EFEE

NEWSLETTER

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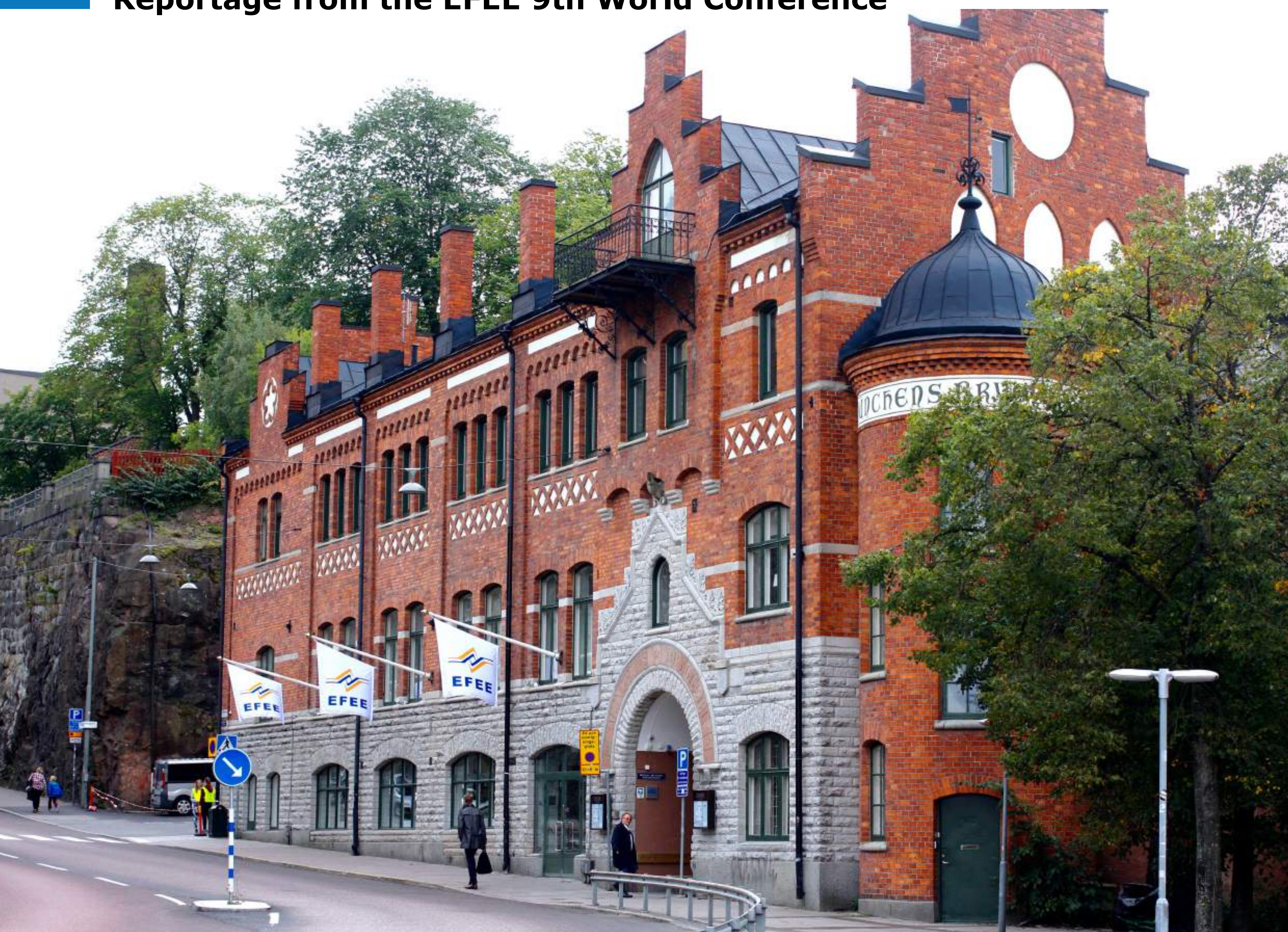
Modeling the danger of injury when fragments of material result from the detonation of explosive charges

Special blasting techniques applied in underground shafts

Blasting the Bonn Centre

Reportage from the EFEE 9th World Conference



November 2017

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We in EFEE hope you will enjoy the present EFEE-Newsletter. The next edition will be published in February 2018. Please feel free to contact the EFEE secretariat or write to newsletter@efee.eu in case:

- You have a story you want to bring in the Newsletter
- You have a future event for the next EFEE Newsletter upcoming events list
- You want to advertise in an upcoming Newsletter edition

Or any other matter.

Jari Honkanen, Chairman of the Newsletter Committee and the Vice President of

EFEE and Teele Tuuna, Editor of EFEE Newsletter - newsletter@efee.eu

Dear EFEE members, the President´s voice

I´m delighted to introduce you the forth and the last issue of EFEE Newsletter in this year. Our Federation had the unique opportunity to successfully organize its 9th EFEE World Conference held 10th to 12th September 2017 in Stockholm. The review of this conference was extremely positive, and I have to thank our sponsors, exhibitors, speakers and international delegations for helping to ensure that our 9th World Conference was the best conference to date. We are very grateful that you decided to attend the EFEE 9th World Conference on Explosives and Blasting in Stockholm. It was really great to see the participants from all over the world who came to exchange the experience and work together for a few days. The conference provided an excellent opportunity for networking and for the building of mutual relationships. The atmosphere was collegiate and friendly starting from Welcoming Drinks reception, Conference itself and Gala dinner in Vinterviken.

We thank you very much for coming and attending our conference which was brought to you in association with the Swedish Rock Engineering Association and supported also by the International Society of Explosives Engineers from Cleveland, Ohio, USA.

Therefore I have to express my gratitude to Mr. Robert Sturk - the Chairman of Swedish Rock Engineering Association as well as to Mr. Jack Eloranta - the President of International Society of Explosives Engineers. At the same time it is my duty to thank Roger Holmberg, the Chairman of Technical Committee and also the committee members for their excellent and diligent work. We came away from the conference with a feeling of community, and we foresee exciting collaborations resulting from the new professional friendships that were initiated at this conference.

We will pay sufficient attention to the organization of the next 10th EFEE World Conference which will take place in Helsinki - the capital city of Finland in 2019 in order to meet your expectations resulting from our conference in Stockholm.

During the year 2017 our federation was repeatedly and continuously growing and increasing the number of its members. I have to say thank you to all EFEE partners, members and simply to all who contributed to our mutual productive work which resulted in fact to a very positive year. Particularly I am very grateful for the excellent work of our Secretary General Roger Holmberg. Thank you very much Roger.

Now when we are approaching the end of 2017 I would like to take this opportunity to extend my best wishes to all of you. May all who celebrate Christmas enjoy the festive season and to all who are able to take a break at the end of year, enjoy every moment.

Finally please do not finish reading our Newsletter with my foreword but kindly continue to read all the interesting articles prepared especially for you in this newsletter.

Igor Kopal, President of EFEE

MODELING THE DANGER OF INJURY WHEN FRAGMENTS OF MATERIAL RESULT FROM THE DETONATION OF EXPLOSIVE CHARGES

Abstract

The paper shows a summary of the results of research undertaken in the field of modelling the dangers of injury / destruction when fragments of material resulting from the detonation of explosive charges are jettisoned on workers and / or industrial objectives from the explosives testing center. So, American scientific practice from the moment is (FRMS type) developed to improve the performance of the specialized software from the security of explosives for civil use type IMESAFR (ex. Version 2.0) which was acquired in the NUCLEU project- PN 16 43 02 15/2016- 2017, using different probability functions dedicated to this field type PDF (Probability Density Functions) in order to shape the graphic-analytical phenomenon when fragments of material resulting from the detonation of explosive charges are jettisoned.

Overview on the mechanisms of formation of fragments of the material resulting from the detonation of explosive charges

Detonation of explosives

Detonation is a physical-chemical process, characterized by a high reaction speed and by the formation of large quantities of gases, at high temperatures, which leads to the generation of high forces of breaking and dislocation of rocks. To interpret the physical phenomenon of detonation, worldwide were expressed various theories, one of them being the hydrodynamic theory. It was accepted unanimously, considering the similarity of its mode of propagation by explosives with the propagation of the pressurized fluid. The detonation mechanism comprises three steps: **I.** The mechanical compression of each molecule of the explosive substance carried by a dynamic pulse; **II.** The thermal decomposition of each layer in the structure of the explosive, up to high temperatures, when given the rapidity of the chemical reaction, the dynamic compression process being carried out without heat exchange in the environment (adiabatic compression); III. The exo-thermal decomposition of the explosive due to the action of high temperatures.

The formation of craters:

In figure No. 1 is presented schematically a crater produced by the detonation of an explosive (explosive charge [1]). Dimensions associated to a crater are the following:

D2 = the apparent diameter of the crater;
D1 = the actual diameter of the crater;
h1 = the actual depth of the crater;
h = berm height.

Craters are formed when there is a detonation of explosive charges that is placed as follows: below ground level (closed space); on the ground (air-ground interface); suspended in the air. Regardless of the location of the explosive charge, the crater is the destructive effect of a blasting. When initiating the explosive charge, in his mass, there is a violent decomposition reaction, the detonation wave which results is propagated at a speed of 2000 – 8000 m/s. In the detonation wave front is developed a pressure that can reach 104 MPa and it is transmitted in the environment in the form of a shock wave, having the same direction of propagation as the detonation wave.

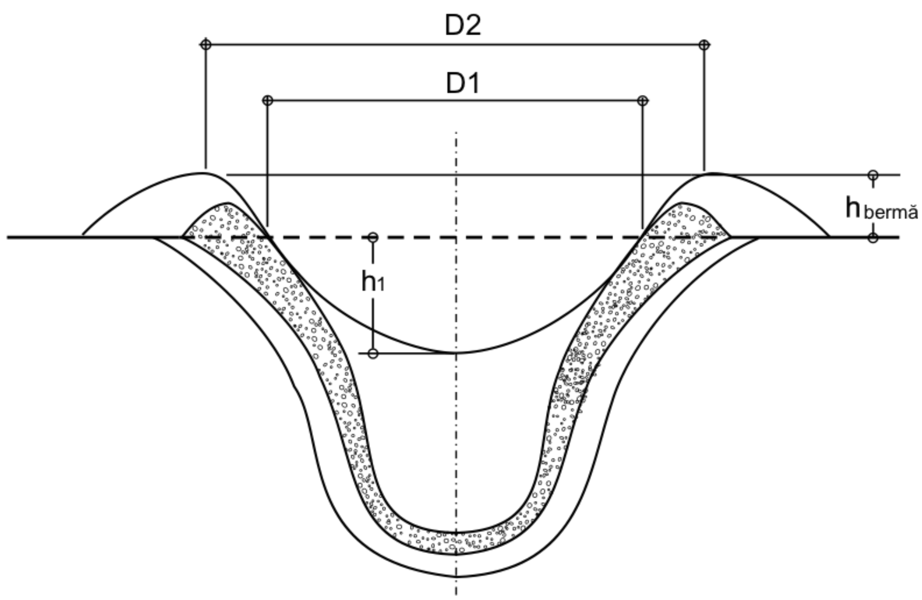

Fig. 1. Defining the size of a crater

[1] The explosive charge is the quantity of explosives prepared for detonation, in the view of displacement a volume of material (rack) for carrying out excavations.

The material resulting from an explosion type event considers three types of fragments: primary, secondary and scrap resulting from the crater formed. The primary fragments are coming from the body of the explosive detonated, and secondarily from the structure of the storage room (eg. roof, end walls, side and rear). Also, other residues that are generated in the impact crater formation are fragments from the ground or the foundation structure of the storage room. In the event of an explosion type event there may result a large number of individual fragments (of the order of thousands) that can be uniquely identified by its mass and speed of the main parameters (and implicitly by the kinetic energy). The model type QRA (Quantitative Risk Assessment) consecrated to quantitative risk assessment, provides opportunities for an analysis of the whole volume of fragments designed, based on a dynamic model of meshing of the mass, using the distribution pattern of recurrent Bin n, (1). to provide a general overview of the 10 classes of results (Bini, i=1,10).

