exists* $\alpha_1 \geq \alpha_0$ *so that* $\gamma_i(F_{\alpha\alpha'}) < d, i \in K$ *for* $\alpha, \alpha' \geq \alpha_1$. *For E* $\in \mathcal{S}$ *in the semigroup* $X_3 \times X_3$, *we can write:*

$$\left(\int_E f_\alpha d\mu, \int_E f_{\alpha'} d\mu\right) = \left(\int_{E \cap F_{\alpha\alpha'}} f_\alpha d\mu, \int_{E \cap F_{\alpha\alpha'}} f_{\alpha'} d\mu\right)$$
$$+\left(\int_{E \setminus (F_{\alpha\alpha'} \cup F)} f_\alpha d\mu, \int_{E \setminus (F_{\alpha\alpha'} \cup F)} f_{\alpha'} d\mu\right) +$$
$$\left(\int_{E \setminus (F_{\alpha\alpha'} \cap F)} f_\alpha d\mu, \int_{E \setminus (F_{\alpha\alpha'} \cap F)} f_{\alpha'} d\mu\right)$$
$$\in W(0) \times W(0) + W(o) \times W(0) + W \subseteq W^2 + W^2 + W^2, \alpha, \alpha' \geq \alpha_1$$

Corollary 3.4. *Let* $\{f_\alpha\}$ *and* $\{g_\beta\}$ *be two generalized sequences from* $\mathcal{E}(\mathcal{S},\Gamma_\mu, X_1, X_3)$, *convergent in* $X_1^S(\Gamma_\mu)$ *to the same function.*

If $\left\{\int_E f_\alpha d\mu,\right\}$ *and* $\left\{\int_E g_\beta d\mu\right\}$ *are generalized Cauchy sequences in* X_3 *uniformly in* $E \in \mathcal{S}$, *then for any entourage W from* X_3 *there exists* α_0 *and* β_0 *so that if* $\alpha \geq \alpha_0$, $\beta \geq \beta_0$ *it results that* $\left(\int_E f_\alpha d\mu, \int_E g_\beta d\mu\right) \in W$, *uniformly in* $E \in \mathcal{S}$.

Proof. *Given a symmetric entourage* W_1 *from* X_3 *so that* $W_1^2 + W_1^2 + W_1^2 \subseteq W$ *we choose an entourage U from* X_1 *corresponding to* W_1 *according to axiom* C_1.

We write $F_{\alpha\beta} = \{s \in S; (f_\alpha(s), g_\beta(s)) \notin U\}$.

From the previous Lemma it results that there exits $\alpha_0, \beta_0, d \in D, K =$ *finite* $\subset I$ *so that if* $F \in \mathcal{S}$ *and* $\alpha > \alpha_0, \beta > \beta_0, \gamma_i(E) < d, i \in K$, *E* $\subset S - F$*,* $E \in \mathcal{S}$ *we have* $\int_E f_\alpha d\mu \in W_1(0)$ *and* $\int_E f_\beta d\mu \in W_1(0)$

By hypothesis there exist if $\alpha_1 \geq \alpha_0$ *and* $\beta_1 \geq \beta_0$ *so that for* $\alpha > \alpha_1, \beta > \beta_1$, *we have* $\gamma_i(F_{\alpha\beta}) < d, i \in K$.

Expressing the pair $\left(\int_E f_\alpha d\mu, \int_E g_\beta d\mu\right)$ *in the same way as in the proof of the sufficiency from Lemma 3.3., the result is obtained.*

Definition 3.5. *The function* $f \in X_1^S$ *is called* Γ_μ*- integrable of there exists a generalized sequence* $\{f_\alpha$ *from* $\mathcal{E}(\mathcal{S},\Gamma_\mu,X_1,X_3)\}$ *so that* $f_\alpha \xrightarrow{\Gamma_\mu} f$ *and* $\left\{\int_E f_\alpha d\mu,\right\}$ *is a generalized Cauchy sequence in* X_3, *uniformly in* $E \in \mathcal{S}$. *Then the* Γ_μ*-integral is the element from* $\hat{X}_3$ *the completion of* X_3, *defined by:*

$$\int_E f_\alpha d\mu = \lim_\alpha \int_E f_\alpha d\mu .$$

From the Corollary 3.4 it results that above Γ_μ*-integral is properly defined. We denote by* $\mathcal{L}(\mathcal{S},\Gamma_\mu,X_1,X_3)$ *the set of* Γ_μ*-integrable functions from* $\mathcal{M}\lfloor\mathcal{S},\Gamma_\mu,X_1\rfloor$.

It is obvious that $\mathcal{E}(\mathcal{S},\Gamma_\mu,X_1,X_3) \subset \mathcal{L}(\mathcal{S},\Gamma_\mu,X_1,X_3)$ *and the* Γ_μ*-integral restricted to* $\mathcal{E}(\mathcal{S},\Gamma_\mu,X_1,X_3)$ *coincides with the* Γ_μ*-integral from Definition 3.1.*

Theorem 3.6. *Relatively to the operation of addition the set* $\mathcal{L}(\mathcal{S},\Gamma_\mu,X_1,X_3)$ *is a subsemigroup of* X_1^S

(i) *For* $E \in \mathcal{S}$, *the mapping* $f \to \int_E fd\mu$ *of* $\mathcal{L}(\mathcal{S},\Gamma_\mu,X_1,X_3)$ *in* $\hat{X}_3$ *is additive:*

$$\int_E (f+g)d\mu = \int_E fd\mu + \int_E gd\mu,\ f,g \in \mathcal{L}(\mathcal{S},\Gamma_\mu,X_1,X_3)$$

(ii) *For* $f \in \mathcal{L}(\mathcal{S},\Gamma_\mu,X_1,X_3)$ *the mapping* $E \to v(E) = \int_E fd\mu, E \in \mathcal{S}$ *is additive:*

$$v\left(\bigcup_{i=1}^n E_i\right) = \sum_{i=1}^n v(E_i),\ E_i \cap E_j = \emptyset, i \neq j, v(\emptyset) = 0$$

For $f \in \mathcal{L}(\mathcal{S},\Gamma_\mu,X_1,X_3)$ *we have:*

$$\lim_{E \xrightarrow[E\in\mathcal{S}]{\Gamma_\mu}} v(E) = 0$$

The proof follows from Corollary 3.4. and the definition 3.5.

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ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

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ON H-TRICHOTOMY IN BANACH SPACES

Abstract:
In this paper we emphasize the notion of skew-evolution semiflows, considered a generalization of semigroups, evolution operators and skew-product semiflows, which arise in the stability theory. We define and characterize a particular case of trichotomy, called the H-trichotomy, which is useful in describing the behaviors of the solution of evolution equations. We emphasize the fact that the trichtomy, introduced in finite dimensions in [1] and [5], is a natural generalization of dichotomy. A similar concept for stability was studied for evolution operators in [2]. This paper considers also other asymptotic properties, as exponential growth and decay, stability and instability.
Mathematics Subject Classification: 34D09

Keywords:
evolution equation, skew-evolution semiflow, H-trichotomy

INTRODUCTION

The concept of skew-evolution semiflows arises in the theory of evolution equations, which, as well as the theory of optimal control, is an important tool in describing processes derived from engineering or economics. The dynamical systems that study the real life phenomena are complex and the identification of appropriated mathematical models is difficult because in the case of systems described by partial differential equations the state space is often of infinite dimension. It is interesting to reconsider the definitions of asymptotic properties for differential equations by means of skew-evolution semiflows. In what follows, we will consider a more general case for asymptotic behaviors that not involves necessarily exponentials, but, instead, properly defined functions. Let us define the set Γ *of all continuous functions* $H:\mathbb{R}_+\to\mathbb{R}_+^*$. *We will denote by* Θ *the set of all functions* $f:\mathbb{R}_+\to\mathbb{R}_+$ *with the property that there exists a constant* $\mu\in\mathbb{R}$ *such that* $f(t)=e^{\mu t}$, $\forall t\geq 0$, *with the subsets* Θ_+ *and* Θ_-, *for positive, respectively negative values of* μ. *By* Ψ *is denoted the set of continuous functions* $h:\mathbb{R}_+\to[1,\infty)$ *defined such that, for all* $H\in\Gamma$, *there exist a function* $f\in\Theta$ *and a constant* $k>0$ *with the properties*

$$h(s)\leq kf(t-s)H(t),\ \forall t,s\geq 0 \text{ and}$$
$$h(2t)h(2s)\leq H(t+s),\ \forall t,s\geq 0.$$

Remark 1.1. *The set* Ψ *is not empty, as we can consider*

$$h(t)=f(t)=e^{\nu t} \text{ and } H(t)=e^{2\nu t},\ \nu>0,\ t\geq 0.$$

We will emphasize the notion of skew-evolution semiflows by means of evolution semiflows and evolution cocycles, as introduced by us in [4]. They naturally generalize notions as operators semigroups, evolution operators or skew-product semiflows. A skew-evolution semiflow depends on three variabiles, contrary to a skew-product semiflow, which depends only on two, and, hence, the study of asymptotic behaviors for skew-evolution semiflows in the nonuniform *setting arises as natural, relative to the third variabile. In this paper we will also consider the definitions and characterizations of some asymptotic properties, by means of the set of functions* Θ, Γ *and* Ψ.

SKEW-EVOLUTION SEMIFLOWS

Let us consider (X, d) a metric space, V a real or complex Banach space , V^* *its topological dual and B(V) the family of linear V-valued bounded operators defined on V. The norm of vectors and operators is* $\|\cdot\|$.

In what follows, we will denote Y = X× V and we will consider the set $T=\{(t,t_0)\in R \mid t\geq t_0\geq 0\}$. *By I is designed the identity operator on V.*

Definition 2.1. *A mapping* $\varphi: T\times X\rightarrow X$ *with the properties:*

(s₁) $\varphi(t,t,x)=x$, $\forall(t,x)\in R_+\times X$;

(s₂) $\varphi(t,s,\varphi(s,t_0,x))=\varphi(t,t_0,x)$, $\forall(t,s),(s,t_0)\in T$, $\forall x\in X$ *is called evolution semiflow on X.*

Definition 2.2. *A mapping* $\Phi: T\times X\rightarrow B(V)$ *with the properties:*

(c₁) $\Phi(t,t,x)=I$, $\forall(t,x)\in R_+\times X$;

(c₂) $\Phi(t,s,\varphi(s,t_0,x))\Phi(s,t_0,x)=\Phi(t,t_0,x)$, $\forall(t,s),(s,t_0)\in T$, $\forall x\in X$

is called evolution cocycle over the evolution semiflow φ.

