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Destructive impacts of explosion & estimating maximum weight of authorized explosive materials at constructive projects with case study of explosions at jamishan reservoir dam

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ABSTRACT

Maximum velocity of particles and specifying pattern for energy radiation and nature of frequency as a result of explosions is regarded as most important criterion for evaluating dangers as a result of trembling earth. Based on researches it is indicated that these parameters may indicate possible damage. Until now different relations are offered for calculating these parameters by researchers but none of them has application in all of the fields and each of them in accordance with regional conditions including geology, tectonic and rock mechanics may have application at that special region. In these studies by registering and processing seismographs related to seismic data as a result of 20 explosion at Jamishan reservoir dam located at Sangher the status of vulnerability of diversion tunnel and cutoff wall of dam and also adjacent village was studied and the results are analyzed based on received data and comparing with available standards and the best method of boring and level of explosive materials for preventing from possible damages are offered.

Introduction

One of the most common methods for drilling mines, tunnels and trench is applying from boring and explosion. Generally engineers are faced with complicated problems in the way of applying from explosive materials. The energy as a result of explosive materials besides crushing rocks may result in tremble at the surround lands in which these trembles may influence on health of people and surround structures. In many of the mines and constructive projects in order to decrease tremble of land in the adjacent structure, stability of remained mass of rock, decreasing repair and reconstruction cost, decreasing backwardness and monotonous explosions it is applied from controlled blasting. In the explosions at place of dam the tremble as a result of explosion either at stage of construction or utilization has special importance and it is necessary to control them through any possible mode. In tremble as a result of explosion factors including distance from place of explosion and geological characteristics of land are uncontrollable, but factors including boring pattern and blasting are controllable; therefore boring and blasting operation shall be performed so that trembles as a result of explosion will be lower than standard level. Jamishan reservoir dam with respect to civil divisions is regarded within Kermanshah province and with respect to basin it is part of head branches of Karkheh river basin. The body of Jamishan reservoir dam is made of rock fill with clay cutoff wall element by having building altitude of 53m until balance of 1539m from surface of water and length of annulus as 277.68m. Adjacency of Jamishan reservoir dam at Sangher city with sensitive structures including diversion tunnel and cutoff wall and also villages including Jamishan, Pirsoleiman, Gelvich and Aeinleh has created several problems on explosion operation. Therefore designing safe explosive patterns and studying limits of damages related to aforesaid explosions on structure and referred villages at this region seems necessary. One of the methods for studying destructive impacts as a result of explosions on structure and surround of them is to register maximum velocity for displacement of particles, specifying energy radiation pattern and frequency nature as a result of explosion. For registering maximum velocity of displacement of particles it is applied from seismograph machine. In this research project we have applied from 4 digit seismograph machine GMG-6TD manufactured by England Corlap Co. The most important impact as a result of explosion include separating and crushing mineral material mine, land tremble, creation of audio waves, throwing stone and creating dust as a result of explosion. Besides separating and crushing mine any of the other impacts may result in damage to human, principal roads and structures around place of explosion. Land tremble influences on stability of around mass of rocks and facilities in that region. In order to decrease impacts as a result of trembling land and protection of different structures, researchers have conducted several broad researches in which their research activities are summarized in the following 2 fields.

A) Anticipating Level of Tremble & Achieving to Danger **Domain around Place of Explosion**

B) Decreasing Level of Tremble as a result of Explosion

Therefore the most important criterion to evaluate and anticipate level of damage as a result of land tremble due to explosion is maximum velocity of displacement of particles. Standard of authorized tremble have been offered by researchers based on different indices and mathematical models to anticipate maximum velocity of displacement of particles in which each of them may have application in accordance with geological characteristics of the land. Serious studies in this field were studied in the year 1930 by US Department of Mines in which the result of first research was published in the year 1942(Kenia and Walter 1985).