RM – the residual material mass of fragment

DM – the fragment mass of material dispersion

Thus, Bin1/Bin10 represents the fragments with the high / low mass and level significant / low of damage and / or destruction of the human component and / or structures.

Table 1 shows the results obtained for the ten classes (Bin1÷Bin10) corresponding to level of damage / destruction (via kinetic energy) at the odds of maximum, medium and minimum, and average weight of each fragment designed depending on the type of material.

$$Bin\ n{:}DAM_n = RM_n + \left(\sum_{i=1}^{n-1}(DM_{[i,n]})\right) + \left(\sum_{i=2}^{n-1}(B11DM_{[i,n]})\right) \qquad (1)$$

where:

DAM – dynamic adjustment of the mass of the material fragment

n – the order of meshing of the fragment mass of material

Class (Bin_{in} n=1,10)	Bin_1	Bin_2	Bin_3	Bin_4	Bin_5	Bin_6	Bin_7	Bin_8	Bin_9	Bin_{10}
Minimum kinetic energy (m-Kg)	100K	30K	10K	3K	1K	300	100	30	10	3
Average kinetic energy (m-Kg)	173K	54K	17K	5K	1,7K	547	173	54	17	5
The maximum kinetic energy (m-Kg)	≥300K	100K	30K	10K	3K	1K	300	100	30	10
The average weight of fragments of steel (Kg)	16,19352	6,75864	2,875824	1,206576	0,512568	0,214553	0,090266	0,038647	0,017191	0,006441
The average weight of concrete fragments (Kg)	34,20144	14,2884	6,07824	2,544696	1,079568	0,4536	0,190512	0,081648	0,036288	0,013608

Table 1.

Description of the primary fragments

The primary fragments result from explosive destruction and its packaging after detonation, and their design mechanism by modelling is based on the number of fragments, by their mass and by the maximum range of throwing. (Figure no.2).

The number of explosive products (Nw) is determined by the relation (2):

$$N_w = \frac{W_1}{NEW \times QD_1} \qquad (2)$$

where:

W_1 – amount of explosives of the explosive product No.1

NEW – net explosive quantity of a single product (V. Table 2)

QD_1 – distance depending on the amount of explosives

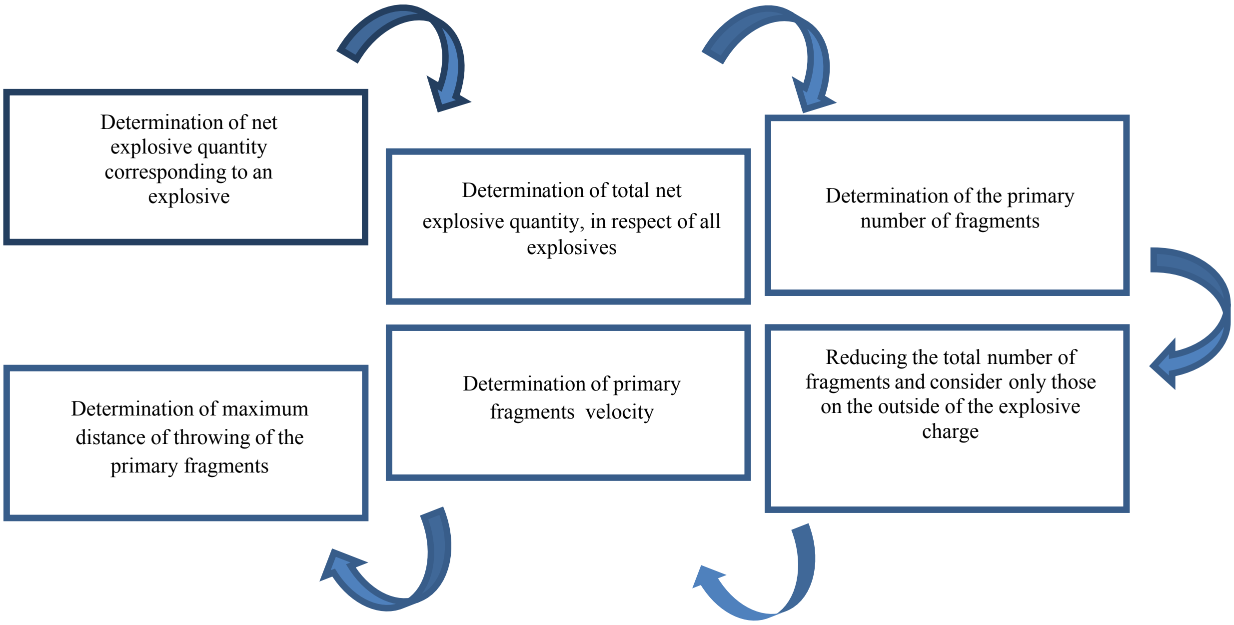

Fig.2. Process diagram for primary fragments projection

Explosive charges	NEW specific for a single type of explosive product (Kg)	Fragments derived from a single product Mass Bin$_n$, n=1÷10									
		1	2	3	4	5	6	7	8	9	10
explosive charges with small fragments	0,4536	0	0	0	0	0	0	0	1	5	10
Explosive charges without primer fragments	0,4536	0	0	0	0	0	0	0	0	0	0
metallic container with explosive charge	4.536	0	0	0	0	0	0	80	4.111	796	319
Explosive charge confined in the metal pipe	3,901	0	0	0	0	0	0	4	19	44	79

Table 2.

Further are displayed in tables the maximum range values of action / projection of the primary fragments (Rmax), which is determined for each fragment, according to the average weight, of the suitable bin and the initial rate (v. Table 3).

explosive charges	V (m/s)	R_s(m)	R_M(m)
explosive charges with small fragments	1219,2	569,976	683,9712
Explosive charges without primer fragments	NA	NA	NA
metallic container with explosive charge	1219,2	569,976	683,9712
Explosive charge confined in the metal pipe	1219,2	569,976	683,9712

Table 3.

The value Rmax is set at the maximum value for the projection, whether for one explosive product (RS) or for multiple products (RM), depending on the amount of explosives considered, W1. In case of W1 lower than the net quantity of explosive from the explosive product it is used the value of RS, and where W1 is greater than this quantity, then it is used the value of RM. Usually, the value of RM is 20% higher than Rs, taking into consideration the known spraying debris.

In the event of an explosion type event, product within a potentially explosive structure type PES (for storing explosives for civil uses), results a very large amount of primary fragments whose number and the initial speed is determined according to the data of presented in tables No.2 and 3. Also, the components of the PES structure, remaining after the explosion, can block and remove the primary fragments resulting from this event. At the same time, it is necessary to determine the fraction of primary fragment blocked by structural components of PES (roof, front wall, rear wall and side walls).

Thus, to determine the number of primary fragments which may be blocked by various components of the structure of the PES, they must be divided depending on the angle of projection, namely: large angular throw fragments (hitting the roof) and lower angular throw fragments (the lower) (hitting the walls). The lower angular fragments are divided, at their turn, further in side impact fragments and horizontal fragments displaced in a direction nearly horizontal. Also, side impact fragments have an arched trajectory, to ES-type structure (the structure exposed to explosion), but it can be blocked, in the end, the wall of this structure, by artificial obstacles (Figure 3).

The primary fragments are divided as follows, 25% of the total number of the fragments is considered to be high angle fragments, 7.5% of the total is considered to be fragments of the side impact, and 67.5% is considered to be horizontal fragments. Setting these values are based on interpretation of test data, including high-speed video analysis. The primary fragments are divided into fragments that can be blocked or contained by each structure type PES.

The side impact fragments and the horizontal fragments are potentially blocked by the front wall, sidewalls and the components of the rear wall structure type PES, while high angle fragments are assumed to be potentially blocked by the roof component (Figure 4).

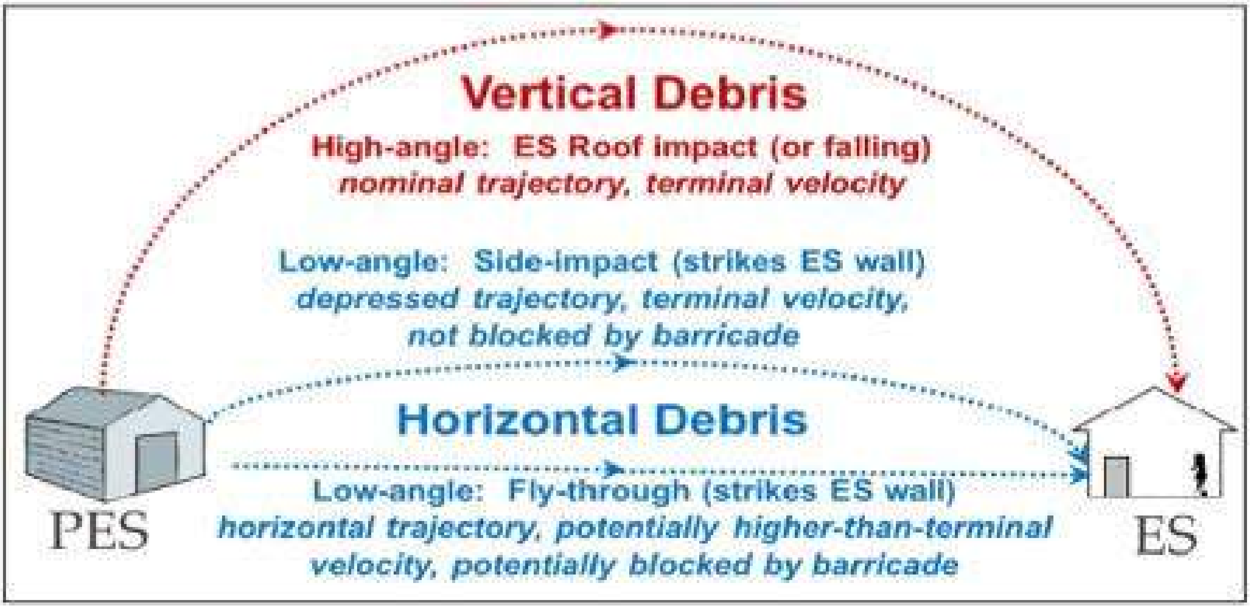

Fig.3. The design trajectories of primary fragments

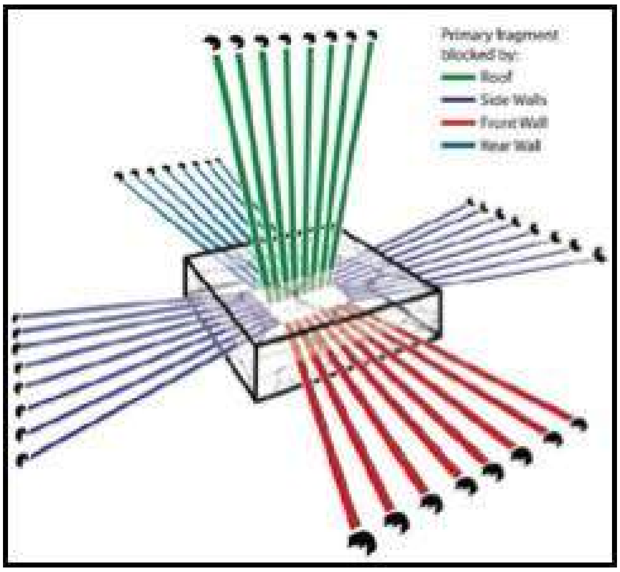

Fig. 4. Blocking the primary fragments

Density estimation of the material fragments projected

The configuration estimating of the path travelled by the material thrown away, can be done by using the methodologies results within various research conducted in this domain and requires well-grounded scientific knowledge on the main parameters evaluated, namely: the speed of impact and the mass of material fragment projected. It would be ideal for determining the position and speed of impact, specific to each fragment of discarded material, to use physical laws based on differential equations that characterize the wave phenomena, however, at the moment, there do not exist proven scientific results for a specific scenario related to an explosion type event.