Definition 2.3. *The mapping*

$C: T\times Y\rightarrow Y$, $C(t,s,x,v)=(\varphi(t,s,x),\Phi(t,s,x)v)$,

where φ *is an evolution semiflow on X and the mapping* Φ *is an evolution cocycle over* φ, *is called skew-evolution semiflow on Y.*

The next example emphasizes a skew-evolution semiflow generated by a system of differential equations.

Example 2.1. *Let us consider the system of differential equations*

$$\begin{cases} \dot{u}=(2t\sin t-3)u \\ \dot{w}=(t\cos t+2)w \\ \dot{z}=(2-\cos t)z. \end{cases}$$

Let us define the spaces X = R_+ *and V =* R^3, *which is endowed with the norm* $\|v\| = |v_1|+|v_2|+|v_3|$, *where* $v=(v_1,v_2,v_3)\in V$.

The mapping

$$\varphi: T\times R_+\rightarrow R_+,\ \varphi(t,s,x)=t-s+x$$

is an evolution semiflow on R_+.

The mapping

$$\Phi: T\times X\rightarrow B(V),$$

$$\Phi(t,s,x)(v_1,v_2,v_3)=(U(t,s)v_1,W(t,s)v_2,Z(t,s)v_3),$$

where $U(t,s)=u(t)u^{-1}(s)$, $W(t,s)=w(t)w^{-1}(s)$, $Z(t,s)=z(t)z^{-1}(s)$, $\forall(t,s)\in T$ *and u(t), w(t) and z(t), where* $t\in R_+$, *are the solutions of the given system of differential equations, is an evolution cocycle over the evolution semiflow* φ *on the metric space* R_+. *We obtain that* $C=(\varphi,\Phi)$ *is a skew-evolution.*

The following asymptotic behaviors of skew-evolution semiflow are useful in characterizing the property of H-trichotomy, as well as their characterizations.

Definition 2.2. *A skew-evolution semiflow* $C=(\varphi,\Phi)$ *is said to have exponential growth if there exists a nondecreasing function* $g: R_+\rightarrow[1,\infty)$ *with the property* $\lim_{t\to\infty} g(t)=\infty$ *such that:*

$$\|\Phi(t,t_0,x)v\|\leq g(t-s)\|\Phi(s,t_0,x)v\|,$$

$$\forall (t,s),(s,t_0)\in T,\ \forall (x,v)\in Y.$$

Proposition 2.1. *A skew-evolution semiflow* $C=(\varphi,\Phi)$ *has exponential growth if and only if there exist some constants* $M\geq 1$ *and* $\omega>0$ *such that:*

$$\|\Phi(t,t_0,x)v\|\leq Me^{\omega(t-s)}\|\Phi(s,t_0,x)v\|,$$

$$\forall (t,s),(s,t_0)\in T,\ \forall (x,v)\in Y.$$

Proof. *Necessity. Let* $t\geq s\geq t_0\geq 0$ *and n be the integer part of the real number t - s. We obtain successively*

$$\|\Phi(t,t_0,x)v\|\leq g(1)\|\Phi(t-1,t_0,x)v\|$$

$$\leq\ldots\leq[g(1)]^n\|\Phi(t-n,t_0,x)v\|\leq$$

$$\leq Me^{n\omega}\|\Phi(s,t_0,x)v\|\leq Me^{\omega(t-s)}\|\Phi(s,t_0,x)v\|,$$

for all $(t,s),(s,t_0)\in T$ *and all* $(x,v)\in Y$, *where we have denoted* $M=g(1)>1$ *and* $\omega=\ln M>0$.

Sufficiency. It is obtained immediately if we consider $g(u)=Me^{\omega u}$, $u\geq 0$.

Definition 2.3. *A skew-evolution semiflow* $C=(\varphi,\Phi)$ *is said to be with exponential decay if there exists a nondecreasing function* $g: R_+\rightarrow[1,\infty)$ *with the property* $\lim_{t\to\infty} g(t)=\infty$ *such that:*

$$\|\Phi(s,t_0,x)v\| \le g(t-s)\|\Phi(t,t_0,x)v\|,$$
$$\forall\ (t,s),(s,t_0)\in T,\ \forall\ (x,v)\in Y.$$

Proposition 2.2. *A skew-evolution semiflow C = (φ,Φ) has exponential decay if and only if there exist some constants* $M\ge 1$ *and* $\omega>0$ *such that:*

$$\|\Phi(s,t_0,x)v\| \le Me^{\omega(t-s)}\|\Phi(t,t_0,x)v\|,$$
$$\forall\ (t,s),(s,t_0)\in T,\ \forall\ (x,v)\in Y.$$

Proof. *Necessity. Let* $t\ge s\ge t_0\ge 0$. *There exists a natural number n such that. We have following relations*

$$\|\Phi(s,t_0,x)v\| \le g(1)\|\Phi(s+1,t_0,x)v\| \le$$
$$\dots \le [g(1)]^n\|\Phi(s+n,t_0,x)v\| \le$$
$$\le Me^{n\omega}\|\Phi(t,t_0,x)v\| \le Me^{\omega(t-s)}\|\Phi(t,t_0,x)v\|,$$

for all $(t,s),(s,t_0)\in T$ *and all* $(x,v)\in Y$, *where we have considered the constants M = g(1) > 1 and* $\omega=\ln M>0$.
Sufficiency. It follows immediately for $g(u)=Me^{\omega u}$, $u\ge 0$

ON THE PROPERTY OF H-TRICHOTOMY

A general concept of exponential trichotomy is emphasized in this section.

Definition 3.1. *A mapping P:Y→ Y given by P(x,v)=(x, P(x)v), where P(x) is a projection on* Y_x *= {x} × V and x ∈ X, is called projector on Y.*

Definition 3.2. *A skew-evolution semiflow C = (φ,Φ) is said to be H-trichotomic if there exist some mappings* N_1, N_2, N_3: $\mathbb{R}_+\to\mathbb{R}_+^*$ *and three projectors families* $\{P_k\}_{k\in\{1,2,3\}}$ *such that following conditions hold:*

(t_1) for each projector P_k, *k∈ {1,2,3}, the relation*

$$P(\varphi(t,s,x))\Phi(t,s,x)=\Phi(t,s,x)P(x)$$

holds for all $(t,s)\in T$ *and all x ∈ X;*
(t_2) for all x ∈ X, the projections $P_1(x)$, $P_2(x)$ *and* $P_3(x)$ *satisfy the conditions*

$$P_1(x)+P_2(x)+P_3(x)=I \text{ and } P_i(x)P_j(x)=0, \text{ for all } i,j\in\{1,2,3\},\ i\neq j;$$

(t_3) following inequalities

$$(t_3^1)\quad \begin{aligned} &H(t)\|\Phi(t,t_0,x)P_1(x)v\| \\ &\le N_1(s)\|\Phi(s,t_0,x)P_1(x)v\|; \end{aligned}$$

$$(t_3^2)\quad \begin{aligned} &H(s)\|\Phi(s,t_0,x)P_2(x)v\| \\ &\le N_2(t)\|\Phi(t,t_0,x)P_2(x)v\|; \end{aligned}$$

$$(t_3^3)\quad \begin{aligned} &\|\Phi(t,t_0,x)P_3(x)v\| \\ &\le N_3(s)H(t)\|\Phi(s,t_0,x)P_3(x)v\| \end{aligned}$$

and

$$\|\Phi(s,t_0,x)P_3(x)v\| \le N_3(t)H(s)\|\Phi(t,t_0,x)P_3(x)v\|,$$

hold for all $(t,s),(s,t_0)\in T$, *for all* $(x,v)\in Y$ *and all H∈ Γ.*

Remark 3.1. *In the particular case H(t) =* $e^{\nu t}$, *t ≥ 0, ν > 0, the exponential trichotomy for skew-evolution semiflows, defined and characterized by us in [3] for evolution operators, is obtained in a nonuniform setting.*

Remark 3.2. *(i) A projector P on Y with property (t_1) is also called invariant relative to the skew-evolution semiflow C = (φ, Φ);*
(ii) If three projectors families $\{P_k\}_{k\in\{1,2,3\}}$ *satisfy relations (t_1) and (t_2) of Definition 3.2, they are usually said to be compatible with the skew-evolution semiflow C.*
In what follows, we will denote a skew-evolution semiflow C_k = (φ, Φ_k), *k∈ {1,2,3}, where* $\Phi_k(t,s,x)v=\Phi(t,s,x)P_k(x)v$, $(t,s)\in T$, $(x,v)\in Y$.

Example 3.1. *Let us consider the skew-evolution semiflow given in Example 2.1.*
We obtain for the evolution cocycle $\Phi: T\times X\to B(V)$ *following relations*

$$\Phi(t,s,x)(v_1,v_2,v_3)=$$
$$=(e^{2t\cos t-2s\cos s-2\sin t+2\sin s-3t+3s}v_1,$$
$$e^{t\sin t-s\sin t+\cos t-\cos s+2t-2s}v_2,$$
$$e^{-\sin t+\sin s+2t-2s}v_3)$$

Let us define the projectors $P_1(x,v)=(v_1,0,0)$, $P_2(x,v)=(0,v_2,0)$ *and* $P_3(x,v)=(0,0,v_3)$. *As following relation holds*

$$2t\cos t-2s\cos s-2\sin t+2\sin s-3t+3s \le -t+5s+4,\ \forall (t,s)\in T,$$

we have that

$$H_1(t)\|\Phi(t,s,x)P_1(x)v\| \le N_1(s)|v_1|,$$
$\forall$ *(t, s, x, v)* $\in$ *T× Y,*

where we have denoted $H_1(t) = e^t$ *and* $N_1(s) = e^{5s+4}$.

According to the inequality

t sin t – s sin s + cos t - cos s + 2t - 2s ≥ t – 3s - 2, $\forall$ *(t, s)* $\in$ *T,*

it follows that

$$N_2(t)\|\Phi(t,s,x)P_2(x)v\| \ge H_2(s)|v_2|,$$
(t, s, x, v) $\in$ *T× Y,*

where we have considered $H_2(s) = e^{-3s}$ *and* $N_2(t) = e^{-t+2}$.