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Methodology:

Explosion operation in extracting mines and constructive works is regarded as one of the principal stages in operational cycle. The energy that is released as a result of a roofless explosion besides crushing and warming rocks around place of explosion may result in publishing seismic energy all through the surround environment. In order to register and study impact of explosion on structures and important roads we have applied from seismograph machines, so that by measuring velocity of displacing land as a result of explosion this issue can be studied. The main parameters that play important role in this impact include:

* Explosion characteristics
* Seismic wave characteristics
* Geology of region
* Environment of seismic publish
* Distance from place of explosion
* Dominant frequency of site
* Characteristics of Structure

Many researchers have conducted research in the field of studying impact of explosion on structures including Arandolovich(1969) and Lopezjinoz and coworkers(1995). Their studies resulted in offering tables and diagrams in which upon adapting them with results of registering vibrations of roofless explosions it will be possible to study effectiveness of around structures and to separate safe and unsafe regions with respect to seismic point of view. In this advertisement project in order to study impact of explosions in spill way the RA and RC mines at domain of Jamishan reservoir dam located at Sangher city one of the cities around Kermanshah province on diversion tunnel of dam, cutoff wall and villages including Jamishan, Pirsoleiman, Gelvich and Aeinleh within domain of aforesaid dam, we have applied from 4 digit machine with type of CMG-6TD. The seismic trembles as a result of 20 explosions was analyzed and processed by aforesaid machines. Distribution of seismograph machines around place of explosions and the subjects under study were so that in which 3 components including radiation pattern for explosion seismic energy within 3 directions including vertical, radius and width were registered and always it was attempted to register radius component of explosion, a component (N component) will be in the way of place of explosion. The changes for maximum velocity of displacement of particles based on scale distance and also registered spectrum of domain of seismograph was specified for studying aforesaid explosions. Upon comparing results of this research and available standards of explosion it was indicated that for the explosions at diversion tunnel of dam, cutoff wall and villages including Jamishan, Pirsoleiman, Gelvich and Aeinleh with respect to seismic there was completely safe explosions in the above mentioned region.

Characteristics of Explosion:

The most important factors of explosion which play important role on land tremble include amount, type of explosive materials, geometrical arrays of explosion and delay between explosions of bore holes. These factors shall be selected so that which result in highest percentage of energy as a result of explosion by separating mineral materials from cancer and possibly the lowest amount may be changed into seismic energy. Amount and type of explosive materials directly depends on amount of seismic energy as a result of explosion. Geometrical array and suitable delays between explosions of bore holes may play great role in decreasing energy change as a result of explosion to seismic energy. Geometrical array and delay shall be selected so that it will result in maximum destructive mixture of seismic waves so that the vibrations may have the lowest seismic energy. Distance between bore holes and delay depends on over coming frequency of waves as a result of explosion in bore holes and velocity of distributing waves within environment of mineral materials. It is obvious that velocity of distributing waves within environment of mineral materials and frequency domain of waves are regarded as influencing factors on wavelength in which length of waves may play important role in selecting distance of bore holes and delay. Of course suitable distance between bore holes from walls at surround of explosion environment may play effective role on destructive mixture of seismic waves.

Characteristics of Explosion Seismic Waves:

Explosion at homogenous spinal environment only result in density waves. While distributing these waves may distribute alongside of vibration and displacement of particles alongside of path, therefore such waves are called lengthwise waves. Whereas domain of arrays of bore holes of explosion of a mine are heterogeneous it is natural to expected that besides density waves a percentage of seismic energy may be published as width waves while explosion. While distributing widthwise waves the extension of displacement or distributing particles are orthogonal to extension of distribution and due to this reason these waves are called cutting waves. The velocity of distributing cutting waves is lower than velocity of distributing condensed waves. It is to be noted that in explosions the percentage of seismic energy as condensed waves is higher than widthwise waves. Whereas generally the environment for distributing seismic waves has layering the mathematical equations dominating over distribution of seismic waves indicates that due to distributing condensed and width waves under special conditions some border or surface waves may create in which the main type of them is rail and love waves. The important characteristic of these waves is decreasing domain of vibration displacement as exponential or deep. In relation to rail waves the extension of vibration of particles in vertical plate and at land is on oval and retrograde basis, meanwhile in love waves the extension of vibration of particles is at horizontal and vertical plate on extension of their distribution. Figure 2 indicates relationship between vibration of particles and extension of vibration related to 4 types of waves.
Besides aforesaid cases the main common characteristics among these waves include domain, velocity and acceleration for displacement of particles, frequency content of vibration of particles, duration of tremble, wavelength and velocity of their distribution; in accordance with frequency content of seismic waves that are created by seismic fountain and type of seismograph machine in relation to selecting which quantities of wave(domain for displacement of particles, velocity for displacement of particles and acceleration of displacement. Experience has indicated that according to according to frequency domain of frequency the seismic waves as a result of roofless explosion may be more suitable than seismographs which register velocity of displacement of particles.