The number of fragments and individual characteristics of mass and speed are dependent both on the type of material (eg. steel or concrete), and the characteristics of explosives used to testing. Thus, the conceptual models can be developed for the production of trajectory calculations for the intervals of fragment of mass, launch angle and speed. However, Monte Carlo simulations are sensitive to present ranges assigned to each variable trajectory. Also, these models require running a series of simulations at the time of analysis, requiring extensive resources of time and the calculation result being one detailed and based only on assumptions. Where, test results of explosives accident statistics, validated simulation data are available, then type models Fast-Running Models (FRMs) can be created for the analysis of hazards in a simplified manner, without using difficulty complex physical models based on the equation of state. So, American scientific practice from the moment (type FRMs), developed for specialized software in the field of explosives for civil uses security type IMESAFR 2.0 which was acquired in the Program NUCLEU-Project PN 16 43 02 15/2016-2017, using different probability density functions dedicated to this field type PDF (Probability Density Functions) for graphic-analytical model of the phenomenon of projecting portions of the material, which result from such explosion events. This PDF is obtained by pre-processing, simulation and / or analysis of test data in a dedicated equation (closed form), after the pre-set density function can generate immediate results. Figure No. 5 shows an example of simulation test data, by a number of data-points that have been translated into a closed-form equation.

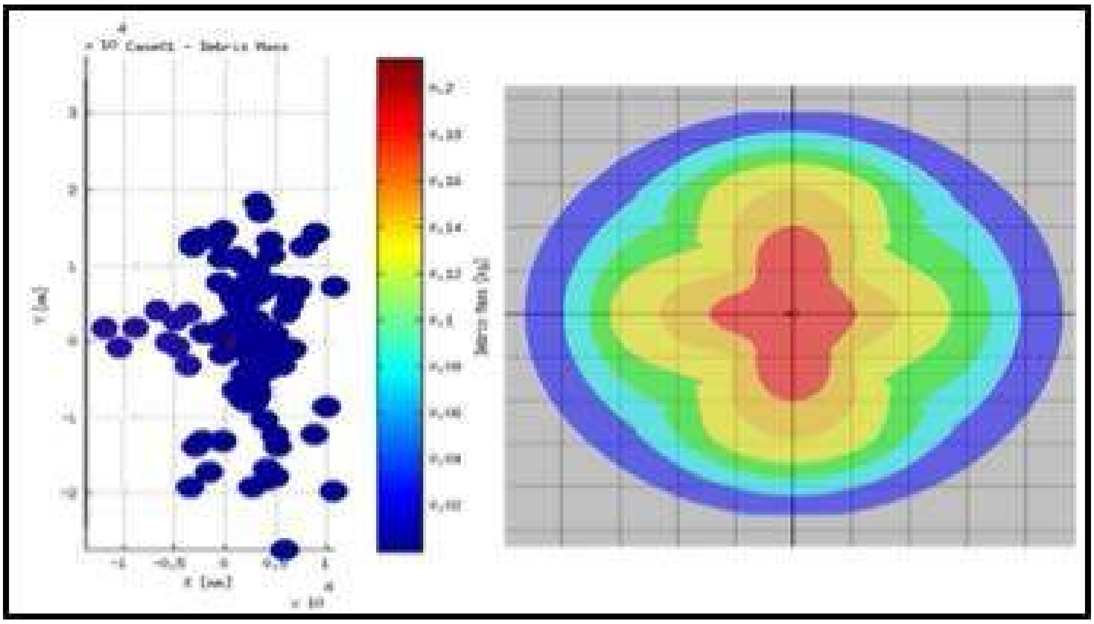

Fig. 5. Representative test transposition date in PDF

This PDF serves as a contour map, almost instantaneous forecasting projected portions of the material density. To represent different types of models based on the use of probability density functions, it can be designed with different levels of complexity. Thus, PDFs are composed of elements “down-range” type and azimuth (cross-range). “Down-range” component reproduces the shape of the origin of the blast outwards in any radial direction. This essential component distance determines the design portions of the material from the original location in which the explosive charge detonation occurs, and the range of their greater density. Cross range component determines the form of the tool when moving radially at a constant distance from the origin (azimuthal direction or cross-range). In the following, there will be detailed the two components of PDFs modelling practice often used in explosives security.

The most common PDFs are the uniform distributions in all directions from the origin (that is, no azimuthal variation). These distributions may be used effectively for modelling safety are evenly distributed or random in all directions around the site of an explosion such as both pieces of material resulting from the destruction of the roof that are thrown up and scattered, as well as fragments of wall structures of the various arcuate shape. The first example is a function of the type Gauss - normal of distribution (ex. a bell-shaped curve) used as component down-range without azimuthal variation, producing a distribution parameter type bi-variant Normal (BVN), characterized by the highest density at the origin which resembles a hill (Figure 6).

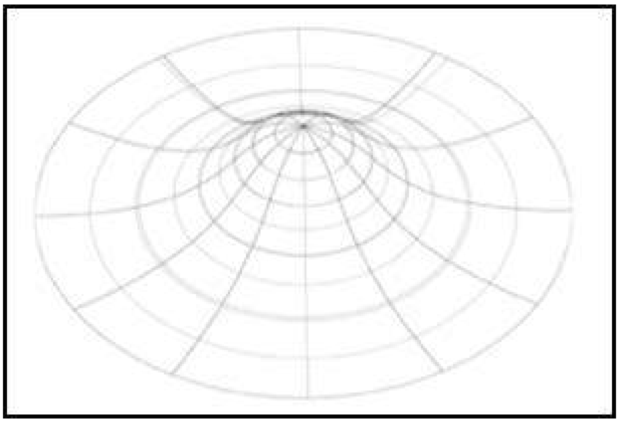

Fig. 6. Distribution type Bi-Standard version (BVN)*)*

The shape of PDF- for the distribution of BVN is given by the following equation:

$$P_i = \frac{1}{2\pi\sigma^2} e^{\left(\frac{-r^2}{2\sigma^2}\right)} \qquad (3)$$

where:

Pi - the probability of a single piece designed in a certain area;

σ - the standard deviation of the distance *"down-range"* ;

r - the range from the origin to the point of interest.

The ISURF model

Probability density function BVN is useful for substantiating the basic scenarios, in which case is available a limited number of data and information, the danger of projecting fragments of material is assumed to be higher in the vicinity of the blast origin for the production location, as a result of the detonation of the charging material. However, there may be situations under which, a lot of the fragments are thrown out of origin. This aspect is especially true for primary fragments, the residues from the explosive charge and secondary arising from pieces of wall. When the model *"BVN down-range"* is used in these types of scenarios, the problem of the PDF is related to resolving over-prediction of throwing fragments near origin, in small amounts at intervals. Research conducted by the Institute of Explosives Manufacturers (IME) to develop specialized computer infrastructure for the security of explosives (IMESAFR), Research APT has developed a new function *"down-range"* to improve the model *"BVN down-range"*, resulting in a toroidal PDF with azimuthal variation (Figure 7).

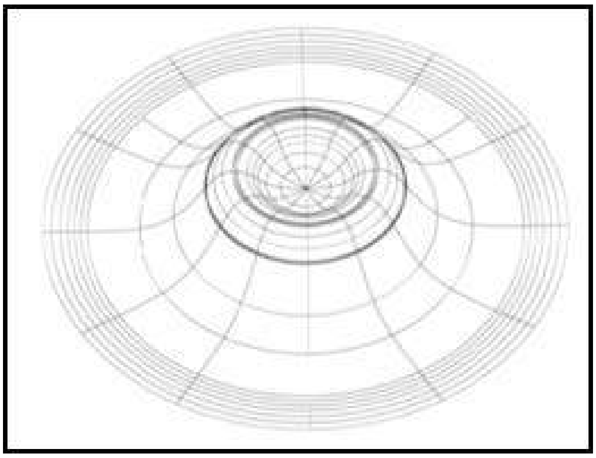

Fig.7. PDF toroidal without azimuthal variation, type ISURF

Comparative analysis of the two established models for substantiating the scenarios of projecting the fragments of material resulting after the detonation of explosive charges, respectively: *Curve ''BVN down-range''* and *Curve "PDF* toroidal down-range'', points out that the areas occupied by the two curves are identical, and declaring the approximate representation of the same amount of total mass of the projected fragments. It is also found that the model of the curve BVN is type conservative at certain intervals, compared with the curve PDF toroidal (Figure 8). The new component of the model PDF down-range is referred to as slope (Range) and it is given by initial ascending function of the new model – ISURF, (figure no.9). The complex shape of the model ISURF is provided by the three parameters mentioned, respectively a, b and c, which may have different values depending on: size of fragments thrown away of the resulting material type after detonation by explosive charge and type of structures used \ in the scenario of the explosion (ie. the wall or roof).

The presentation chart of the model highlights the following elements of structure:

- parameter "a" is the ratio of the horizontal coordinate of the maximum likelihood (Xpeak) and the maximum horizontal distance of throw (or "full-throw") the density of fragments (XMT), it is used to determine the maximum range;

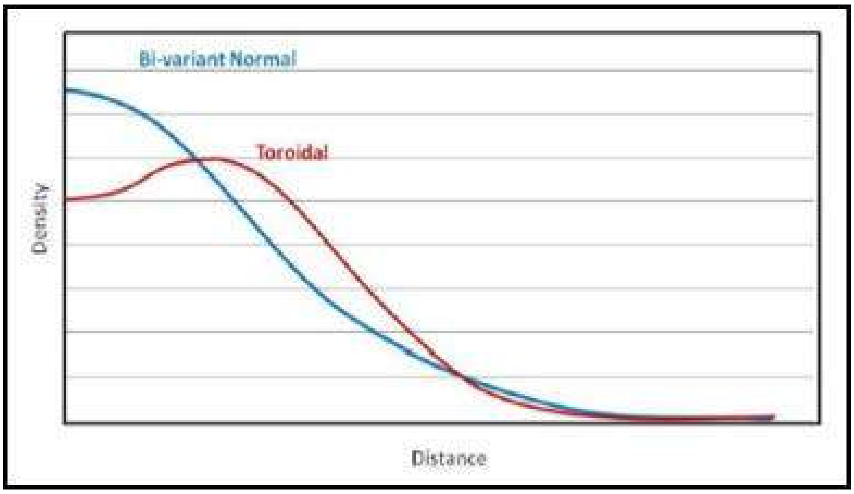

Fig. 8. Graph of curves *BVN down-range* and *PDF toroidal down-range*

Knowing the percentage by calculating the area under the curve will result in the determination of both the inner face of the slope and the slope of the outer surface.

- parameter "b" the relation between probability density at origin (Y0) and the maximum probability density (Ypeak) is used to determine the maximum magnitude;

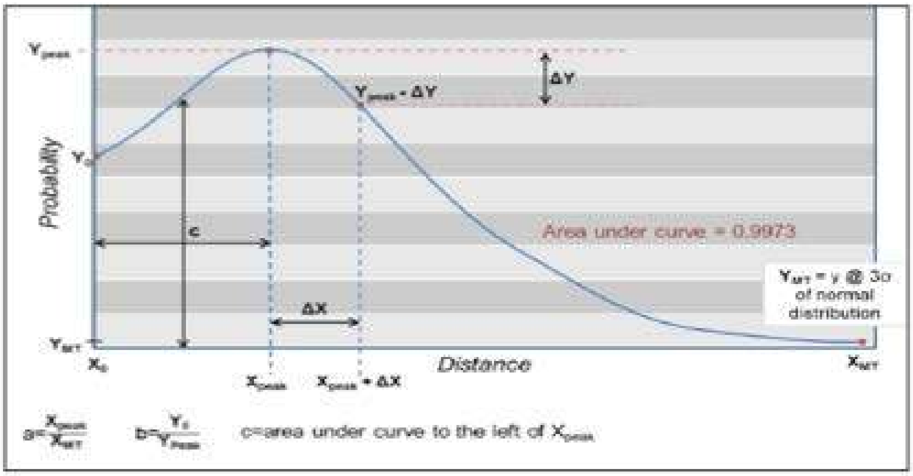

Fig. 9. Graphics details of the model ISURF down-range

- parameter "c" is used for controlling the shape of curves which are joining the set points and represents the percentage of probability generated by the surface under the curve, which is bounded by the horizontal distance from the origin to the maximum value of the curve, determining the percentage of the area under the curve.