Also, as

- sin t + sin s + 2t - 2s ≤ 2t – s + 1, $\forall$ *(t, s)* $\in$ *T,*

we have

$$\|\Phi(t,s,x)P_3(x)v\| \le N_3(s)H_3(t)|v_3|$$
$\forall$ *(t, s, x, v)* $\in$ *T× Y*

and, as

- sin t + sin s + 2t - 2s ≥ t - 2s - 1, $\forall$ *(t, s)* $\in$ *T,*

we obtain

$$N_3(t)H_3(s)\|\Phi(t,s,x)P_3(x)v\| \ge |v_3|,$$
$\forall$ *(t, s, x, v)* $\in$ *T× Y,*

where, in both cases, we have denoted $H_3(u) = e^{2u}$ *and* $N_3(u) = e^{-u+1}$.

As a remark, we can consider, without any loss of generality, the function denoted H(t) = min{H₁(t), H₂(t), H₃(t)}, $t \ge 0$.

It follows that the skew-evolution semiflow C = (φ, Φ) is H-trichotomic.

The next main result of this paper can be considered as an integral characterization for the concept of H-trichotomy.

Theorem 3.1. *Let H∈ Γ and h∈ Ψ . A skew-evolution semiflow C = (φ, Φ) is H-trichotomic if and only if there exist some mappings* M_1, M_2, M_3: $R_+ \to R_+^*$, *some functions* $f_1, f_2 \in \Theta$ *and three projectors families* $\{P_k\}_{k \in \{1,2,3\}}$ *compatible with C such that the skew-evolution semiflow* C_1 *has exponential growth and the skew-evolution semiflow* C_2 *has exponential decay and such that following conditions hold:*

(i) $$\frac{1}{H(t)}\int_{t_0}^{t} h(\tau)\|\Phi_1(t,\tau,x)^* v^*\|d\tau \le M_1(t_0)\|P_1(x)v^*\|;$$

(ii) $$h(t_0)\int_{t_0}^{t}\frac{1}{H(\tau)}\|\Phi_2(\tau,t_0,x)v\|d\tau \le M_2(t)\|\Phi_2(t,t_0,x)v\|;$$

(iii) $$\int_s^t f_1(\tau-s)\|\Phi_3(\tau,t_0,x)v\|d\tau \le M_3(t_0)\|\Phi_3(s,t_0,x)v\|;$$

(iv) $$\int_s^t f_2(t-\tau)\|\Phi_3(\tau,t_0,x)v\|d\tau \le M_3(t_0)\|\Phi_3(t,t_0,x)v\|,$$

for all (t,s), (s,t₀) $\in$ *T and all (x,v)* $\in$ *Y,* $v^* \in V^*$ *with* $\|v^*\| \le 1$.

Proof. *Necessity. As the skew-evolution semiflow C is H-trichotomic, it implies that the relations (t₃) of Definition 3.2 hold.*

(i) There exist a function $f \in \Theta_-$ *and a constant k > 0 with the property* $h(s) \le kf(t-s)H(t)$, $\forall t \ge s \ge 0$. *Let us denote* $f(t) = e^{-\nu t}$, $\nu > 0$. *We obtain*

$$\|\Phi_1(t,t_0,x)v\| \le \frac{N_1(s)}{H(t)}\|\Phi_1(s,t_0,x)v\|$$
$$\le \overline{M}_1(s)e^{-\nu(t-s)}\|\Phi_1(s,t_0,x)v\|$$

for all $(t,s),(s,t_0) \in T$ *and for all* $(x,v) \in Y$, *where we have considered the function* $\overline{M}_1 : R_+ \to R_+$, $\overline{M}_1(u) = k\frac{N_1(u)}{h(u)}$.

We obtain further

$$\frac{1}{H(t)}\int_{t_0}^{t} h(\tau)\|\Phi_1(t,\tau,x)^* v^*\|d\tau$$
$$\le k\int_{t_0}^{t} e^{-\nu(t-\tau)}\|\Phi_1(t,\tau,x)^* v^*\|d\tau$$
$$\le M_1(t_0)\|P_1(x)v^*\|$$

where we have denoted $M_1(u) = k\nu^{-1}\overline{M}_1(u)$, $u \ge 0$.

(ii) There exist a function $f \in \Theta_-$ *and a constant k > 0 with the property* $h(t_0) \le kf(s-t_0)H(s)$, $\forall s \ge t_0 \ge 0$. *Let us consider* $f(t) = e^{-\nu t}$, $\nu > 0$. *We have*

$$\|\Phi_2(s,t_0,x)v\| \le \frac{N_2(t)}{H(s)}\|\Phi_2(t,t_0,x)v\|$$
$$\le k\frac{N_2(t)}{h(t_0)}e^{-\nu(s-t_0)}\|\Phi_2(t,t_0,x)v\| \le$$
$$\le k\frac{N_2(t)}{h(t_0)}e^{\nu t}e^{-\nu(t-s)}e^{-\nu(2s-t_0)}\|\Phi_2(t,t_0,x)v\|$$
$$\le \overline{M}_2(t)e^{-\nu(t-s)}\|\Phi_2(t,t_0,x)v\|$$

for all $(t,s),(s,t_0)\in T$ *and for all* $(x,v)\in Y$, *where we have denoted the function* $\overline{M}_2:\mathbb{R}_+\to\mathbb{R}_+$, $\overline{M}_2(u)=kN_2(u)e^{\nu u}$.

(iii) and (iv) are obtained by a similar argumentation, according to Proposition 2.1 and Proposition 2.2.

Sufficiency. *(i) Let* $t\ge t_0+1$ *and* $s\in[t_0,t_0+1]$. *As* $H\in\Gamma$ *and* $h\in\Psi$, *there exists a constant* $\alpha>0$ *such that* $h(s)\le e^{-\alpha(t-s)}H(t)$, *for all* $(t,s)\in T$. *Then, as the skew-evolution semiflow* C_1 *has exponential growth, according to Proposition 2.1, there exist some constants* $M\ge 1$ *and* $\omega>0$ *such that following relations hold*

$$e^{-(\alpha+\omega)}\left|\left\langle v^*,e^{\alpha(t-t_0)}\Phi_1(t,t_0,x)v\right\rangle\right|=$$

$$e^{-(\alpha+\omega)}\int_{t_0}^{t_0+1}\left|\left\langle \Phi_1(t,\tau,x)^*v^*,e^{\alpha(t-t_0)}\Phi_1(\tau,t_0,x)v\right\rangle\right|d\tau\le$$

$$\le\int_{t_0}^{t_0+1}e^{\alpha(t-\tau)}\left\|\Phi_1(t,\tau,\varphi(\tau,t_0,x))^*v^*\right\|e^{-\omega(\tau-t_0)}\left\|\Phi_1(\tau,t_0,x)v\right\|d\tau\le$$

$$\le M\|v\|\int_{t_0}^{t}e^{\alpha(t-\tau)}\left\|\Phi_1(t,\tau,\varphi(\tau,t_0,x))^*v^*\right\|d\tau$$

$$\le MN_1(t_0)\|P_1(x)v\|\|P_1(x)v^*\|$$

By taking supremum relative to $\|v^*\|\le 1$, *we have*

$$\|\Phi_1(t,t_0,x)v\|\le M_1(t_0)e^{-\alpha(t-t_0)}\|P_1(x)v\|,$$

for all $t\ge t_0+1$ *and all* $(x,v)\in Y$, *where* $M_1(u)=MN(u)e^{\alpha+\omega}$, $u\ge 0$.

On the other hand, for $t\in[t_0,t_0+1]$ *and* $(x,v)\in Y$, *we obtain*

$$\|\Phi_1(t,t_0,x)v\|\le Me^{\omega(t-t_0)}\|v\|\le\hat{M}e^{-\alpha(t-t_0)}\|v\|,$$

where we have denoted $\hat{M}=Me^{\alpha+\omega}$. *Hence, it follows that*

$$\|\Phi_1(t,t_0,x)v\|\le[M_1(t_0)+\hat{M}]e^{-\alpha(t-t_0)}\|v\|,$$

for all $(t,t_0)\in T$ *and for all* $(x,v)\in Y$.

Further, if we consider

$$H(u)=f(u)\ \textit{and}\ N_1(u)=[M_1(u)+\hat{M}]f(u),$$

where $f(u)=e^{\nu u}\in\Theta_+$ *and* $u\ge 0$, *we obtain relation* (t_3^1).

(ii) We have considered $H\in\Gamma$ *and* $h\in\Psi$, *hence there exists a constant* $\beta>0$ *such that* $h(s)\le e^{-\beta(t-s)}H(t)$, *for all* $(t,s)\in T$. *As the skew-evolution semiflow* C_2 *has exponential growth, according to Definition 2.3, there exists a nondecreasing function* $g:\mathbb{R}_+\to[1,\infty)$ *with the property* $\lim_{t\to\infty}g(t)=\infty$ *such that*

$$\|\Phi_2(s,t_0,x)v\|\le g(t-s)\|\Phi_2(t,t_0,x)v\|,$$
$$\forall\ (t,s),(s,t_0)\in T,\ \forall\ (x,v)\in Y.$$

We will denote

$$K=\int_0^1 e^{-\beta\tau}g(\tau)d\tau.$$

We obtain successively following relations

$$K\|P_2(x)v\|=\int_{t_0}^{t_0+1}e^{-\beta(\tau-t_0)}g(\tau-t_0)\|\Phi_2(t_0,t_0,x)v\|d\tau\le$$

$$\le\int_{t_0}^{t_0+1}e^{-\beta(\tau-t_0)}\|\Phi_2(\tau,t_0,x)v\|d\tau$$

$$\le M_2(t)e^{\beta(t-t_0)}\|\Phi_2(t,t_0,x)v\|$$

for all $(t,t_0)\in T$ *and for all* $(x,v)\in Y$. *According to Definition 2.2, this relation is equivalent with*

$$\|\Phi_2(s,t_0x)v\|\le\frac{1}{K}M_2(t)e^{\beta(t-s)}\|\Phi_2(t,t_0,x)v\|,$$

for all $(t,s),(s,t_0)\in T$ *and for all* $(x,v)\in Y$.