Geology of Region & Distribution Environment:

Local geology at place surround of explosion and also geodynamic characteristics of surround rocks has great influence on characteristics of vibration. In homogenous land the vibration distributes in all direction on same basis but in environments with complicated geological characteristics the waves may distribute in different directions, therefore their weakness at different directions may be different. Existence of loose layers at path of distribution may result in more prompt and higher abruption seismic waves. Whereas elasticity coefficients of loose layers are lower than rigid layers the seismic vibrations in loose layers in comparison to rigid layers will be more

dampened. The result of this behavior of environment is that overcoming frequency of waves while passing from loose and soft environments may be decreased. On the other hand the seismic energy while passing from a rigid environment (including igneous rocks or condensed limes) and entering to a soft environment (including shale or soil) the domain, velocity and acceleration of vibration for displacement of particles will be considerably increased. In case of having structure on such site it is expected that seismic energy may have more unsuitable impact on structure in comparison to mode when structure is constructed on rigid site.

Distance from Place of Explosion:

In the distances close to place of explosion the characteristic of land vibration will go under impact of factors including power of explosion, geometrical array of explosion and other factors related to explosion but in the distances far from place of explosion, the environment of explosion and distance until place of explosion have more impact on characteristic of land vibration. Weakness of seismic waves is performed in different mode in which the main factors including geometrical distribution, absorption and energy distribution at common border among layers. In a homogenous environment when the seismic fountain is regarded as a point the wave front will be concentric and in this way due to distributing seismic energy on surface of spheres greater than density seismic energy upon increasing distance from place of explosion it will be decreased. Domain of displacement of particles may be decreased with second power of distance. If the seismic fountain may be estimated as line the wave front and surface of cylinder will be based on line of fountain and domain of displacement of particles will be decreased with first power of distance. If the seismic fountain may be regarded as a horizontal surface in this way due to geometrical distribution of seismic energy upon increasing distance it will not be decreased during path. Level of decreasing domain of seismic waves as a result of absorbing cement depends on depends on several factors including percentage of saturation, type of cement, particles of rocks, components of rocks, level of porosity, cracks, holes and other parameters. This decrease in domain of seismic waves is optional and generally higher frequencies are more absorbed in comparison to lower frequencies i.e. seismic energy is changed into heating energy. Generally the land for environment of distribution may be assumed as down filter. Decreasing domain of seismic energy at common border among 2 environments depends on difference of audio resistance. At common border among 2 environments with different audio resistance a percentage of seismic waves may pass unchanged and other percentage may be changed into another wave and some other may be reflection or at common border between 2 layers at continuation of path. The Snel law dominates over extension of distributing different waves at common wave between 2 layers. Impact of distance on domain, velocity and acceleration of displacement of particles are studied by researchers and since here the measured quantity in explosion is velocity of displacement of particles, we have referred to some relations that were achieved by researchers. Lecant(1967) has offered empirical relation(Lopez Jemino and coworkers, 1995).

Formula 1

In which V is velocity of displacement of particles based on mm/s, K is empirical fixed amount, Q is total mass of explosive material at per delay based on kg and D is distance from place of explosion based on meter. Ambersiz and Hendoran(1968) and Dading(1971) have offered relation(Lopez Jemino and coworkers, 1995).

Formula 2

Davin(1962) and Davin and Doal(1963) have observed explosive materials as cylinders and have offered relation 3. This relation is greatly applied by many researchers and executors of explosive plans (Lopez Jemino and coworkers, 1995).

Formula 3

Recent researches have offered better estimation by entering environment absorption coefficient, this relation was offered by Just & Feri(1980) (Lopez Jemino and coworkers, 1985 as relation 4 for volume waves (Lopez Jemino and coworkers, 1995).