The ISURFGAD model

This model is characterized by a zero change in azimuth (they produce the same results in all directions), being used for modelling uniform of the directional hazard, both for fragments by the roof, the circular crater effect at warehouses of explosives and for scenarios of explosion where fragments are thrown in random directions. Because, in the case of centrally located loads in rectangular buildings, it has been observed that the density of the thrown material is strongly affected by the azimuth (debris of material tend to "move along the normal" and not in the "corners") generating an effect type Cloverleaf (PDF with azimuth zero – transversely range) shown in Figure 10, Figure No. 11 presents a new type of PDF (ISURFGAD) based on a model range transverse that take this type of effect into account.

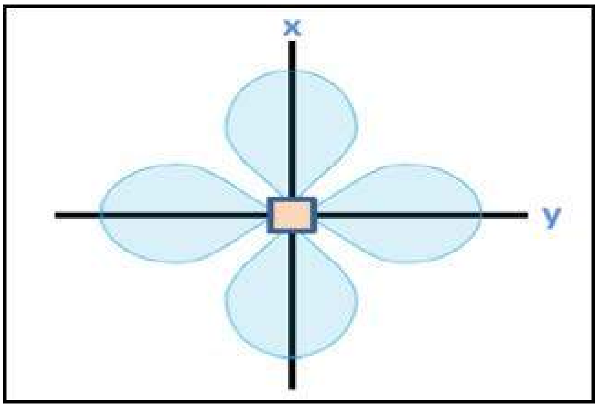

Fig.10. The model Cloverleaf of the dispersion of the fragments of material

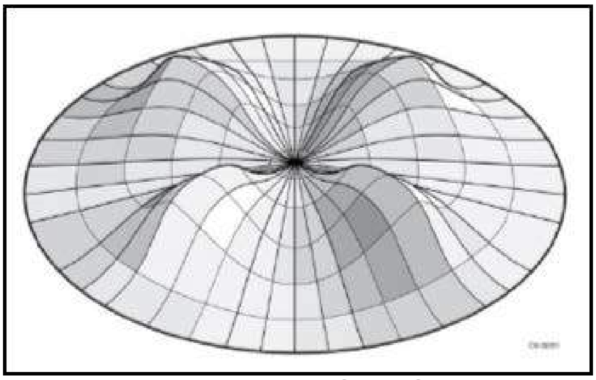

Fig. 11. New PDF-type ISURFGAD

PDF derivation type ISURFGAD is performed independently for functions down-range and the transverse radius. The function is represented for one dial of 900, probability density of the portions of the material characterized by independent parameters, respective interval of the range (r) and the throwing angle (θ), thus:

$$PDF = f(r) * g(\theta) \qquad (4)$$

in which:

$f(r) = f_1 = A' + B'r + C'r^2 + D'r^3$, out of range $[0, R_{P+}]$

$f(r) = f_2 = k_1 \exp[k_2 * (r - R_{P+})]$, out of range $[R_{P+}, R_{max}]$

$g(\theta) = [1/(2\pi R_c \sigma_\theta)] \exp[-0,5(\theta/\sigma_\theta)^2]$

where:

Rp+ - peak value of probability density

Rmax - the maximum radius of the throwing portions of the material

RC - the centroid radius

Human vulnerability assessment under the action of portions of the material resulting from the detonation of explosive charges

In previous sections were presented technical aspects of modelling portions of the material resulting from the detonation of explosive charges from structures type PES (for the storage of explosive materials) which can destroy structures exposed to explosion type events ES (for specific activities), with serious effects on the health and integrity of staff, and the population in surrounding areas. For modelling the degree of damage to the human component using probability equation (of the impact between the human body and thrown fragment) configured based on Poisson probability distribution (5), respective:

$$P_{impact} = 1 - e^{-EN^{*}} \qquad (5)$$

where:

E - It is the human exposure (0.278 m^2)

N* - is the number of fragments which may damage the integrity of the human component

For solving the equation of probability, the model provides the estimation possibility of fatality areas with major and minor injuries based on the kinetic energy of the fragments projected (6), respectively:

The lethality value is obtained from the curve shown in Figure No. 12, highlighting the likelihood of fatality for an event Pf|e compared with the kinetic energy of the fragments projected. Finally, the model calculates the overall probability of fatality caused by projected fragments, Pf(d), by summing the projecting path, corresponding to the angular projection, of the large fragments and to the displacement of small angular, and the total probability of death is obtained by using the additive rule applied in the case of events which are not mutually exclusive (7), respectively:

$$P_{f(d)} = Valoarea\ de\ mortalitate \times P_{impact} \qquad (6)$$

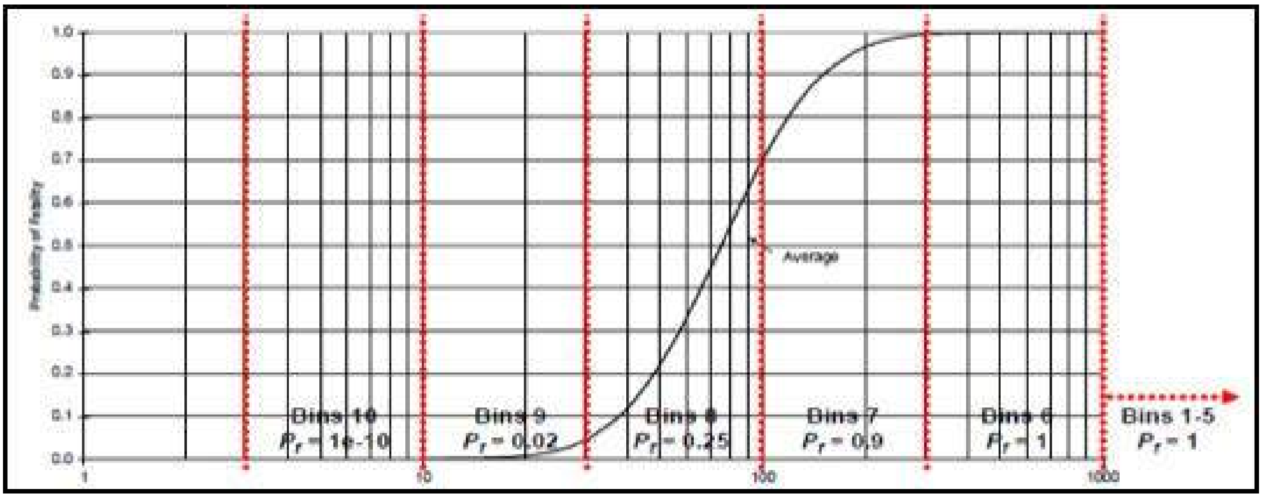

Fig.12. The probability of exposure of the human component by kinetic energy

$$P_{f(d)} = P_{f(d)unghi\ redus} + \left(1 - P_{f(d)unghi\ redus}\right) \times P_{f(d)unghi\ mare} \quad (7)$$

where:

Pf(d) - probability of death of a person due to the impact with a projected fragment.

Completely analogous is determined the likelihood of major damage/minor injuries Pmaji(d)/Pmini(d).

To substantiate the danger of the mechanism of thrown fragments is using a pattern type SCIFM (Simplified Cose-In Fatality Mechanism) all scenarios specific to this phenomenon (Figure No.13).

Examples of application of the presented models

An example of surface PDF with the following characteristics: a = 0.330, b = 0.038, c = 50%, d = 10%, maximum range extender = 579 m and σ = 20^0,and it is presented in Figure No.14.

The results obtained after modelling the risk of injury from projected fragments of the material resulting from an explosion type event, can be highlighted graphic-analytical, both through the associated diagrams of

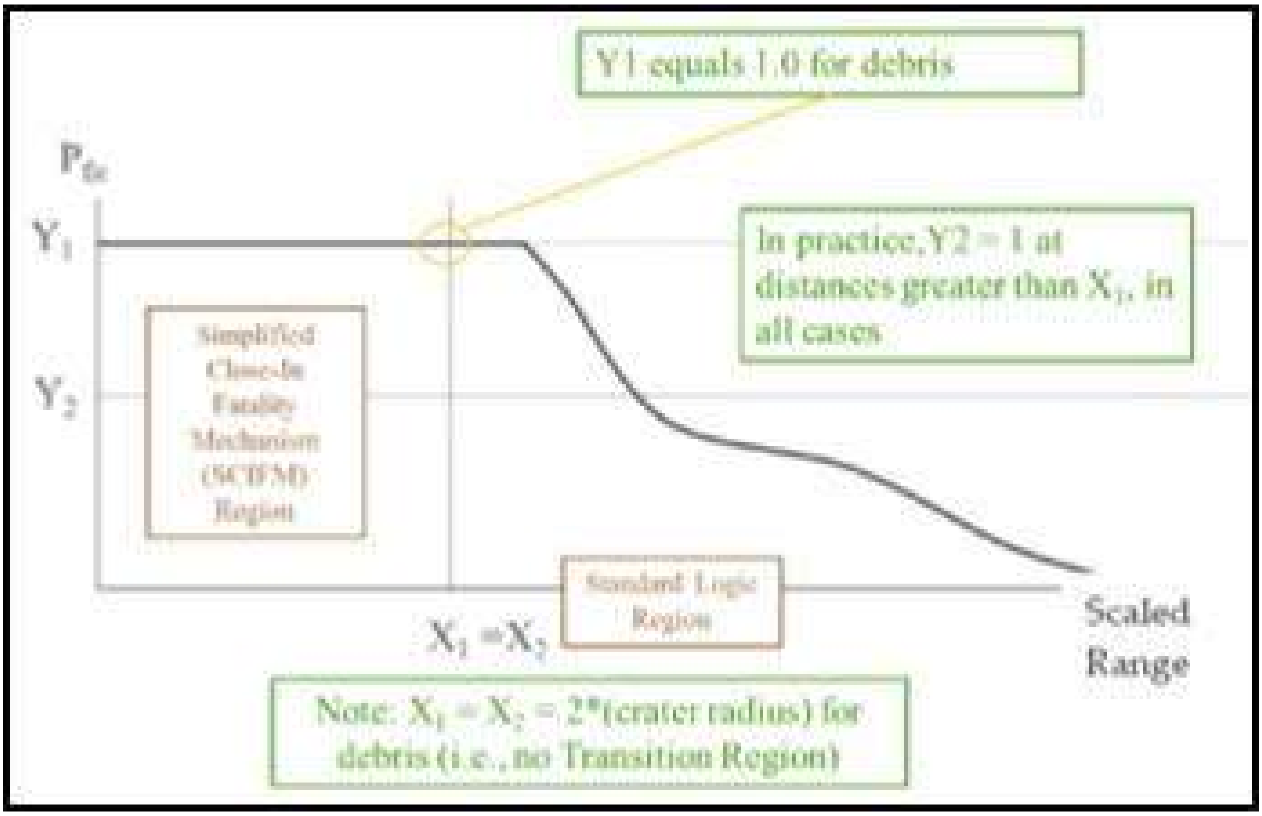

Fig. 13. The Model SCIFM for fragments projected

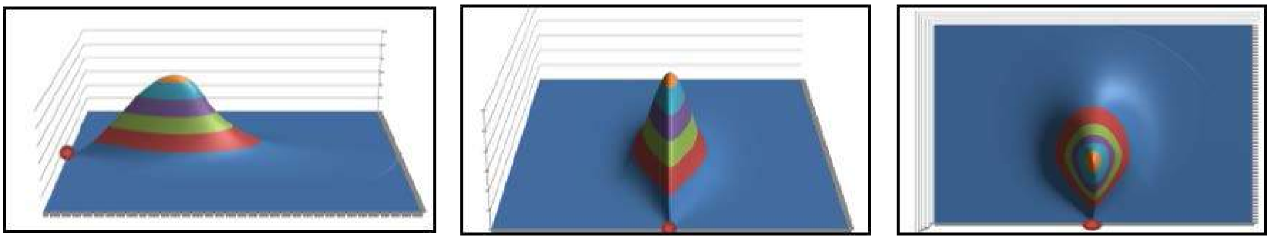

Fig. 14. PDF surface - ISURFGAD PDF

the contour maps of the destructive capacity, specific to the thrown fragments (kinetic energy of impact from fragments of the material), shown in Figure No. 15, and on the histograms of probability values of damage on the human component that define the following areas of interest, respectively: the area of fatality (the degree of mortality), area of major injuries (the extent of damage irreversible) and area of minor injuries (the extent of damage reversible), shown in Figure no.16.