If we take

$$H(u)=f(u)\ \textit{and}\ N_2(u)=M_2(u)f(u),$$

for $f(u)=e^{-\nu u}\in\Theta_-$ *and* $u\ge 0$, *relation* (t_3^2) *is obtained.*

(iii) and (iv) can simmilarly be proved.

CONCLUSION

In the last decades, a great progress concerning the study of asymptotic behaviors for evolution equations can be observed. The possibility of reducing the nonautonomous case in the study of evolutionary families or skew-product flows to the autonomous case of evolution semigroups on Banach spaces is considered an important way toward interesting applications. The study of the asymptotic behavior of linear skew-product semiflows has been used in the theory of evolution equations in infinite dimensional spaces. The approach from the point of view of asymptotic properties for the evolution *semigroup associated to the linear skew-product semiflows was essential. Instead, in our study we have considered more general characterizations for the asymptotic properties of the solutions of evolution equations, described by means of skew-evolution semiflows, which generalize the above notions. Also, the approach was not restrained by considering in the definitions exponentials. As a remark, in Definition 3.2 we have the definitions for H-stability, H-instability, H-growth and H-decay, characterized, respectively, by Theorem 3.1, which extends toward applications in engineering and economics the study of evolution equations.*

ACKNOWLEDGMENT

This work is financially supported by the Research Grant CNCSIS PN II ID 1080 of the Romanian Ministry of Education, Research and Innovation.

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ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

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FATIGUE TESTS AT HYBRYD ALUMINUM ALLOY JOINTS

Abstract:
This paper presents a study on fatigue performance of adhesive/rivets joints in an aluminum structures. Hybrid joints were shown to have greater strength, stiffness and fatigue life in comparison to adhesive joints. The results from fatigue tests confirm the static tests made on the same type of test samples.

Keywords:
Aluminum, Adenit, Si-Plane, joints

INTRODUCTION

Aluminum alloy joints are used in aircraft construction, some cars, railway vehicles etc.
The joints can be assembling by welding, gluing, rivets etc.
In this paper it will be presented joints assembled hybrid (gluing and rivets).
The tests were performed in the CEEX program named "Adhesives, Rivets and Hybrid Aluminum Alloy and Composite Materials Joints".

MEASUREMENT DEVICES AND JOINT TYPES

The tensile fatigue tests were performed at Romanian Railway Authority – AFER on universal testing machine SI-PLANE 942-1 type (fig. 1). The testing machine was designed and manufactured by British Company Si-Plan Electronics Research Limited in the year 2005.
The machine is hydraulically manipulated from a computer and can perform tests with tensile or compressive forces (static and dynamic) and it has the next characteristics:

- *Maximum force for static tests: ±350kN;*
- *Maximum force for dynamic tests: ±250kN;*
- *Maximum high for the vertical tests: 400mm;*
- *Frequency for dynamic tests: ≤ 40Hz.*

All the preparing operations and the test are performed by the hydraulic installation of the machine. He steps for performing the tests were:

a. *Each type of joint was named **N"tip"n** , where „**tip**" means the joint type of the aluminum alloy (nit – rivet joint, hib – hybrid joint or adz – adhesive joint), **N** is given by the thickness of the material or the joint geometry and **n** is the identification number for the same type of joint.*
b. *For each of joint a reference tensile force was calculated based on static tests which were performed on other stage of the project.*
c. *Based on reference tensile force, the maximum and minimum dynamic tensile forces were calculated for five value domains as following: 80%, 70%, 60%, 50% and 40% from the reference tensile force and the minimum values were 10% from the maximum values (the 1/10 value was used for each fatigue cycle).*

d. *A 5Hz frequency was used for all fatigue tests. During the test it was cases when the joints break it after hundreds of cycles before to reach the stability of the dynamic regime at 5Hz frequency (the test was repeated if it was possible on another same type joint) or the joint doesn't break it not even after 500.000 cycles.*

e. *For each joint it was recorded the number of cycles when the joint was break it and the type of joint break (adhesive, cohesive or adhesive-cohesive).*

f. *Photos were made on each joint before, during and after the tests. Also a print screen on Si-Plane machine computer for each joint was made. In this print screen it is shown the minim and maximum of force cycle, frequency and number of cycles.*

g. *Based on values recorded at step number 6, the normalized curve $S-N$ (Wöhler curve) was draw by quasi-linearity interpolation which crosses the horizontal axis in the point which has the coordinates (0; 1).*

$$\frac{F_M}{F_R} = 1 - k \cdot \lg(N) \qquad (1)$$

which mean that the ratio between maximum force of the cycle and the reference force depending on decimal logarithm of breaking number of cycles.

h. *The tests were performed at 21 degree Celsius temperature and 55% relative humidity.*

Figure 1 The Universal Testing Machine SI-PLAN 942-1 type

Many types of joints were tested. The aluminum pieces were jointed in different shapes: end to end, one above other, angle joint etc. as follows:

- *Adhesive joints;*
- *Hybrid joints (adhesive+rivet).*

In fig. 2÷3 are shown the types of joints were the value of ratio 1/K had the highest value.

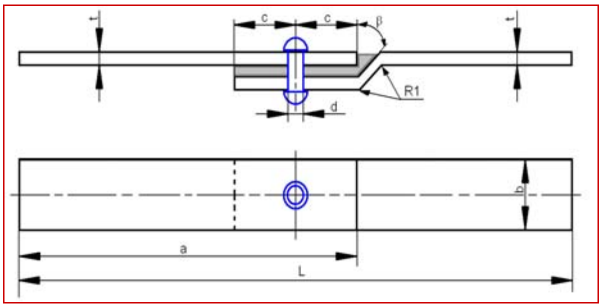

Figure 2 4hib joint type

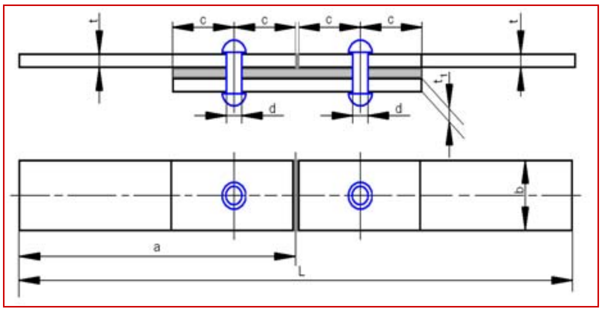

Figure 3 5hib joint type

RESULTS

4hib joint type

In table number 1 are presented the results for 4hib joint type.

Table 1. Results for 4hib joint type.

Proof sample	F_{max}	F_{min}	N	Lg(N)
4hib_3	170	17	59844	4,78
4hib_4	200	20	184432	5,27
4hib_5	200	20	2579	3,40
4hib_6	230	23	68413	4,84
4hib_7	230	23	2583	3,41

Regarding to this table the following explanation are necessary:

- *F_{max} and F_{min} measured in daN units are maximum and minimum value for a pulsate cycle at 5Hz frequency;*
- *The value F_{max}=170daN, is represent 60% from tensile reference force;*
- *The value F_{max}=200daN, is represent 70% from tensile reference force;*
- *The value F_{max}=230daN, is represent 80% from tensile reference force;*
- *N is the number of cycles when the joint break it*

In fig. 4 is shown the normalized Wöhler curve draw by quasi-linearity interpolation.

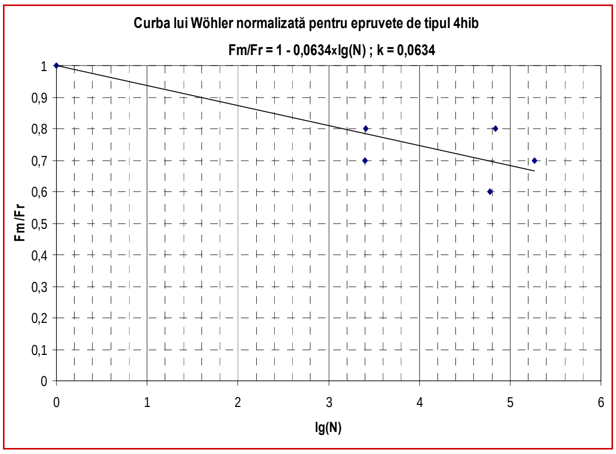

Figure 4. Wöhler curve for 4hib joint type

The proof sample 4hib_3, 4hib_4 and 4hib_6 were break it in the metal and the proof sample 4hib_5 and 4hib_7 were break it in the adhesive.
In fig. 5 it is presented an adhesive break and in fig. 6 it is presented a metal break.

Figure 5. Adhesive break

Figure 6. Metal break

5hib joint type

In table number 2 are presented the results for 5hib joint type.
Regarding to this table the following explanation are necessary:

- *F_{max} and F_{min} measured in daN units are maximum and minimum value for a pulsate cycle at 5Hz frequency;*
- *The value F_{max}=190daN, is represent 60% from tensile reference force;*
- *The value F_{max}=220daN, is represent 70% from tensile reference force;*
- *The value F_{max}=260daN, is represent 80% from tensile reference force;*
- *N is the number of cycles when the joint break it.*

Table 2. Results for 5hib joint type.

Proof sample	F_{max}	F_{min}	N	Lg(N)
5hib_6	190	19	240037	5,38
5hib_4	220	22	103031	5,01
5hib_7	220	22	120806	5,08
5hib_8	220	22	40100	4,60
5hib_5	260	26	605	2,78
5hib_9	260	26	1939	3,29
5hib_10	260	26	5537	3,74

In fig. 7 is shown the normalized Wöhler curve draw by quasi-linearity interpolation.

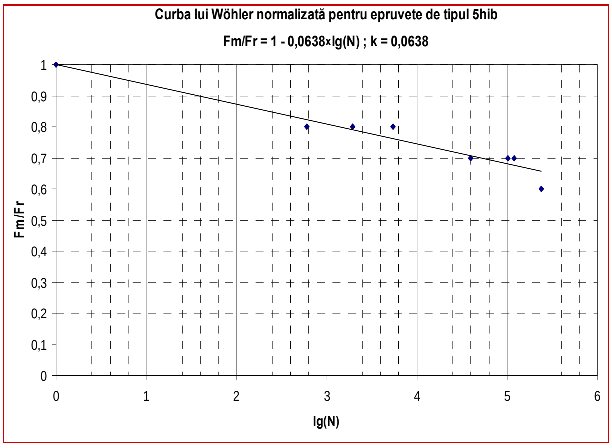

Figure 7. Wöhler curve for 5hib joint type

The proof sample 5hib_6 has an adhesive break but not a rivet break. The proof sample 5hib_4 has an adhesive-cohesive break and the other proof sample had an adhesive break.