Formula 4

In which α is environment absorption environment

6- Site Characteristics:

Of important characteristics of site include rigidness, thickness of sediments and dominant frequency. If seismic energy may apply to site and if site may be consisted of rigid and condensed rocks, the elasticity coefficients will be higher than mode when there are loose, uncondensed rocks or rocks with great porosity and crack which cause that in rigid rocks the domain of displacement of particles, velocity and acceleration of displacement of particles may be lower than these quantities under loose mode. Besides rigidness and thickness of sediments of a site has direct role on dominant frequency.

Characteristics of Structure:

Type, shape, altitude and more importantly natural frequency are among characteristics of a structure. If contents of frequency of seismic waves will be close to structure and include natural frequency of structure; the structure will be damaged due to intensifying vibration phenomena. Whereas land acts as down filter, therefore distances far away from seismic fountains have low frequencies and such frequencies may impact on structures with tall altitude.

Impact of Delay on Intensity of Explosion:

Of different parameters effective on land tremble, delay has great importance. Bleir(1993) has conducted some researches in relation to effect of different delays on land tremble, also Wiler(1988) and George Vich(1997) have conducted researches in the field of minimizing tremble by specifying suitable delay. Researches of all researchers indicate that by increasing delay the maximum velocity for displacement of particles may be exponentially decreased (Lopez Jemino and coworkers, 1995).

Limit of Health:

Many scholars have conducted research on impacts of roofless explosions of structures, including Arandelovich(1969) conducted such study on a mine located at ex-Yugoslavia. The total mass of explosive material in an explosion which was studies by him was 1000kg, also velocity of displacement of particles were performed at 6 places. Whereas radius components have the highest amount in comparison to other components, the equal velocity connective line for this explosion and for radius component were drawn which is indicated at figure 3.

In this study the velocity of displacement of particles lower than 1.5m/s is regarded as complete safe region and velocity of displacement of particles higher than 6cm/s is regarded as complete unsafe region. The same researcher by measuring maximum displacement velocity of particles in 10 points has achieved to relation of displacement velocity based on scaled distance for copper mine. This relation is indicated in figure 4. In this figure the high limit for displacement velocity is measured which are expectable and are indicated as multipoint line. At top right corner of this figure, the velocity-displacement diagram based on distance of scale for broader domain of

velocity-displacement is drawn. (For velocity more than 2m/s). The same researcher has studied IMPA rock crusher machine and has achieved to velocity displacement of particles on land due to performance of rock crusher machine. This measurement was performed in 8 places while working with rock crusher machine (6 places on land and 2 places on building). Maximum velocity of displacement of particles with distance is indicated at figure 6. This figure indicate that within distances more than 27m the amount of displacement velocity of particles will be more limited and lower than 0.2cm/s. Lopez Jemino and coworkers(1995) within similar researches have achieved to relation of velocity of displacement of particles based on distance of scale which is offered in figure 7. These researchers have offered table 1 for limit of health (maximum tolerable velocity for displacement of particles) and distance of scale that is suggested by US Department of Roofless Mines in the year 1983 as reference. Figure 7 indicates relation of velocity-displacement of particles based on scale distance (formula), in which D is distance from place of explosion and Q is amount of explosive material. In order to study health limit only observing maximum velocity of displacement of particles is not enough rather the domain of frequency of vibrations shall be observed i.e. mixing 2 maximum physical quantities of velocity for displacement of particles and domain for frequency of vibrations may be regarded as principal quantities for studying health limit of structure. Figure 8 indicates these 2 quantities for health limit of different structures. In this figure the domain of frequency as 10 to 80 Hz is observed meanwhile figure 9 indicates health limit within broader domain of frequencies (0 to 100Hz)(Lopez Jemino and coworkers 1995). Figure 8 indicates health limit and destruction limit for different structures against seismic vibrations at domain of frequency 10 to 80Hz (Lopez Jemino and coworkers 1995).

Class I: Metal structure or reinforced concrete

Class II: Concrete structure or masonry structure

Class III: Structures that have applied from wood or prefabricated walls

Class IV: Very sensitive structures to vibrations including historical structures

Figure 9: Figure 9 indicates health limit and destruction limit for different structures against seismic vibrations at domain of frequency 0 to 100Hz (Lopez Jemino and coworkers 1995).