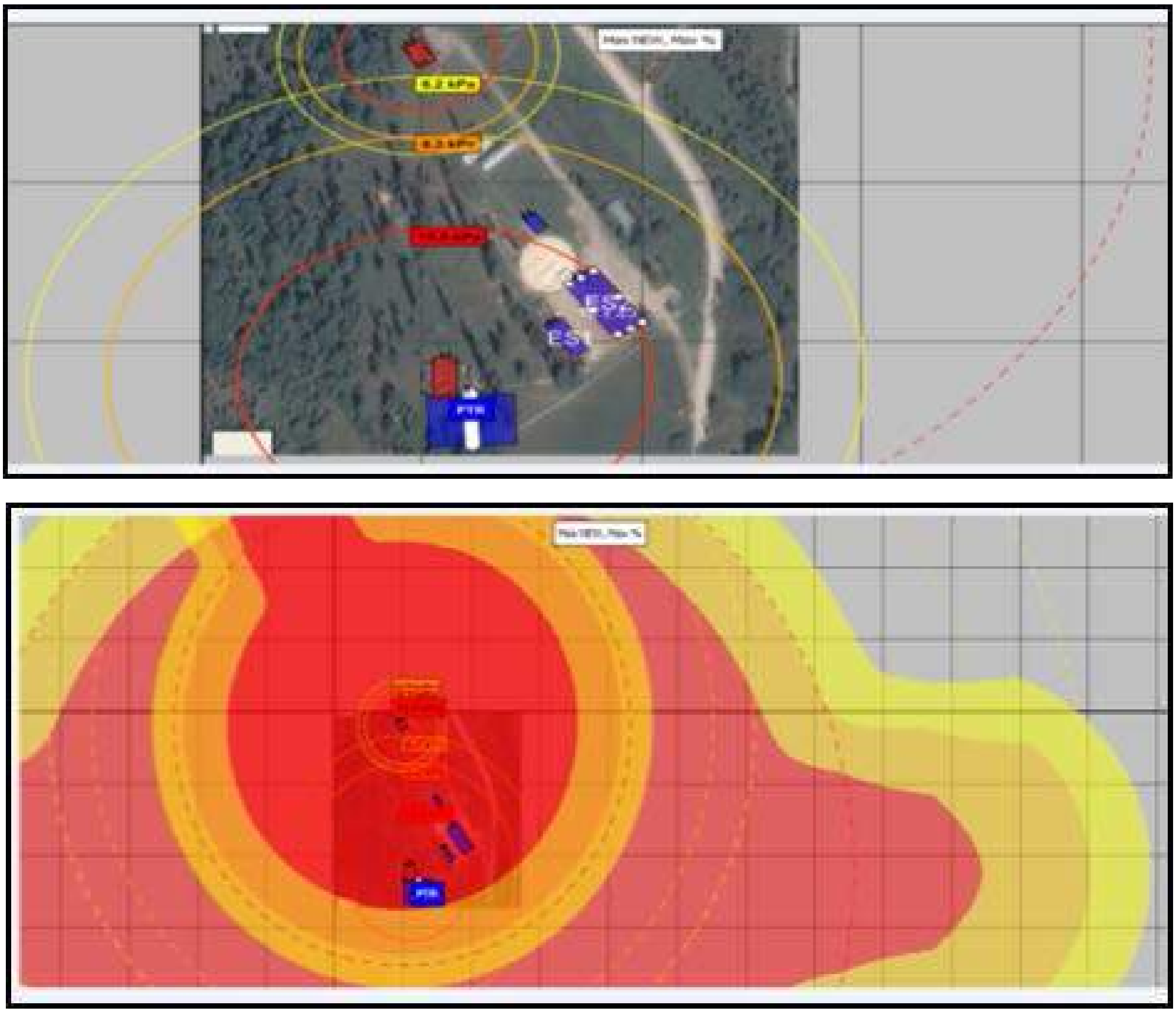

Fig. 15. Contour map for a deposit of explosives with a capacity of 1220 kg ETNT

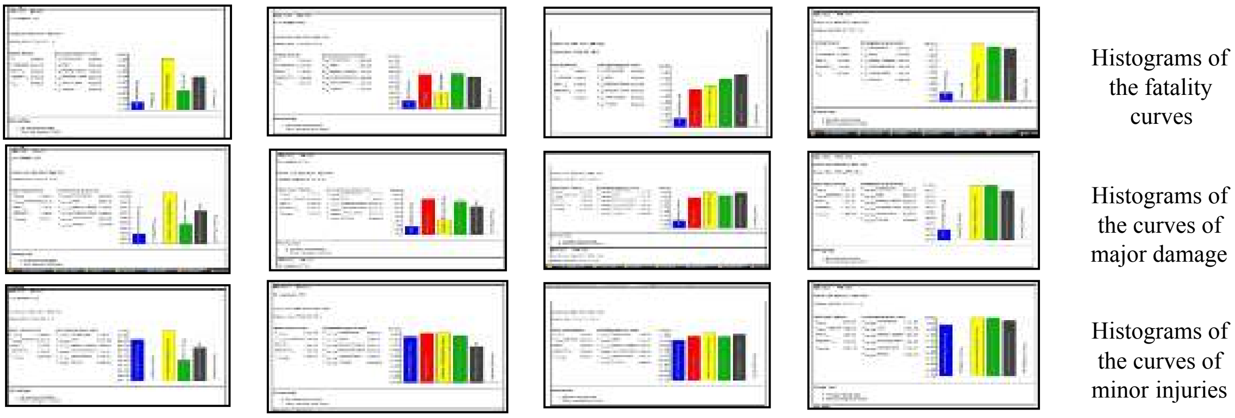

Fig. 16. Histograms of areas of damage on the human component and structures

The results shown in Figures 15 and 16 are needed to establish the areas of interest, in the case of an explosion type event as a result of detonation of explosive charges, resulting in the following planning areas: **area of high mortality**, defined as the area in which it accrues the death of approx. 50% of the exposed population; **the area of irreversible injuries,** defined as the area in which the exposed population is suffering serious harm to somatic level and lung, serious illness, first and second degree burns. Light buildings, suffer major damage becoming unusable. Heavy structures may undergo minor damage; **attention area,** defined as the distance that the effects of the accident can be felt and can cause a mild illness, of short duration, or superficial burns easily curable. When explosion accidents occur, light buildings existing in the area of attention, may suffer minor damage.

Conclusions

Estimating the route configuration of the fragments of material projected can be achieved using model type Fast-Running Models (FRMs), created for hazard analysis in a simplified manner, using different functions for probability dedicated to this area (ex. model type ISURFGAD with the azimuthal variation), for graphic-analytical modelling of the phenomenon of projected pieces of material resulting from explosion type events.

The model of projecting the resulting material after an explosion considers three types of fragments: primary, secondary and scrap resulting from the area of the crater formed. Thus, primary fragments come from the detonated explosives body, and the secondary ones are coming from the structure of the storage room (ex. roof, front, side and rear walls). Also, the other debris of impact which are generated in the area of crater, are fragments coming from the ground or from the foundation structure of the storage room.

This paper has presented the technical aspects of material fragments modelling resulting from the detonation of explosive charges coming from potentially explosive structures, type PES (for the storage of explosive materials) which can destroy the structures exposed to explosion type, ES (for specific activities), with the serious effects on health and integrity of the working staff, and the population from surrounding areas.

The final results of modelling the risk of injury from projection of the material resulting from an explosion event, may be highlighted graphic-analytical, through the associated diagrams of the contour map and histograms of probability values of damage of the human component (death, major injuries and minor injuries).

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*** Raport de expertiză tehnică privind *Evenimentul produs în data de 26.05.2008 la SC SPAROMEX SRL Victoria,* INCD INSEMEX Petrosani.

SPECIAL BLASTING TECHNIQUES APPLIED IN UNDERGROUND SHAFTS

Abstract

The blasting activities can affect the hardness and cohesion of the concrete and for this reason the blasting design and execution should be take care with proper attention. In our study case we present the blasting design necessary for modifying the pumps hall at CHE – Lotru – Ciunget for reequipping with new pumping units.

Concrete structures are very common solutions in industrial development. Modern buildings and industrial plants cannot be imagined without steel and concrete, but the upgrading of such structures are quiet difficult to do.

To change some technical characteristics of steel – concrete structures in order to maintain their stability and safety is a hard work to do. In some cases very important technological installations must be over vied or replaced. To make changes to the steel-concrete structures is quite difficult without affecting their hardness and stability. Any external intervention with mechanical tools or blasting could decrees the characteristics of the steel – concrete structures. With additional actions we can preserve the main mechanical characteristics of the structure if the modifying actions were made under appropriate condition.

In our study we will show you a special case of underground engineering of modifying steel – concrete structures, with blasting some parts of existing underground constructions. The purposes of these actions were the reason to could change underground pump installation with a new group.

For dimensional reasons for equipping works, appeared the necessity to remove some parts of the foundation of the existing installation and to rebuild after the blasting work the steel concrete structure.

The blasting activities can affect the hardness and cohesion of the concrete and for this reason the blasting design and execution should be taken care with proper attention.

In our study case we present the blasting design necessary for modifying the pumps hall at CHE – Lotru – Ciunget for reequipping with new pumping units.

The project describes in 8 chapters the main and auxiliary activities needed to develop for a proper execution of the blasting. In order to maintain the fragmentation and the cracking of the concrete at reasonable level the quantities of the explosives blasted in one round should be maintained at the minimums level with the necessity of an efficient blasting.

As it show in Figure 1 it was necessary to take out the upper part of the vertical shaft between level 492,100 – 493,600 m in order to enlarge the diameters of the shaft from ϕ1000 to ϕ 2000 mm. Figure 1 – existing situation and Figure 2 – the new design.