Figure 8 5hib_6 proof sample

Figure 9 5hib_9 proof sample

In fig. 8 it is presented an adhesive break and in figure 9 it is presented an metal break.

CONCLUSION

In fig. 10 the different types of joints had been arranged from the point of view of 1/K ratio (the inverted of normalized Wöhler curve) which significance is the fatigue lastingness of the proof sample.

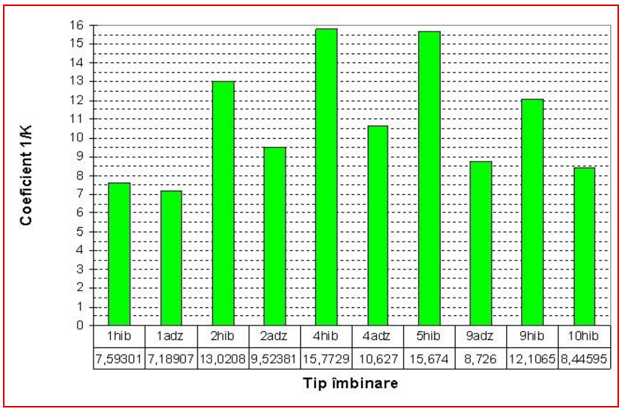

Figure 10. 1/K ratio histogram

From fig. 10, it can be seen that the hybrid proof sample number had a higher lastingness but we must remember that the tensile reference forces are different from one type of joint to other (the tensile reference forces are higher at adhesive joints).

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ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

RADU ILEA

DYNAMICS OF WORKING PROCESS OF FLAT SIEVES

Abstract:
The operation of separation of seeds is realized due to the vibration of sieve. The operation of separation is analyzed with the help of the particle model which executes vibration motions on a plane with friction. There are analyzed displacement regimes of particle by forward sliding and back sliding without detachment. Because of velocity discontinuity which appears as consequence of friction between particle and plan or of dropping on plan in the case of detachment, vibro-impact motion regimes appear. That is why, for the study of motion, there are applied the specific methods, concerning the vibro-impact regimes.

Keywords:
motion, flat sieves, dynamic model, sliding regimes

INTRODUCTION

Generally, the phenomenon of vibro-transfer is essentially influenced by the material behavior, characterized by composition, humidity, adherence, nature etc. In the first approximation, the experiences shown that the material can be schematized by a simple material particle which moves with friction on the vibrating surface (Figure 1).

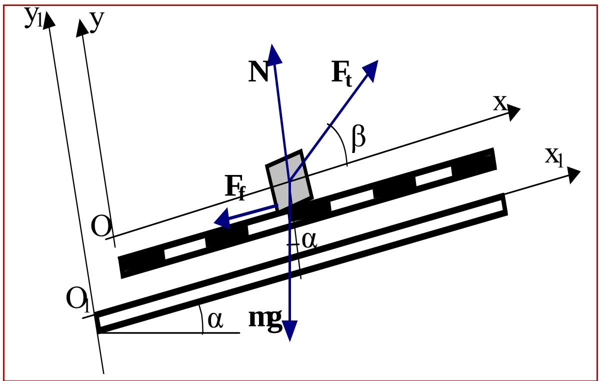

Figure 1. Dynamic model

The particle of mass m is supposed to be placed on the vibrating plan, inclined to the angle α, in relation to the horizontal surface. It is supposed that the vibrating plan executes a vibration translation motion on a direction which makes the angle β with the inclined plan and it has the amplitude r. Thus, a current point of the plan executes a vibration displacement, given by the law rsinψ, on a direction which makes the angle β with the inclined plan, where ψ=ωt. So, in relation to the fixed frame $O_1x_1y_1$, the coordinates of the point O, the origin of the mobile frame Oxy, bound to the inclined plan, (figure 1), at a certain moment are

$$x_0 = r\cos\beta\sin\psi$$

and

$$y_0 = r\sin\beta\sin\psi \qquad (1)$$

The differential equation of relative motion of particle of mass m has the form

$$m\overline{a}_r = \overline{F}_f + \overline{N} + m\overline{g} + \overline{F}_t \qquad (2)$$

Because the transport force of inertia is $\overline{F}_t = -m\overline{a}_t$, where a_t is the acceleration of transport of particle, identical to the acceleration of the point O, the components of the transport force of inertia are

$$F_{tx} = -m\ddot{x}_0 = mr\omega^2 \cos\beta \sin\psi \,, \qquad (3)$$

$$F_{ty} = -m\ddot{y}_0 = mr\omega^2 \sin\beta \sin\psi \,.$$

As consequence, the differential equation of relative motion (2) has the following projections on the axes of the frame Oxy:

$$m\ddot{x} = -\mu N sign\dot{x} + mr\omega^2 \cos\beta \sin\psi - mg\sin\alpha \,, \qquad (4)$$

$$m\ddot{y} = N + mr\omega^2 \sin\beta \sin\psi - mg\cos\alpha \,.$$

Taking into account that there are considered only the motions of particle, in contact to the plan, it must be put y=0, so that from the second equation (4), it results

$$N = m\left(g\cos\alpha - r\omega^2 \sin\beta \sin\psi\right). \qquad (5)$$

CHARACTERISTICS OF MOTION OF SLIDING

As a principle, the particle which is situated in the rest position, at a certain moment becomes to slide on the plan, forward or back.

For the beginning it is supposed that the particle executes a forward sliding motion in relation to the sieve. On the particle act the force of weight mg, the normal reaction N, and the force of friction F= μN; the motion of transport being a translation, the Coriolis force of inertia is null.

If the expression (5) of the normal reaction N is introduced in the first differential equation in (4), it arrives at the following relation:

$$\ddot{x} = -\frac{g\sin(\alpha+\phi)}{\cos\phi} + \frac{r\omega^2\cos(\beta-\phi)}{\cos\phi}\sin\psi \,, \; (\psi=\omega t). \qquad (6)$$

This relation represents the fundamental equation for the study of the forward motions of sliding on the vibrating sieve.

The beginning moment of the forward sliding is denoted by $t=t_1$ and so, $\psi_1 = \omega t_1$. It can mention that this moment corresponds to the condition that the acceleration $\ddot{x}$ to be null.

If the acceleration (6) is made equal to zero, it is obtained the following equation, in the initial moment of the forward motion of sliding:

$$\sin\psi_1 = \frac{g}{r\omega^2}\cdot\frac{\sin(\alpha+\phi)}{\cos(\beta-\phi)} \qquad (7)$$

Taking into account the relation (7), the fundamental equation (6) can be also written

$$\ddot{x} = r\omega^2\frac{\cos(\beta-\phi)}{\cos\phi}\left(\sin\psi - \sin\psi_1\right) \qquad (8)$$

The forward motion of sliding is characterized by $t > t_1$ and so, $\psi > \psi_1$.

Considering the function $\dot{x} = \dot{x}(t)$, if $\ddot{x}$ >0, the function $\dot{x}$ is increasing. Thus, from the moment $t = t_1$ when the velocity is nullifying, i.e. $\dot{x}(t_1) = 0$ and $\ddot{x}$ >0, it results $\dot{x}$ >0. So, the forward motion of sliding takes place. Thus, from the relation (8), written for the moment given by ψ_1 it must be satisfied the inequality

$$sin\psi > sin\psi_1. \qquad (9)$$

From the relation (7), written for ψ_1 it can be supposed that $\psi_1 \in \left(0;\frac{\pi}{2}\right)$ which, in accordance to the inequality (9), leads to the condition $\psi \in (\psi_1; \pi - \psi_1)$.

By integrating the differential equation of sliding motion which begins for $t=t_1$ it is found

$$\dot{x} = -r\omega\frac{\cos(\beta-\phi)}{\cos\phi}\begin{bmatrix}\cos\psi - \cos\psi_1 \\ +\sin\psi_1\cdot(\psi-\psi_1)\end{bmatrix} \qquad (10)$$

The forward regime of sliding stops at the moment $t = t_1^{/}$, respectively the angle $\psi = \psi_1^{/}$ which corresponds to the nullifying of the relative velocity, $\dot{x} = 0$. So, by nullifying the expression of $\dot{x}$, it is deduced the equation

$$\sin\psi_1 = \frac{\cos\psi_1^{/} - \cos\psi_1}{\psi_1 - \psi_1^{/}} \qquad (11)$$

This equation permits the calculus of the moment $t = t_1^{/}$, corresponding to the cessation of sliding.