Class I: Industrial and general structures

Class II: Brick structures

Class III: Very sensitive structures to vibrations including historical structures

10- Registering Seismic Data at Domain under Study:

In this research project in order to study effect of explosions at spill way of Jamishan reservoir dam, located at Sangher city from dependants of Kermanshah province and also explosion of RA and RC mines on diversion tunnel of dam, cutoff wall and villages including Jamishan, Pirsoleiman, Gelvich and Aienleh located at domain of aforesaid dam, we have applied from 4 sesimographs digit CMG-6TD manufactured by Gorlap England Co. Picture of this machine is shown at figure 10. Layout of aforesaid machine was so that always one component of seismograph was in the way of explosion, so that it is possible to register radius component of explosion. Also distance between 2 successive samples while digit is 5m/s i.e. 200 samples were taken per second.

* Ability of simultaneous registration of 3 components of waves
* Ability of registering micro trembles up to nano m/s
* Ability of registering waves within 0,0027 to 100 Hz
* Ability of equal response at domain of aforesaid frequency
* Ability of output with different type of ordinary formats
* Simultaneous registration of data besides adjusted time and **place by GPS**

The operation of registering seismograph lasts for 5 days within 2 stages, the first stage is from Dec.17, 2010 until Dec.19, 2010 and the second stage is from Jan.7, 2011 until Jan.8, 2011. In the first stage during 3 days there were 7 explosions in spill way and 4 explosions at RA mine. The second stage of operation was performed in 2 days and on the first day there was 3 explosions at RA mine and on the second day there was 6 explosions at RC mine.

1-10 Explosions at Spill Way of Jamishan Dam:

Data as a result of 7 explosions at spill way of Jamishan dam within 26^{th} and 27^{th} days besides summary of explosions and velocity of displacement of particles as a result of explosion are offered in table 2. Complete information related to blasting of these explosions is offered at table P1 and P7 and appendix 1. The status of 4 seismographs besides status for place of explosion for spill way explosions are indicated in figure 11. All of the 4 seismograph machines are installed and launched in pre-specified places under title of STA1 to STA4 which are indicated by triangle mark. Also in this figure the status for explosive pattern is indicated by star mark. Figure 11 indicates status of seismograph CMG-6TD machines at domains of Jamishan reservoir dam located at Sangher city with the goal of registering vibrations as a result of explosions in spill way of dam. The status of 7 explosive patterns in indicated in this figure by star and also seismography stations STA1 to STA4 are indicated with triangle. The goal of offering this array of seismographs is specifying explosion radiation pattern and impact of maximum velocity of displacement of particles as a result of these explosions on diversion tunnel of dam and cutoff wall. This array is selected so that alongside of status the topic under study and situation of explosion may be covered. 3 components seismographs at each of the stations are installed so that there will be one horizontal component(N component) toward place of explosion and another horizontal component(E component) vertical to aforesaid direction and the third component(Z component) that is vertical to surface of land. Sample of registered seismographs at station No.1 (STA1) located at diversion tunnel of Jamishan reservoir dam is indicated in figure 12. In this shape there 3 components including vertical, radius and width for station No.1. This explosion was performed on Dec.17 on spill way of Jamishan reservoir dam. Complete characteristics of this dam are offered in table 2. Figure 12 indicates vertical component Z, radius component N and width component E which is registered by seismograph at station 1(STA1) located at diversion tunnel of Jamishan reservoir dam related to second explosion from table 2 and vertical axis is domain of land displacement based on counts and the horizontal axis is time based on second

Explosions at RA Mine of Jamishan Reservoir Dam:

On Dec.19 and Jan.7 some data as a result of 7 explosions at RA mine of Jamishan reservoir dam was achieved. Summary of characteristics of explosion is offered at table 3. Complete blasting information of this explosion is offered at table P8 and P17 and appendix 1. Location of 4 seismography machines besides locating for place of explosion at RA mine is indicated at figure 13. All of the 4 seismograph machines are installed and launched at specified places under title of STA1 and STA2 which are indicated by triangle mark. Also the location of explosive patterns is indicated with star mark. Figure 13 indicates location of CMG-6TD seismograph at domain of Jamishan reservoir dam located at Sangher city with the goal of registering vibrations as a result of explosions at RA mine of dam. Location of 7 explosive patterns is indicated by triangle