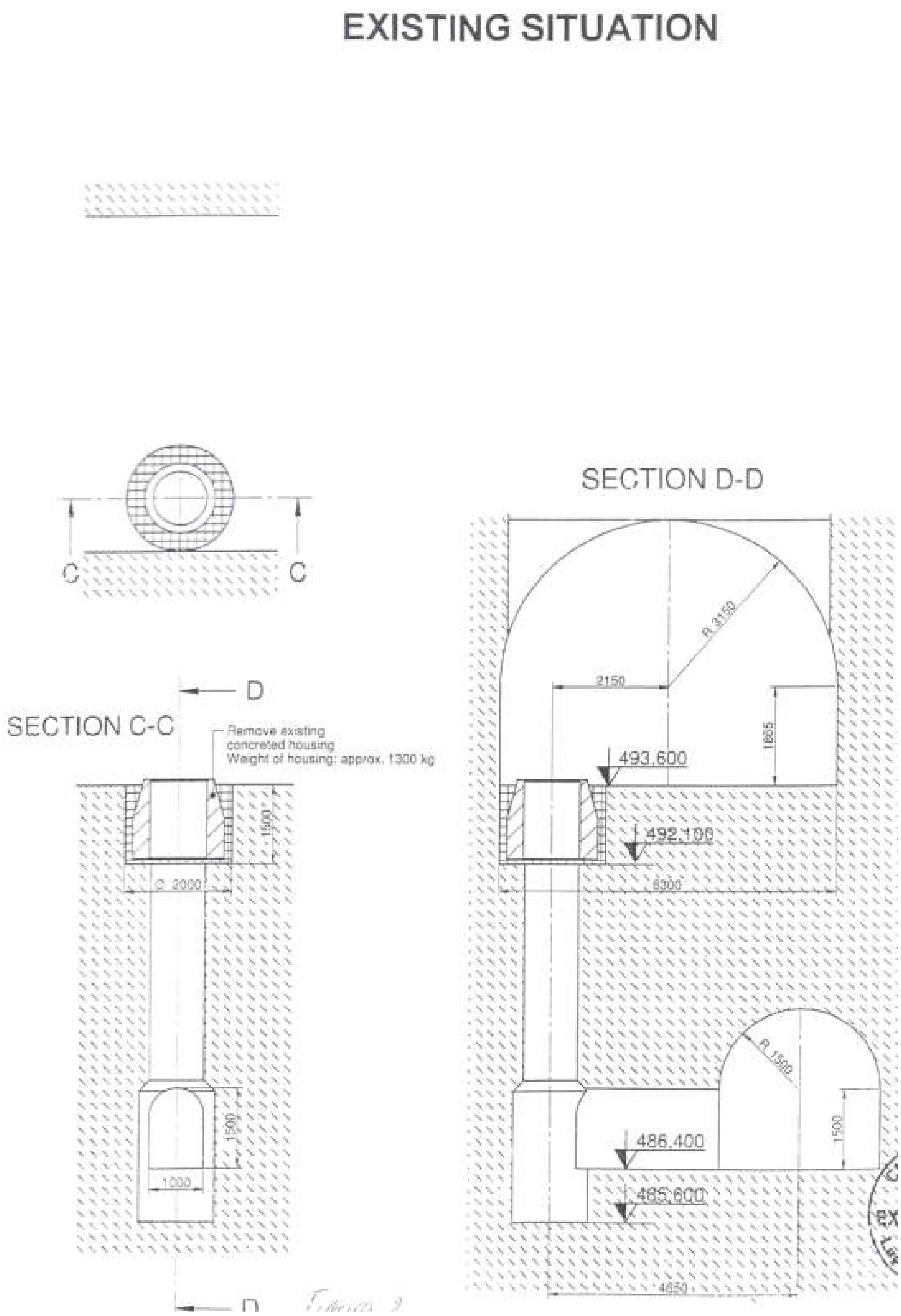
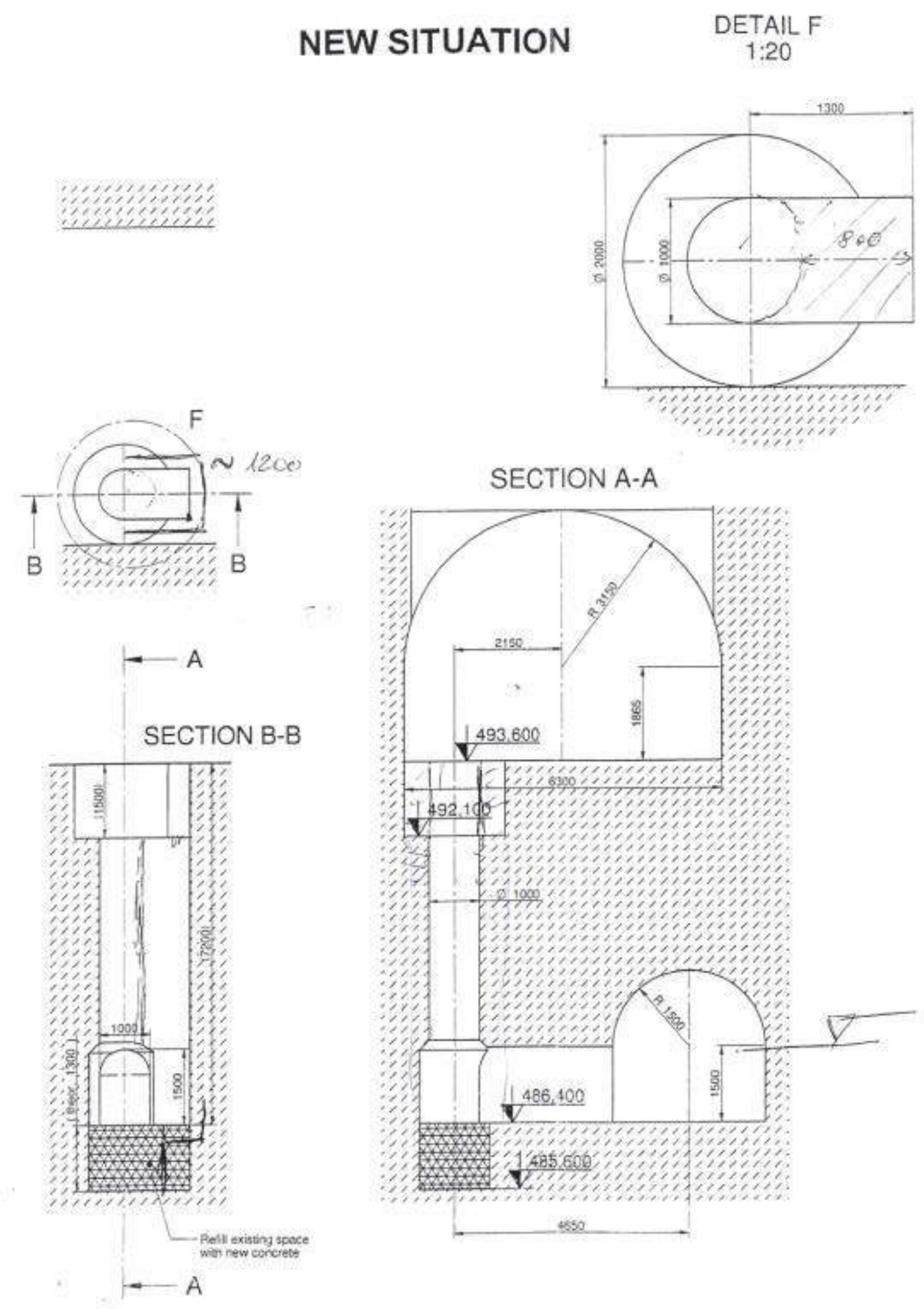


Fig. 1.



NEW SITUATION
DETAIL F
1:20
1300
F
B
B
SECTION A-A
R 3150
2150
1865
493.600
492.100
Ø 1000
R 1500
1500
486.400
485.600
4650
A
SECTION B-B
1000
1500
Refill existing space
with new concrete
A

Fig. 2.

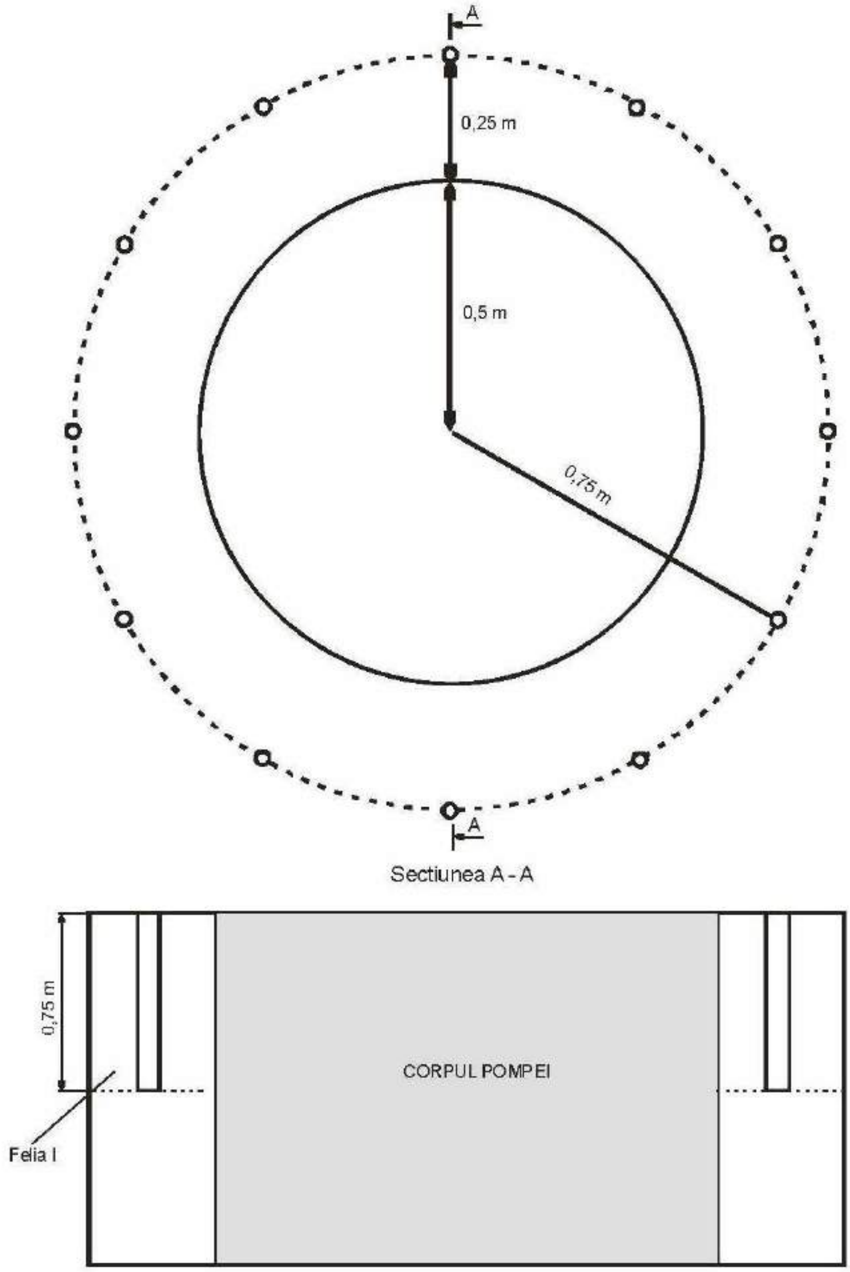


Fig. 3.

The blasting was designed to be made in several steps (several layers). The importance of the objective being very high, it was necessary to establish very restrictive rules in preparing and executing the blastings. To avoid the damaging the remaining steel-concrete structures the designed blasting techniques established a limited quantity of dynamite used in boreholes (between 0,1 kg and 0,2 kg) with discontinuous placement. Also the blasting parameters of the boreholes geometry were carefully calculated. For the replacing of the concrete around the existing pump it was established 12 boreholes as is shown in Figure 3.