The distance, covered in the case of the forward sliding is given by the integral

$$s_{1,2}=\int_{t_1}^{t_1'}\dot{x}dt \qquad (12)$$

Taking into account the relation (10), after the effecting of calculus, the integral (12') becomes

$$s_1=-\frac{r\cos(\beta-\phi)}{\cos\phi}\left[\begin{array}{l}\frac{(\psi_1'-\psi_1)^2}{2}\sin\psi_1\\+\sin\psi_1'-\sin\psi_1-(\psi_1'-\psi_1)\cos\psi_1\end{array}\right] \qquad (13)$$

If in the relation (13) it is replaced $\sin\psi_1$ *given by the equation (11), then for the displacements with forward sliding, it can be written the relation*

$$s_1=\frac{r\cos(\beta-\phi)}{\cos\phi}\cdot\Phi(\psi_1), \qquad (14)$$

In an analogous way it is treated the case corresponding to the back motion of sliding. By back sliding it means the relative motion with friction of the material particle on the vibrating sieve, in the negative direction of the Ox axis, i.e. in opposite direction to the transporting one.
Taking into account that the force of friction is orientated in the positive direction of the Ox axis and projecting the differential equation of the relative motion, it is obtained

$$m\ddot{x}=\mu N-mg\sin\alpha+mr\omega^2\cos\beta\sin\psi \qquad (15)$$

or, if it is taken into account the equation (2), it results

$$\ddot{x}=-\frac{g\sin(\alpha-\phi)}{\cos\phi}+r\omega^2\frac{\cos(\beta+\phi)}{\cos\phi}\sin\psi \qquad (16)$$

This relation represents the fundamental equation for the study of the back motions of sliding on the vibrating sieve.
The back sliding begins at the moment t=t₂ and $\psi_2=\omega t_2$, *when* $\ddot{x}=0$.
From the expression (16) of the acceleration, made equal to zero, it is obtained the equation

$$\sin\psi_2=\frac{g}{r\omega^2}\cdot\frac{\sin(\alpha-\phi)}{\cos(\beta+\phi)} \qquad (17)$$

Taking into account the relation (17), the fundamental equation (16) can be also written as fallows:

$$\ddot{x}=r\omega^2\frac{\cos(\beta+\phi)}{\cos\phi}(\sin\psi-\sin\psi_2) \qquad (18)$$

Because the back motion of sliding begins at the moment $t=t_2$ *and it correspunds to the interval* $t>t_2$, *respectively* $\psi>\psi_2$, *in the same way as in the previous case, it is considered the function* $\dot{x}=\dot{x}(t)$ *which, for* $\ddot{x}<0$, *is a decreasing one. Thus, begining with the moment* $t=t_2$ *for wich* $\ddot{x}(t_2)=0$, *the velocity* $\dot{x}$ *is negative (*$\dot{x}<0$*), so that a back motion of sliding takes place.*
In accordance to the relation (18) and from the condition $\ddot{x}<0$, *it results*

$$\sin\psi<\sin\psi_2. \qquad (19)$$

Supposing ψ_2 *given by the relation (17) in the first quadrant, i.e.* $\psi_2\in\left(0;\frac{\pi}{2}\right)$, *it results that the angle* ψ *must be in the interval* $\psi\in(\pi-\psi_2;2\pi)$.
By the integration of the differential equation (18), it is obtained the expression of the velocity:

$$\dot{x}=-r\omega\frac{\cos(\beta+\phi)}{\cos\phi}\left[\begin{array}{l}\cos\psi-\cos\psi_2\\+\sin\psi_2\cdot(\psi-\psi_2)\end{array}\right] \qquad (20)$$

The end of duration of the back sliding is obtained by nullifying the expression of the velocity $\dot{x}$, *given by the relation (20). The final moment, denoted by* $t=t_2'$, *respectively the angle* $\psi=\psi_2'$, *is obtained by solving the transcedental equation*

$$\sin\psi_2=\frac{\cos\psi_2'-\cos\psi_2}{\psi_2-\psi_2'} \qquad (21)$$

The distance, covered in the case of the back sliding, is given by the integral

$$s_2=\int_{t_2}^{t_2'}\dot{x}dt \qquad (22)$$

Taking into account the relation (20), after effecting the calculus, becomes

$$s_2=-\frac{r\cos(\beta+\phi)}{\cos\phi}\left[\begin{array}{l}\frac{(\psi_2'-\psi_2)^2}{2}\sin\psi_2+\sin\psi_2'\\-\sin\psi_2-(\psi_2'-\psi_2)\cos\psi_2\end{array}\right] \qquad (23)$$

If in the relation (23), it is replaced $\sin\psi_2$ *given by the equation (21), then for the displacements with back sliding, it can be written the relation*

$$s_2 = \frac{r\cos(\beta+\phi)}{\cos\phi}\cdot\Phi(\psi_2) \quad (24)$$

If during the time $T = \frac{2\pi}{\omega}$, *the material particle moves by forward and back sliding, the advance in the positive direction of the axis* O_1x_1 *has the value*

$$s = s_1 - s_2 \quad (25)$$

and the average velocity of particle is

$$\upsilon_m = (s_1 - s_2)\frac{1}{T} = (s_1 - s_2)\frac{\omega}{2\pi}. \quad (26)$$

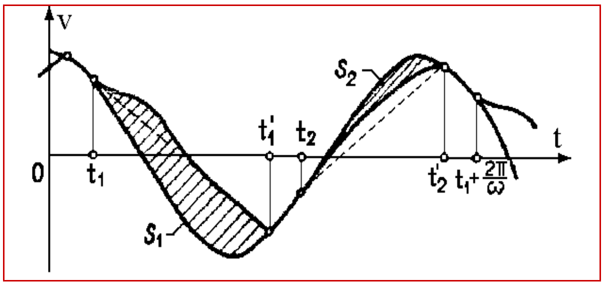

Figure 2. Absolute velocity, transport velocity and displacement

The graphical representations of the absolute velocity v, transport velocity v_t *and displacement* s_t *with sliding along the vibrating sieve, on which there are superposed the slips* s_1 *and* s_2, *are shown in Figure 2, for a cycle of vibration.*

CONCLUSION

All obtained results correspond to the case of sliding motion, without detachment, i.e. for N > 0. In accordance to the relation (5), it results

$$\sin\psi < \frac{g}{r\omega^2}\cdot\frac{\cos\alpha}{\sin\beta}. \quad (27)$$

The analysis of possible motion regimes can be more easily made with the help of the kinematical index:

$$K = \frac{r\omega^2}{g} \quad (28)$$

Thus, a condition for do not exist detachment, in accordance to the relation (5), is that the equation N=0 do not have solution, that leads to the inequality

$$K < \frac{\cos\alpha}{\sin\beta} \quad (29)$$

Now, it is supposed the condition (27) as satisfied, so that all regimes of motion are with sliding, only. The characteristic indexes of forward and back motions of sliding are denoted by the parameters

$$K_{1,2} = \frac{\sin(\alpha\mp\phi)}{\cos(\beta\pm\phi)}. \quad (30)$$

As consequence, the relation (7), with the notations (29), becomes

$$\sin\psi_{1,2} = \frac{K_{1,2}}{K} \quad (31)$$

For the beginning, it is considered $K_1<K_2$. *Then, there are the following possible situations:*

a] $K_1<K<K_2$ *for which the angle* ψ_2 *can not exist, situation that corresponds to a sliding motion, forward only* (AI_t)*;*

b] $K<K_1<K_2$ *when no one of the angles of motion initiation is possible, that corresponds to the situation of rest (R);*

c] $K_1<K_2<K$, *situation when both types of sliding are possible* ($\psi_1<\psi_2$), *and the regime of motion is with forward and back sliding* (AI_t+AI_p).

For the situation when $K_1> K_2$ *the possible cases are as follows:*

a] $K_2<K<K_1$ *for which the moment* ψ_1 *does not exist, which shows that the only possible regime of motion is with back sliding* (AI_p)*;*

b] $K<K_2<K_1$, *where initial moments for motions with sliding do not exist, i.e. there is the rest, only (R);*

c] $K_2<K_1<K$ *where there are possible solutions for both initial moments* ($\psi_1 <\psi_2$) *and so, the regime of motion is with forward and back sliding* (AI_t+AI_p).

Finally, in accordance to the relations (31), it can be written

$$K_1 - K_2 = -\frac{\sin 2\phi\cos(\alpha+\beta)}{\cos(\beta+\phi)\cos(\beta-\phi)} \quad (32)$$

The conditions $K_1<K_2$ *are realized if* $\cos(\alpha+\beta)>0$, *that leads to* $\beta<(\pi/2)-\alpha$. *The other situation,* $K_1>K_2$ *can appear if* $\cos(\alpha+\beta)<0$, *i.e. only for* $\beta>(\pi/2)-\alpha$.

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Scientific supplement of
ANNALS of FACULTY ENGINEERING HUNEDOARA – INTERNATIONAL JOURNAL of ENGINEERING
ISSN: 1584-2665 [print]
ISSN: 1584-2673 [CD-Rom]

http://annals.fih.upt.ro

ACTA TECHNICA CORVINIENSIS
BULLETIN OF ENGINEERING

GENERAL GUIDELINES FOR PREPARATION OF MANUSCRIPTS FOR REVIEW IN ACTA TECHNICA CORVINIENSIS – BULLETIN OF ENGINEERING

Abstract:
*a maximum 100 words abstract will be written, simple spaced, in **ENGLISH***

Keywords:
a maximum 10 representative words for the paper

THE TEXT

*The submitted manuscript must be content **INTRODUCTIVE NOTES (INTRODUCTIONS)**, follow by the **METHODOLOGY**, the **PRELIMINARY RESULTS** or the **FINAL RESULTS**, and, in final, the **CONCLUSIONS** about the presented notes.*
*Also, the paper included the **ABSTRACT**, **KEYWORDS**, and **REFERENCES**.*
The conclusions must be clear, relevant and must be indicate some the empirical, theoretical, methodological or scientific aspects of the research, and the author's contributions, or the future preliminaries of our research. It will publish empirical, theoretical and methodological articles.

THE TABLES, FIGURES, GRAPHS AND EQUATIONS

Tables and Figures should be numbered, titled and the resource should be mentioned below them. Photographs in the text are preferable to be in black and white, but must be clear, with a high contrast. Under each figure there will be typed, centered, "Figure X. Name of the figure".
Tables will be part of the text, designed as "Table y. Name of the table", written above the table, centered.
The equations will be inserted in the text – left aligned – and will be numbered with Arabian figures, in round brackets, right aligned. Before and after the equation a blank line will be left.