mark and seismography stations at location of STA1 to STA4 are indicated by triangle. Table 3 indicates characteristics of explosions in RA mine at Jamishan reservoir dam located at Sangher city and amount of displaced velocity that is registered for different components and total velocity (PPVelocity). The goal of offering this array of seismograph is specifying explosion radiation pattern and impact of maximum velocity of displacement of particles as a result of thee explosions on diversion tunnels of dam and cutoff wall in Jamishan and Pirsoleiman village. This array is selected so that alongside of location the topic under study and explosive location will be covered. Seismographs of 3 components are installed at each station so that there is one horizontal component (N component) toward place of explosion and another horizontal component (E component) vertical to aforesaid direction and a third component (Z component) which is vertical to surface of land. Sample of registered Seismographs is indicated in figure 14. In this figure 3 components including vertical, radius and width that are registered by seismographs at station 3(STA3) located at Pirsoleiman village is indicated. This was the third explosion on Dec.19 at RA mine. Complete characteristics of this explosion are offered in table 3. Figure 14 indicates 3 components as vertical axis (Z), radius axis (N) and width axis (E) for registered seismograph at station 3(STA3) located at Pirsoleiman village which is related to third explosion, the vertical axis is domain of land displacement based on counts and the horizontal axis is time based on m/s.

Explosions at RC Mine of Jamishan Reservoir Dam:

Data as a result of six explosions at RC mine of Jamishan reservoir dam was achieved on Jan.8. Summary of characteristics of explosions besides velocity of displacement of particles as a result of each explosion is offered in table 4. Complete information of blasting for these explosions is offered at table P15 to P20 and appendix 1. Location of 4 seismographs besides location for place of explosion for RC explosions is offered in figure 15. All 4 seismographs which are indicated in place are installed and launched under title of STA1 and STA4 and are shown by triangle mark. Also in this figure the location of explosive pattern is indicated by star mark. Figure 15 indicates location of CMG-6TD seismograph at domain of Jamishan reservoir dam located at Sangher city with the goal of registering vibrations as a result of explosion at RC mine of dam. The location of 4 explosive patterns is indicated in figure by star and also location of seismography stations as STA1 to STA 4 are indicated by triangle. The goal of offering this array of seismography is specifying explosion radiation pattern and impact of maximum velocity of displacement of particles as a result of these explosions on Gelvich and Aeinleh villages. This array was selected so that alongside of status of the subject under study and location of explosion may be covered. The seismograph of 3 components were installed and launched there is one horizontal component (N component) toward place of explosion and another horizontal component (E component) vertical to aforesaid direction and a third component (Z component) which is vertical to surface of land. Sample of registered seismographs is indicated at figure 16. In this figure there 3 components including vertical, radius and width for seismograph which are indicated for station 1(STA 1) that is located at Gelvich village. This was the 4^{th} explosion which was performed on Jan.8 at RC mine. Complete characteristics of this explosion are offered in table4. Figure 16 indicates 3 components including vertical(Z), radius(N) and width(E) that has been registered by seismograph at station 1(STA1) located at Gelvich village that is related to 4^{th} explosion, the vertical axis indicates domain of land displacement based on counts and the horizontal axis indicates time based on second.

Processing Seismic Data as a Result of Explosion:

In order to specify maximum velocity of displacement of particles and studying impact of explosion on diversion tunnel, cutoff wall the Jamishan, Pirsoleiman, Gelvich and Aienleh villages located at domain of Jamishian reservoir dam at Sangher city as one the dependencies of Kermanshah province, the registered seismic data at domain under study have processed whereas follows:

First Stage: Total study of resisted seismograph to specify desired domain with the goal of separating explosion from total seismograph

Second Stage: Changing quantity of vertical axis from counter to displacement velocity and eliminating machine impact

Third Stage: Specifying maximum velocity for displacement of particles and drawing different diagrams

Fourth Stage: Specifying nature of registered frequency of seismography at desired places

Fifth Stage: Specifying blasting parameters with the goal of preventing from health limit