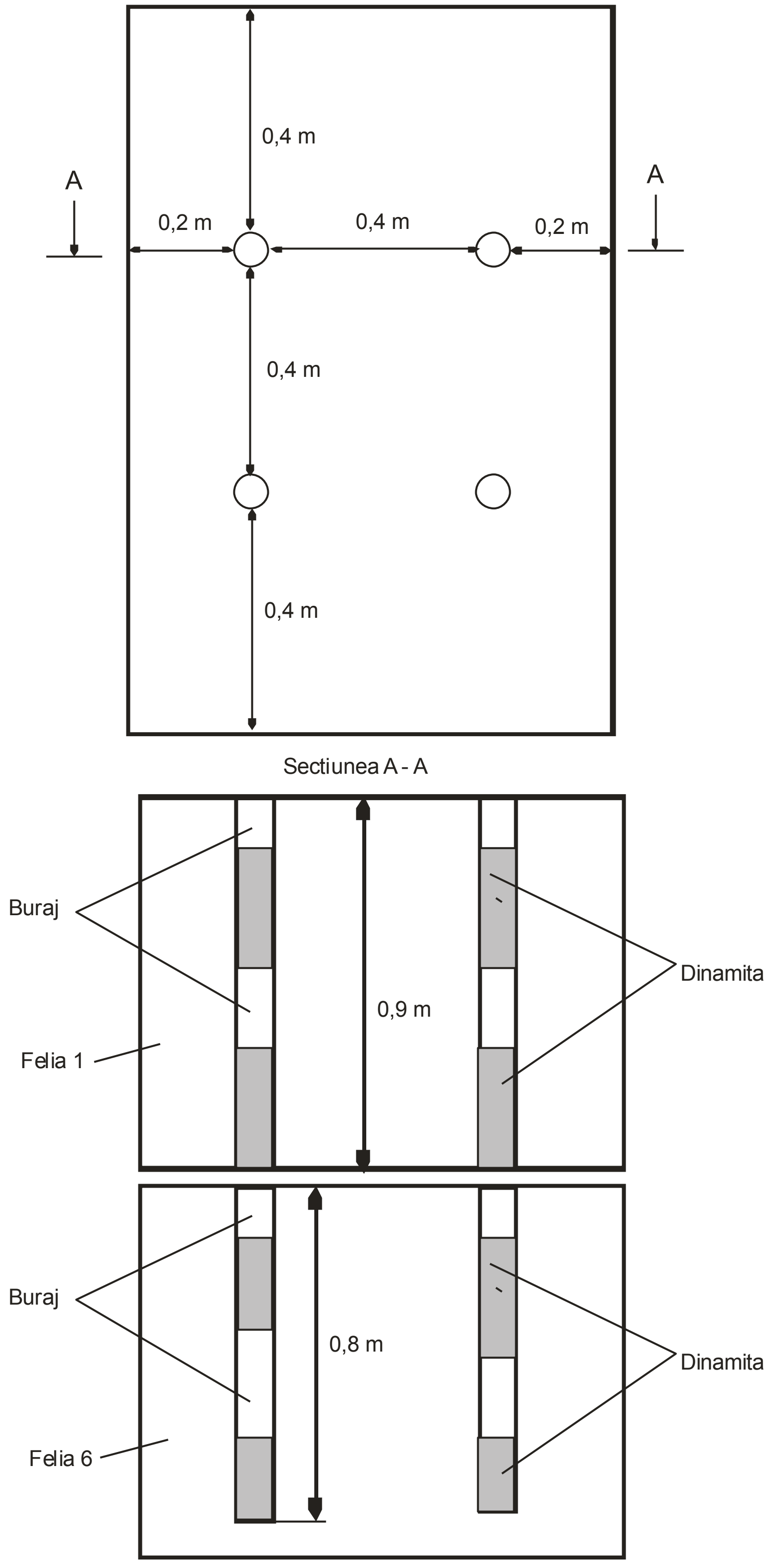


Fig. 4.

For the enlarging of the diameter of the vertical shaft for the first 3 layers of blast we chose to make 4 boreholes with 0,9 m depth, 1 m depth for the layers number 4 and 5 and 0,8 m depth for the last layer, as is shown in Figure 4.

The blasting order of the boreholes was designed to be instantaneous. For the limitation of the discontinues charges we needed to use detonating cord with millisecond electric detonators. The project established also general safety rules in execution of the blasting and for the auxiliary preparing activities.

The blasting was a success and the hydro-technical plant could improve the pumping facility with minimal investment in rebuild the underground shafts system.

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Blasting the Bonn Centre

Applying a new electronic ignition system for the first time in Germany

On behalf of the demolition company RAW Abbruch GmbH, Reisch Sprengtechnik GmbH blasted the Bonn Centre tower building at Bundeskanzlerplatz in Bonn.

Review

The Bonn Centre was built in 1968/69. It was designed as a commercial centre with the intention of revitalizing the district neighboring the Bundesviertel offering evening entertainment.

Initially, the Bonn Centre was home to a hotel with more than 300 beds, conference rooms as well as a popular restaurant. Its signature piece on the rooftop, the star of a famous car manufacturer, could be seen from far and was turning on its own axis twice per minute.

Yet, the building's intended used changed several times throughout the years and several companies moved in and out of the building. In October 2014 the building was 70% empty. At the end, the new investor had to make a decision which was: demolishing the complex and blasting the tower building.

Technical details

Being 56.15 m high (length: 65.66 m, width: 17.04 m), the Bonn Centre was the fifth highest building in Bonn.

Fig. 1: Bonn Centre in April 2017

The tower building had 18 floors as well as two basements. Its supporting structure was a frame construction made of site-mixed concrete. The vertical load was carried mainly by pillars (fig. 2) numerous walls where blasting would be less suitable, it was decided to blast all pillars in the ground and first floor thus causing the frame construction to collapse vertically.

Fig. 2: Pillars laid open after gutting

Later the cores (elevators and staircases) were to be tipped over using a drop direction blasting on the fourth floor. The Reisch team started drilling in January 2017 in the ground floor and first floor (fig. 3) – the same time that gutting as well as a comprehensive clean up of contaminants were done by RAW.

Preparation

Dr. R. Melzer and his planning agency for structure demolition were involved in the project from the beginning. After drafting a feasibility study, the planning agency compiled the execution documents for blasting the tower building. Due to the fact that the basements had

Fig. 3: Spot drilling the pillars using a Commando drilling unit

Fig. 4: Example of a pillar's rising reinforcement on the ground floor

Yet the pillars to be drilled proved to be strongly reinforced (fig. 4)!

Our plan B in this case was to use an oxygen lance for quickly removing the first two rows of the 26 mm reinforcements bars.

Yet, the inspecting structural engineer deemed it too dangerous which is why the oxygen lance was not permitted and plan C had to be applied: coring machines were used to drill the first 25 cm of each drill hole (fig. 5) and after that our drilling units were used to drill the holes to their required final depth.

Fig. 5: Simultaneously applying multiple coring machines

On the fourth floor Commando drilling units were used as well for the cores (hoistways and staircases) while at the same time RAW created falling slits and chippings for the drop direction blasting. Skid loaders were used and diamond sawing technology was applied.

Measures were for instance removing all facade cladding and window panes in order to prevent any damages caused by scattering.

In contrast to wrapping the single blasting objects, which is a more common method, the two lower floors of the Bonn Centre were covered completely from the outside with a combination of mats of fibers and netting wire (forming a so-called sandwich).

Fig. 6: Reinforcement in an falling slit to be chipped

In the southern blasting section of the building, which was closest to the neighbouring residential buildings, neither mats of fibers nor netting wire were used. This section was covered with blasting mats (weighing up to 900 kg) attached to the building's facade (fig. 7).

In order to fully guarantee that the ceilings would be demolished beyond the southern core, RAW created vertical ceiling saw cuts throughout the whole core length on all floors.

Safety measures

Due to the fact that the tower building was quite close to residential buildings (the nearest building was only 27 m away), it was crucial to cover the blasting sections completely with the highest protection against scattering material.

An industrial climber was hired to help the Reisch team with attaching the separate coverings and with the complicated tasks in the hoistways.

Furthermore, the basements were uncovered up to a depth of 6 m, protection walls were constructed with a height of 4 m and a ribbed falling bed was heaped up (fig. 8 and 9).

Fig. 7: Sandwich covering and heavy blasting mats

Fig. 8: Excavation and protective barrier

Fig. 9: Ribbed falling bed

Residents within a 100 m radius were evacuated. There was a safety zone with a radius of 200 m which was forbidden to enter during the blasting operation.

The executing companies and the investor held 2 meetings where they informed the public about the procedures and the blasting process.

Blasting unit

250 kg of explosive was used for 1500 drill holes. The explosive charges were elongated charges made of detonating cords. For the first time in Germany, non-electric detonators were combined with electronic E-Star detonators made by Austin Powder (fig. 10).

Fig. 10: Blasting unit on the fourth floor with electronic E-Star detonators

These electronic detonators can be programmed in steps of 1 ms to 10.000 ms thus providing maximum precision and flexibility of delay steps for almost all blasting operations.

All of these electronic detonators are equipped with a condenser energizing the microelectronics and the (igniting) fuse head.

Blasting

After three months of preparation, it was time for the blasting: it took place on 19th March 2017 at 11 am. The tower building vanished from the cityscape 48 years after it was constructed with the population of Bonn and the media showing great interest.

The blasting went smoothly without causing the least damage.

Fig. 11: Blasting of the Bonn Centre on 19th March 2017

Fig. 12: Detailed view of the blasting result

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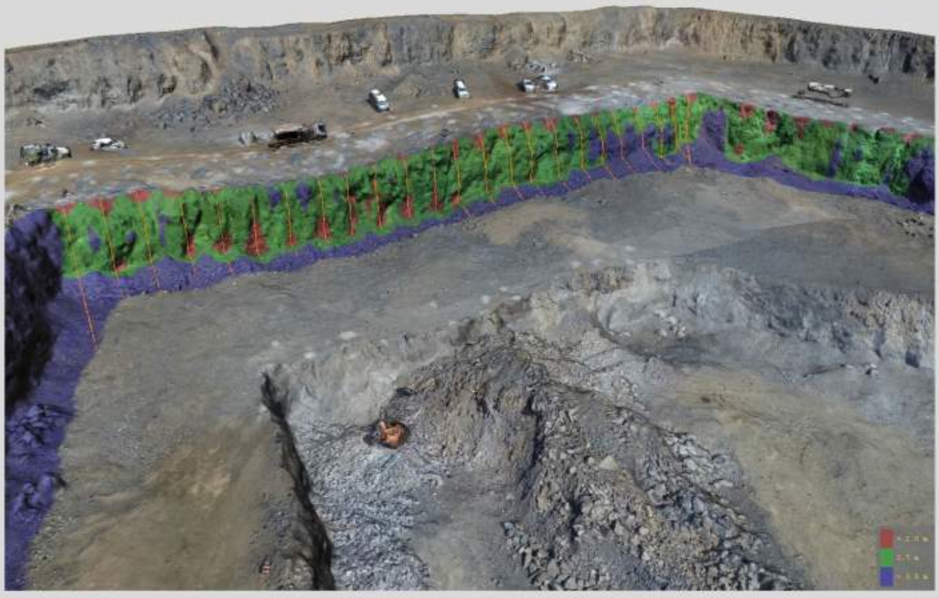
Reisch Sprengtechnik GmbH
Moosleiten 8, 86974 Apfeldorf
www.reisch-sprengtechnik.de

BlastMetriX UAV

Aerial 3D imaging

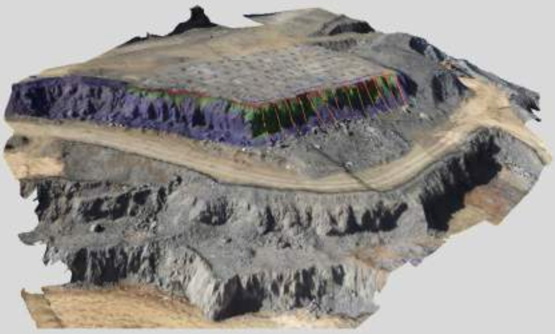
Blast Design and Blast Analysis with 3D images



3D images from drones are a perfect survey of large blast sites. Poor blasting results are often caused by inaccuracy of the front row hole placement and suboptimal blast pattern geometry.

Features

- Face profiles (burden diagrams and maps)
- Volume to blast
- Pre-post blast comparison
- Quantification of muckpile (movement, volume, swell)
- Power trough
- Seamless data flow



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EFEE 9th World Conference

Autumn on the Fennoscandian Shield – the geology of Sweden makes the place worth a visit for everyone connected to blasting and explosives, but this is not why almost 500 people from this area of expertise gathered to Stockholm in the middle of September. It was time for the 9th EFEE World Conference. Already on the 9th of September you could see a bustle about around the Brewery Conference Center on the Stockholm Slussen, where the biggest part of the event took place.