SUBMISSION OF MANUSCRIPTS

The original of the technical paper will be sent through e-mail as attaché document (.doc, Windows 95 or higher).*

ACKNOWLEDGMENT

If is necessary, please write yours works based research [Title, Contract no., Team, Year etc]

REFERENCES

[1] AUTHORS. YEAR. TITLE OF REFERENCE, JOURNALS NAME, VOLUME, PAGES
[2] AUTHORS. YEAR. TITLE OF BOOK, EDITING HOUSE
[3] AUTHORS. YEAR. TITLE OF REFERENCE, CONFERENCE NAME, VOLUME OR PROCEEDING, PAGES

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ACTA TECHNICA CORVINIENSIS
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SCIENTIFIC EVENT

INTERNATIONAL SYMPOSIUM “INTERDISCIPLINARY REGIONAL RESEARCH” – ISIRR 2009 –

ISIRR 2009

ROMANIA - HUNGARY - SERBIA

HUNEDOARA, ROMANIA,
23 - 24 APRIL, 2009

FIRST ANNOUNCEMENT

*It is our great privilege and pleasure to extend a cordial and sincerely invitation to you and your colleagues to attend the **10th INTERNATIONAL SYMPOSIUM “INTERDISCIPLINARY REGIONAL RESEARCH” – ISIRR 2009 – JUBILEE EDITION**, which will be held in **Hunedoara – Romania**, in **April, 23rd – 24th, 2009**.*

*The **10th INTERNATIONAL SYMPOSIUM “INTERDISCIPLINARY REGIONAL RESEARCH” – ISIRR 2009 – JUBILEE EDITION**, will ensure an exchange of scientific information and didactical opinions in fields with an impressive dynamic considering the research and the technological progress.*

*The Symposium will also provide the opportunity for exchanging ideas and experience with our colleagues coming from **HUNGARY**, **SERBIA** and **ROMANIA** and for developing new scientific collaboration.*

KEYWORDS:

Scientific events, Multidisciplinarity, Symposium, Scientific collaborations

GENERAL INFORMATIONS

- Data: THURSDAY, 23RD – FRIDAY, 24th of APRIL, 2009.
- The official language at the SYMPOSIUM is ENGLISH, and the papers will be accepted only in ENGLISH.
- The Symposium includes PLENARY SESSIONS, WORK-SHOPS, POSTER PRESENTATIONS, INFORMATIVE and AGREEMENT ACTIONS.
- The papers of a high scientific level will be presented during the SYMPOSIUM, while the rest of the papers will have a poster-form presentation.
- The papers, classified according to the topics and presented in the SYMPOSIUM sections, will be collected in the CD VOLUME PROCEEDINGS.
- Also, the selected papers will be appear in a special number of the multidisciplinary engineering journal ANNALS OF FACULTY OF ENGINEERING HUNEDOARA – JOURNAL OF ENGINEERING (FASCICULE 4/2009, PRINT VERSION, ISSN 1584-2665).
- A selected lot of papers from the SYMPOSIUM sections will be collected in the ONLINE SUPPLEMENT of ANNALS OF FACULTY OF ENGINEERING HUNEDOARA – JOURNAL OF ENGINEERING, in the ACTA TECHNICA CORVINIENSIS – BULLETIN OF ENGINEERING.
- The papers will have to frame into topics, to have an interdisciplinary character, and to be at the level of an international symposium.
- The selected papers will have to be presented in the SYMPOSIUM sections therefore the presence of one of the authors is required.
- It is preferable for the papers to have an interdisciplinary characteristic and to treat themes of mutual interest for our geographical area: eastern HUNGARY, northern SERBIA and western ROMANIA.
- Priority is given to papers produced by a mixed team of researchers from the three countries.
- Researchers from other countries may participate as well, on the condition of applicability for their results on the above mentioned geographical areas.

ORGANIZERS

The 10th INTERNATIONAL SYMPOSIUM "INTERDISCIPLINARY REGIONAL RESEARCH" – ISIRR 2009 organizers are:

- FACULTY OF ENGINEERING HUNEDOARA,
- UNIVERSITY POLITEHNICA TIMISOARA
- ASSOCIATION FOR MULTIDISCIPLINARY RESEARCH OF THE WEST ZONE OF ROMANIA (ACM-V) – TIMISOARA
- GENERAL ASSOCIATION OF ROMANIAN ENGINEERS (AGIR) – branch of HUNEDOARA
- ROMANIAN NATIONAL PARK "RETEZAT"

with kindly support of our partners:

- HUNGARIAN ACADEMY OF SCIENCE – branch of SZEGED, HUNGARY

and

- UNIVERSITY OF NOVI SAD, NOVI SAD, SERBIA

INTERNATIONAL SCIENTIFIC COMMITTEE

- Prof. dr. NICOLAE FARBAŞ – head of ASSOCIATION FOR MULTIDISCIPLINARY RESEARCH OF THE WEST ZONE OF ROMANIA (ACM-V) – TIMIŞOARA, ROMANIA
- Prof. h.c. dr. eng. GALLIA BUTNARU – „BANAT" UNIVERSITY OF AGRICULTURAL SCIENCES AND VETERINARY MEDICINE TIMISOARA, ROMANIA
- Prof. dr. eng. TEODOR HEPUT – dean of the FACULTY OF ENGINEERING – HUNEDOARA, ROMANIA
- Prof. dr. IMRE DEKANY – president of HUNGARIAN REGIONAL ACADEMY OF SCIENCES, SZEGED, HUNGARY
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- Prof. dr. VLADIMIR KATIC – UNIVERSITY OF NOVI SAD, FACULTY OF ENGINEERING, NOVI SAD, SERBIA
- Prof. dr. eng. FRANCISC WEBER – head of the GENERAL ASSOCIATION OF THE ROMANIAN

SYMPOSIUM TOPICS

- ***SECTION 1.***

***ECONOMICAL DEVELOPMENT AND STRATEGIES IN OUR REGIONS AND ABROAD**, focusing on problems concerning the general field of economics and management, the European Integration of our countries, the differences between the development of the regions from Eastern Europe and the management of diminishing unfavorable differences, including aspects regarding the globalization and economy of small and medium enterprises, human resources, management strategies and organization behavior, provides a leading forum for interaction and research on the competitive strategies of managers and the organizational structure of firms;*

- ***SECTION 2.***

***MEDICAL ISSUES, LABOR HEALTH AND VETERINARY MEDICINE**, focusing on novelties in medical studies and veterinary medicine,* medical *advice, diagnoses and treatment, including new knowledge on pathogens, immunity to pathogenic micro-organisms, epidemiology related to infections, specific aspects of treatment of diseases, pathological and clinical studies (including case reports), diagnosis tests and technical reports, as well as labor related accidents and professional diseases*

- ***SECTION 3.***

***APPLIED ECOLOGY AND ENVIRONMENTAL PROTECTION IN THE REGION**, focusing on the management of the city and on industrial waste materials, debating issues concerning the environmental engineering, the environmental impact analysis and assessment, the industrial and urban environmental management, the cleaning process, pollution agents and pollution sources, water – air – soil quality analysis, the re-utilization of industrial wastes and the diminishing of pollution and the environmental planning and environmental protection in the regions of the Eastern Europe area;*

- ***SECTION 4.***

***USES OF NATURAL RESOURCES IN REGIONS, MINING, ENERGY CONSERVATION AND PLANNING**, focusing on general fields of industry, mining, agriculture, forestry, botany and horticulture, hydrology, biotechnology, material and energetically resources, including energy conservation and planning and alternate energy development, in multidisciplinary studies;*

- ***SECTION 5.***

***APPLIED SCIENCES AND TECHNOLOGIES – MANUFACTURING AND RESEARCH IN ENGINEERING FIELDS**, focusing on engineering science and practice, covering the full spectrum of engineering theory and practice, including studies involving the application of physical and mathematical techniques to fundamental investigations and emerging areas within the engineering fields, incoming with information from a wide variety of applied science specialties in multidisciplinary studies;*

- *SUBSECTION 5.A*
APPLIED SCIENCES AND TECHNOLOGIES – MANUFACTURING AND RESEARCH IN MECHANICAL ENGINEERING, *focusing on mechanical engineering science and practice, covering the full spectrum of mechanical field.*

- *SUBSECTION 5.A*
APPLIED SCIENCES AND TECHNOLOGIES – MANUFACTURING AND RESEARCH IN INFORMATICS & ELECTRICAL ENGINEERING, *focusing on electrical engineering and informatics, covering the full spectrum of electrical field.*

- *SUBSECTION 5.A*
APPLIED SCIENCES AND TECHNOLOGIES – MANUFACTURING AND RESEARCH IN MATERIAL SCIENCE ENGINEERING, *focusing on material science and engineering, theory and practice, covering the full spectrum of metallurgy fields, including raw materials and waste management in this industry.*

- *SECTION 6.*
METHODS AND TECHNIQUES, INSTRUMENTS AND SUPPLIES IN THE NATURAL SCIENCE FIELDS, *focusing on the theory and practice of chemistry and physics, covering the full spectrum of natural sciences in multidisciplinary studies;*

- *SUBSECTION 6.A*
METHODS AND TECHNIQUES, INSTRUMENTS AND SUPPLIES IN THE FIELDS OF CHEMISTRY AND PHYSICS, *focusing on the general chemistry and physics, including the multidisciplinarity in these areas.*

- *SUBSECTION 6.A*
METHODS AND TECHNIQUES, INSTRUMENTS AND SUPPLIES IN THE FIELD OF MATHEMATICS, *focusing on the mathematic fields and the application of mathematics in the engineering.*

- *INFORMATIVE MEETING*,
discussing the topic: REGIONAL INTEGRATION, concerning the expanding of the application area for the transferable credit system between the specialized faculties and universities from HUNGARY, SERBIA and ROMANIA, educational and pedagogical issues common for this countries, as well as problems regarding the extending of connections between the institutions on educational matters, teaching and specializing processes and co-operation between professors and students.

The SYMPOSIUM is an open invitation for all specialists, professors, researchers and experts in all scientific fields, who can produce a free presentation of the results in their activities. It is preferable for the papers to have an interdisciplinary characteristic and to treat themes of mutual interest for our geographical area: eastern HUNGARY, northern SERBIA and western ROMANIA.
Priority is given to papers produced by a mixed team of researchers from the three countries. Researchers from other countries may participate as well, on the condition of applicability for their results on the above mentioned geographical areas.

DEADLINES

- For the paper selection, you are kindly invited to submit a maximum 200 words **abstract** *and post it to the address of the SYMPOSIUM by 15 FEBRUARY 2009, stating the section in which the papers will be presented.*
- *Notification of acceptance, instructions for preparing camera-ready manuscripts, financial and other details will be sent by 15 MARCH 2009.*
- *The camera-ready manuscript must be sent to the ISIRR 2009 – SECRETARY OFFICE by 30 MARCH 2009.*
- *The final announcement of confirmation for publishing and the day of presentation will be sent by 10 APRIL 2009.*

INVITATION

The SYMPOSIUM is an open invitation for all specialists, professors, researchers and experts in all scientific fields, who can produce a free presentation of the results in their activities.
For more information please contact the FACULTY OF ENGINEERING – HUNEDOARA, SECRETARY OFFICE OF THE ORGANIZING COMMITTEE.
An e-mail address was be opened to receive your correspondence: redactie@fih.upt.ro
All information on the conference will also be available on the web at http://annals.fih.upt.ro/sustained-events.