Organised by Tyler Events, the Brewery Conference Center is soon taken over by Explosives and Blasting proffessionals for the 9th EFEE World Conference

On the first day of the Conference, early on Sunday morning, we already gathered for a Workshop. The weather greeted everyone with golden rays of sunshine, while for the first time in the conference history, the quests were taken outside of conference room to an active work site. So after the introduction by Beatrice Lindström, (Trafikverket Big Projects, Technical Specialist) Robert Sturk, (Skanska AB Big Projects, Design Manager) Berglind Sveinsdottir, (Skanska AB Big Projects, Design Manager) Sven-Erik Johansson (Nitro Consult AB, Chief Consultant) and Joachim Jonson, (Nitro Consult AB, Senior Consultant) we climbed on buses, which were already waiting for us, and went to see a part of the E4 Stockholm Bypass.

Donald Jonson opening the Workshop session

As an introduction was made earlier and the professionals working with the project were present, the questions and comments kept coming. Afterwards an elaborated presentation was made in the Hilton Slussen. A great number of people came to listen, learn and see for themselves how a major work like this is being carried out. A lot of discussions arose as the E4 project involves some great innovative technologies, including 3D projects and possibly Virtual Reality glasses on site.

E4 The Stockholm bypass - Förbifart Stockholm

That sunny day ended with welcoming drinks in the Brewery Conference Center, which has a very unique atmosphere and a great view looking towards the Stockholm old town, the weather only complemented it giving a clear rainbow over the city while everyone said hi to old friends, partners and met new ones while talking of explosives. The Welcoming drinks reached a high peak when the President of EFEE, Igor Kopal among with the Vice President - Jari Honkanen, announced a new EFEE Honorary member - Björn Jonsson. There is all together three Honorary Members connected to the long history and accomplishments of EFEE – They all got a symbolical present, a gold plated silver pin, as a token of appreciation for their services and support.

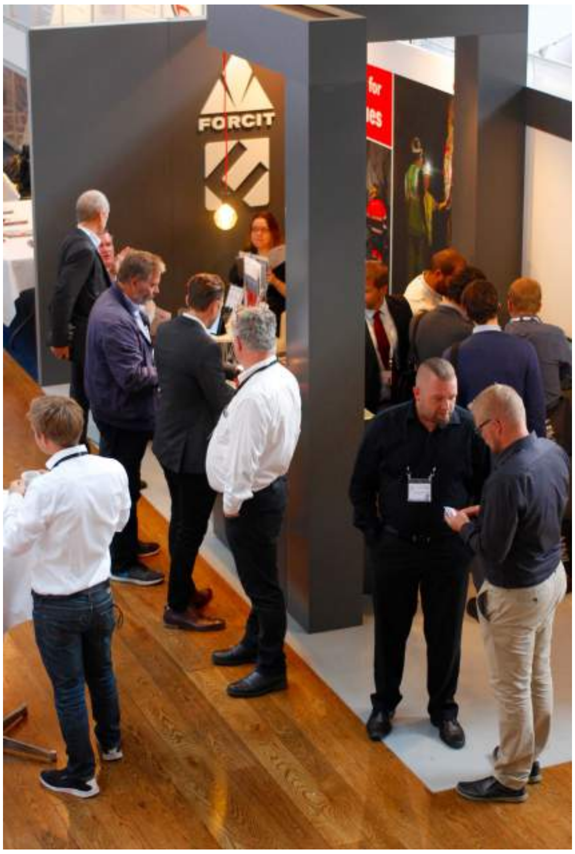
A great company and an enjoyable atmosphere at the Welcoming Drinks

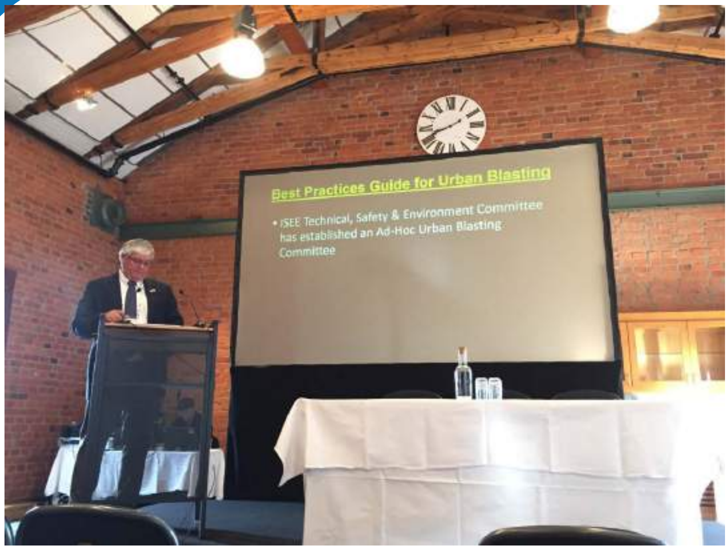


There is now a new name in the list of Honorary Members of EFEE, Björn Jonsson from Sweden (on the left) along with Raimo Vuolio (in the middle) and Walter Werner (on the right)

From the left - The President of EFEE, Igor Kopal and the Vice President of EFEE, Jari Honkanen with the Honorary Members

Then it was time for the full conference, business, contacts, ideas and competition. A record number of exhibition booths were ordered by different organisations, while two big halls invited quests for the Technical sessions. A well crowded, interesting and lively conference.





Monday, 11th of September - a full day of EFEE World Conference with a record number of participants. There was all together 165 exhibitioners and 315 registrations to the Conference

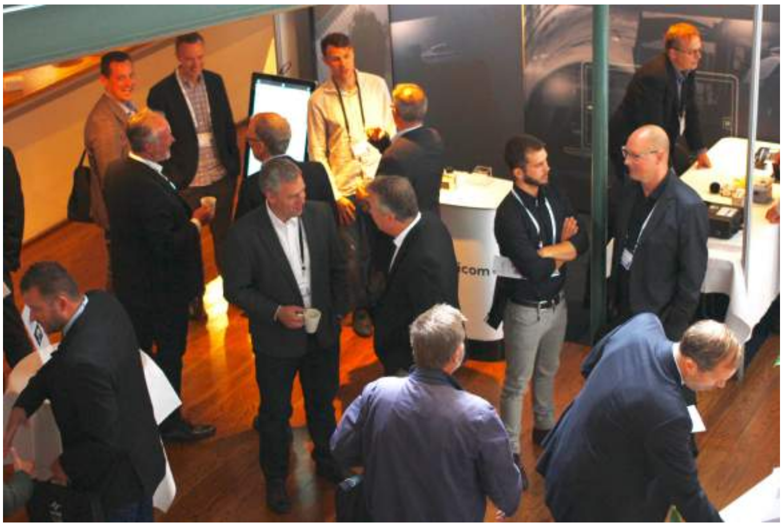
The great success of the Conference asked for a proper celebration. As Stockholm is the capital of dynamite thanks to Alfred Nobel, there was no better place for a Gala dinner than the old Alfred Nobel factory building, which is located in Vinterviken.

Roger Holmberg (on the left) and Donald Jonson (on the right) with Alfred Nobel

At least 320 people came to see this magnificent transformation from old factory house filled with explosives to a festive restaurant filled with music and chatter. But as the guests arrived, all the attention was taken by Alfred Nobel himself. Like a living statue he sat on the stage, with a know it all face, being the star of multiple selfies and portrait photographs. Then, right after the opening speech by Roger Holmberg, Alfred awoke from the dead and told us his amazing life story and the truth behind his Nobel Prize association. The dinner was very educational and entertaining at the same time. Evening ended with music from ABBA, of course, and some superb fireworks by Orica.

Alfred Nobel, coming back to life, was a matter of subject even on the following day, giving the conference a very positive vibe and a good note to end with. EFEE and ISEE Board Members used this meeting point as a possibility to sign a cooperation agreement while a big number of quests still filled the Brewery rooms, the exhibition area and listened to the presentations, even though it was the last day and again time to say goodbye for another two years. The next, already 10th EFEE World Conference will take place in Helsinki on 2019.

The EFEE and ISEE Board members after signing a cooperational agreement.



Teele Tuuna - Editor of EFEE Newsletter

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New EFEE members

EFEE likes to welcome the following members who recently have joined EFEE.

Honorary Member

Björn Jonsson, Sweden

Individual Members

Jan Blomé, Nitro Consult AB, Sweden

John Widmark, Ansvarsbesiktning AB, Sweden

Mohammad Almezini, Saudi Chemical Company, Saudi Arabia

Douglas Anderson, BlastWorks LLC, USA

Bergur Andreasen. Kaj Andreasen & Co. Faroe Islands

Duncan Andrews, Experse, United Kingdom

Miguel Araos, University of Queensland, Australia

Fiona Beach, Orica, Australia

Arne Carlsson, Rockplan Sweden Ab, Sweden

Mark Dorman, Dyno Nobel, USA

Konstantin Efremovtsev. NOIV Ltd., Russia

Nandasena Ekanayake, Alchemy Heavy Metals (Pvt) Ltd, Sri Lanka

Konstantin Fedin, Pjsc ""Yuzhniy Gok"", Ukraine

David Gerber, Black Lotus Ltd., Israel

Ron Glowe, Glowe Consulting Services Inc., Canada

Denis Golubnichy, NOIV Ltd., Russia

Thierry Henon, EPC, France

Charlene Hugo, Base Chemicals, RSA

Daniel Kornfehl, Hirtenberger Engineered Automation GmbH&Co.KG, Austria

Francisco Leite, O-pitblast, Lda, Portugal

Cherie Little, Blasting Geomechanics Pty Ltd., Australia

Michael Lovitt, Orica Australia, Australia

Barry McCreadie, MinBlast Ltd., UK

Pascal Montagneux, EPC Groupe, France

Stanislav Nikolov, PBEx Consulting Ltd., Bulgaria

Toshiyuki Ogura, NOF America Corporation, USA

Mathieu PEBORDE, EPC, France

Konstantin Rekling, Jsc «Karelsky Okatysh» Severstal Management, Russia

Ziad Shammas, Lebanese Explosives Co., Lebanon

Shyam Sharma, Smart Chem Technologies Ltd., India

Ran Tamir, Seekers Strategic Solutions, USA

Mehmet Emre Terzi, Eldorado Gold Corp., Turkey

Juha Tuovinen, Suomen Louhintakonsultit Oy, Finland

Dirk van Soelen, AEL Mining Services, RSA

Tony Rorke, BME, RSA

Upcoming Events

44th Annual Conference on Explosives and Blasting Technique, ISEE
January 28-31, 2018
San Antonio, TX, USA
www.isee.org

Fragblast 12
June 9-15, 2018
Luleå, Sweden
www.fragblast12.org
There will be a course for commercial explosives and mining company personnel particularly those that might be attending Fragblast 12 in Lulea, June 2018.
The course will be jointly run by the universities of Cambridge and Lulea and held on the campus of the latter for three days.
https://www.csc.cam.ac.uk/academic/shortcourses/det2018

2018 SME Annual Conference & Expo
February 25-28. 2018
Minneapolis, MN, USA
http://www.smemeetings.com/sme-ace-2018/

ITA-AITES World Tunnel Congress 2018
April 21-26, 2018
Dubai, United Arab Emirates
http://www.wtc2018.ae/

25th WORLD MINING CONGRESS
June 19-22, 2018
Astana, Kazakhstan
www.wmc2018.org

HILLHEAD 2018
June 26-28, 2018
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EFEE 10th World Conference on Explosives and Blasting
September 17-19, 2019
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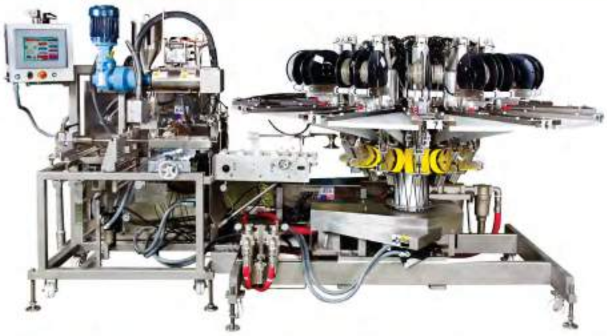

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