SCHEDULE OF EVENTS

1ST DAY, THURSDAY, 23RD APRIL, 2009

08.00 – 10.00 Welcoming of guests and registration of participants – in the HALL of FACULTY OF ENGINEERING – HUNEDOARA

10.00 – 11.30 Opening Ceremony – in the AMPHITHEATRE of FACULTY OF ENGINEERING – HUNEDOARA

Plenary Lecture # 1
FROM THE RETEZAT NATIONAL PARK TO EUROPE'S "YELLOWSTONE" - SEEDS FOR THOUGHTS FOR THE ESTABLISHMENT AND EFFICIENT MANAGEMENT OF EUROPE'S LARGEST PROTECTED AREA COVERING THE SOUTHERN AND WESTERN CARPATHIANS IN ROMANIA AND SERBIA
Dr. ERIKA STANCIU – WWF DANUBE CARPATHIAN PROGRAMME, CARPATHIAN, FORESTS AND PROTECTED AREA LEADER, RETEZAT NATIONAL PARK PRESIDENT

Plenary Lecture # 2
SUSTAINABLE DEVELOPMENT AND THE ECONOMIC CRISIS
Dr. CARMEN HĂRĂU – UNIVERSITY POLITEHNICA TIMIŞOARA, FACULTY OF ENGINEERING – HUNEDOARA

Plenary Lecture # 3
SLAG – UTILIZATION IN ROAD CONSTRUCTION – EXPERIENCE AND SOLUTIONS
Eng. RODICA ISTRATE – BUSINESS SERVICES PREST SRL HUNEDOARA

Plenary Lecture # 4
ADVANCED TECHNIQUES IN ELECTRON SPECTROSCOPY FOR SURFACE AND INTERFACE STUDIES,
Prof. Dr. BERNARD GRUZZA – POLYTECH'CLERMONT-FERRAND UFR SCIENCES, UNIVERSITÉ BLAISE PASCAL – CLERMONT II CLERMONT-FERRAND, HEAD OF THE RESEARCH GROUP "SURFACES AND INTERFACES", LABORATOIRE DES SCIENCES DES MATÉRIAUX POUR L'ELECTRONIQUE ET D'AUTOMATIQUE , LASMEA, FRANCE

11.30 – 12.00 Coffee break – in the HALLS of FACULTY OF ENGINEERING – HUNEDOARA

12.00 – 12.30 Setting of posters by sections – in the HALLS of the FACULTY OF ENGINEERING

12.30 – 14.00 Presentations and debates by sections – in the AMPHITHEATRES of the FACULTY OF ENGINEERING

14.00 – 16.00 Break for lunch – in the STUDENT RESTAURANT of the Faculty of Engineering – Hunedoara

16.00 – 19.00 Debates by sections – in the Amphitheatres of FACULTY OF ENGINEERING

19.00 Festive dinner – in the HOTEL MAIER – HUNEDOARA ***

2ND DAY, FRIDAY, 24TH APRIL, 2009

08.00 – 10.00 Breakfast – in the HOTEL MAIER – HUNEDOARA *** and in the STUDENT RESTAURANT of the FACULTY OF ENGINEERING – HUNEDOARA

10.00 – 11.30 Presentations and debates by sections and posters – in Halls and in Amphitheatres of the FACULTY

11.30 – 12.30 Informative Meeting – in the COUNCIL CHAMBER of the FACULTY OF ENGINEERING

12.30 – 13.30 Final debates and CLOSING CEREMONY – in the Amphitheatre of FACULTY OF ENGINEERING

13.30 – 14.00 Break for lunch – in the STUDENT RESTAURANT of the FACULTY OF ENGINEERING – HUNEDOARA

14.00 Visit to tourist sights (CORVIN CASTLE and surroundings)

PROGRAM SCHEDULE

Faculty of Engineering – Hunedoara
Amphitheatre # 1 – # 6
Group C, Floor 1
Group B, Floor 2
Group F, Floor 1
Presentations and debates by sections

1ST DAY, THURSDAY, 23RD APRIL, 2009

12.30 – 14.00 and 16.00 – 19.00
Faculty of Engineering – Hunedoara
Central Hall # 1 – Group C , Floor 1
Presentations and debates by posters

1ST DAY, THURSDAY, 23RD APRIL, 2009

16.00 – 19.00

2ND DAY, FRIDAY, 24TH APRIL, 2009

10.00 – 12.00

THE INFORMATIVE MEETING

- discussing the topics:

- *REGIONAL INTEGRATION, concerning the expanding of the application area for the transferable credit system between the specialized faculties and universities from HUNGARY, SERBIA and ROMANIA, educational and pedagogical issues common for this countries, as well as problems regarding the extending of connections between the institutions on educational matters, teaching and specializing processes and co-operation between professors and students.*
- *EXTEND AREA OF ISIRR, discussing about the expanding possibilities of the ISIRR in BULGARIA and SLOVAKIA.*
- *ISIRR for ISI PROCEEDINGS APPLICATION, discussing about the possibilities to accede into international databases for recognize the ISIRR as important Symposium in this area.*
- *THE 11th ISIRR, organized in SZEGED, HUNGARY, in preliminary discussions*

SECRETARY OFFICE OF THE ORGANIZING COMMITTEE

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ACTA TECHNICA CORVINIENSIS
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3RD INTERNATIONAL SYMPOSIUM ON TRACE ELEMENTS IN THE FOOD CHAIN – DEFICIENCY OR EXCESS OF TRACE ELEMENTS IN THE ENVIRONMENT AS A RISK OF HEALTH - TEFC 2009

BUDAPEST, HUNGARY
21-23 May 2009

INVITATION

You are cordially invited to attend the

3RD INTERNATIONAL SYMPOSIUM ON TRACE ELEMENTS IN THE FOOD CHAIN – DEFICIENCY OR EXCESS OF TRACE ELEMENTS IN THE ENVIRONMENT AS A RISK OF HEALTH (TEFC – 2009)

to be organized by the Working Committee on Trace Elements of the Hungarian Academy of Sciences (HAS), as well as the Institute of Materials and Environmental Chemistry of the HAS, in

BUDAPEST, HUNGARY

21-23 May 2009.

The purpose of the Symposium is to congregate experts interested in the investigation of trace elements of the food chain, involving analytical, metabolic, toxicological aspects, focussing on the environmental and health concerns.

Accordingly, following our traditions we intend to provide a multidisciplinary forum for exchange of experiences and expertise.

Special attention will be given to the deficiency or excess in the environment as a risk of health, the speciation and transfer of trace elements in the food chain, to the factors influencing these processes.

GENERAL SUBJECT AREAS, TOPICS

Scientific sessions are expected to cover the following general subject areas:

- METHODICAL ASPECTS OF TRACE ELEMENT RESEARCH. SPECIATION.
- NANOTECHNOLOGY FOR TRACE ELEMENT RESEARCH.
- ENVIRONMENTAL ASPECTS OF TRACE ELEMENTS CONCERNING AIR, WATER, SOIL, MICROORGANISMS AND PLANTS.
- TRACE ELEMENT STATUS AND RISK OF HEALTH IN PLANTS, ANIMALS AND MAN.
- FOOD AND FEED SAFETY IN HUMAN AND ANIMAL NUTRITION.

OTHER TOPICS

- POSSIBILITIES AND DIFFICULTIES IN THE ANALYSIS OF TRACE ELEMENTS.
- TRACE ELEMENTS AS AIR POLLUTANTS.
- SEWAGE SLUDGES AS TRACE ELEMENT SOURCES.
- BIOAVAILABILITY AND MOBILITY OF TRACE ELEMENTS IN SOILS.
- REMEDIATION OF TRACE ELEMENT CONTAMINATED SOILS.

- *BIOACCUMULATION AND TRANSLOCATION OF TRACE ELEMENTS IN PLANTS.*
- *TRACE ELEMENTS IN MEDICINAL PLANTS.*
- *TRACE ELEMENT DEFICIENCY: GENETIC AND/OR DIETARY BACKGROUND.*
- *BIOLOGICAL AND TOXICOLOGICAL IMPORTANCE OF TRACE ELEMENTS.*
- *TARGETS OF HEAVY METAL TOXICITY.*
- *NEUROTOXIC EFFECTS OF TRACE ELEMENT DEFICIENCY OR EXCESS.*
- *MICRONUTRIENTS AND CARDIOVASCULAR DISEASES.*
- *DEFICIENCY – EXCESS – METABOLIC DISORDERS.*
- *DEFICIENCY – EXCESS – ANTIOXIDANT STATUS.*
- *HOW MANY IS INSUFFICIENT, OPTIMAL, EXCESS?*
- *TRACE ELEMENTS AND OXIDATIVE STRESS.*
- *TRACE ELEMENTS AS ENVIRONMENTAL POLLUTANTS.*
- *TRACE ELEMENT SUPPLEMENTATION AND FOOD SAFETY IN PUBLIC ADMINISTRATION*

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DEADLINES

Abstract submission: JANUARY 15, 2009.
Information on paper acceptance: FEBRUARY 1, 2009
Early registration: FEBRUARY 28, 2009
Contribution submission: FEBRUARY 28, 2009.
Further information:
http://www.chemres.hu/tefc2009

SECRETARY OFFICE OF THE ORGANIZING COMMITTEE

Dr. KLÁRA SZENTMIHÁLYI, PhD.
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SYMPOSIUM SECRETARIAT

e-mail: tefc2009@chemres.hu
On behalf of the Organising Committee we look forward to meeting you in the more than eleven hundred year old HUNGARY.
Prof. Dr. MIHÁLY SZILÁGYI, PhD, DSc. Chair
Dr. KLÁRA SZENTMIHÁLYI, PhD. Secretary

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Scientific supplement of
ANNALS of FACULTY ENGINEERING HUNEDOARA
– INTERNATIONAL JOURNAL of ENGINEERING
ISSN: 1584-2665 [print]
ISSN: 1584-2673 [CD-Rom]

FACULTY OF ENGINEERING HUNEDOARA
5, REVOLUTIEI
331128 – HUNEDOARA
ROMANIA
http://annals.fih.upt.ro

FACULTY of ENGINEERING HUNEDOARA — 1970

ACTA TECHNICA CORVINIENSIS

BULLETIN OF ENGINEERING

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[January - March]
TOME II [2009]