Seismic data related to explosions at region under study are offered and processed in accordance with 5 stages. The result of this processing within time is specifying diagram of velocity-displacement of particles based on distance of scale for different models and also analyzing registered frequency of scale and specifying nature of frequency at desired places. Whereas seismograph machine CMG-6TD is designed so that the vertical axis of seismograph is based on counts, it is necessary that the scale for measuring quantity will be changed to velocity of displacement of particles. Therefore vertical axis at first shall change from counts to volt and then to mm/s. Also amending response of seismic curve shall be performed simultaneously. This work is fulfilled by applying from manuals for CMG-6TD. By using amended seismographs the maximum velocity for displacement of particles is extracted and table 2 to 4 offers maximum velocity for displacement related to 3 components including vertical, radius, width and total velocity(PPVelocity). Also distance of center for each pattern of seismography stations besides charge in delay for explosion is offered. Then based on achieved amounts for velocity of displacement the diagram for change in maximum velocity of displacement of particles is offered based on scale distance for 3 models. The reason of selecting 3 different models is studying adaptability of suitable model with geological characteristics of region under study.

Studying Vulnerability of Gelvich and Aienleh:

By locating Gelvich and Aienleh villages adjacent to RC mine of Jamishan reservoir dam and lack of invulnerability of these 2 villages in comparison to explosions at this mine, it is necessary to conduct required studies for designing explosive patterns. Thus seismic data related to 6 explosions on Jan.8, 2011 at RC mine of Jamishan reservoir dam at Sangher city was analyzed to study seismic vibrations as a result of explosion at this mine over Gelvich and Aienleh villages. By drawing maximum changes for displacement of particles based on scale distance for different 3 models and specifying frequency content and also in accordance with health limit in explosion of roofless mines; we have studied that whether Gelvich and Aienleh villages are located as safe region with respect to seismic energy point of view in which their description is offered. After processing the registered seismographs at seismography station STA1 to STA4 so that STA1 in Gelvich village and STA2 in Aienleh village was installed and launched, 3 components for maximum velocity of displacement during time and maximum velocity of displacement of particles(PPV) are specified. Results

of maximum velocity of displacement of particles are offered in table 4. As it is indicated from this table the maximum velocity for displacement of particles for Gelvich village is achieved as 0.125mm/s and for Aienleh village as 0.029mm/s. Based on amounts of table 4 that are achieved for velocity of displacement of particles under impact of explosions in RC mine the diagram for maximum changes in velocity of displacement of particles based on scale distance is offered for 3 models that is mentioned at section 5 are calculated. Results of calculating relations indicate that the final model has the best conditions of adaptability with geological characteristics of region, therefore to study vulnerability of Gelvich and Aienleh it is applied from this model. The velocity-displacement diagram of particles based on scale distance is indicated for this model in figure 17. Figure 17 indicates maximum changes of velocity of displacement of particles based on scale distance for model *, equation of this diagram is offered at left bottom corner. In this relation the PPV the maximum velocity of displacement for particles based on mm/s, D is distance from place of explosion based on meter, Q is charge as per delay based on kg. By studying seismographs achieved from frequency, the domain of dominant frequency at vibrations as a result of explosions of RC mine at station in Gelvich and Aienleh village is achieved. Difference at nature of frequency may be due to different amount of charge, different distance of bore holes, different distances of seismography from place of explosion, location of seismograph and other factors. The spectrum for domain of seismographs registered for Gelvich and Aienleh village is offered in figures 18 and 19. As it is indicated from figure 18 and 19, the dominant domain for frequency for 6 registered explosions at Gelvich village is for domain of 1 to 30 Hz and the dominant domain is lower than 10 Hz. Also domain of frequency for 6 registered explosions at Aienleh village is 1 to 30 Hz and dominant domain is lower than 20 Hz. Therefore in order to study vulnerability of structures at Gelvich and Aienleh village is among domain of 1 to 10 Hz for explosions in RC mine. Figure 18 indicates frequency of waves as a result of explosion in RC mine within domain of Jamishan reservoir dam at Sangher city was registered and installed at seismography station, the horizontal axis is frequency based on hertz and vertical axis is domain of seismograph based on cant. In this spectrum the domain for 6 explosions at this mine is within zero to 10Hz and generally it is lower than 10Hz.

Figure 19 indicates nature of frequency as a result of explosions in RC mine at domain of Jamishan dam, Sangher city that is registered at seismography station which is installed at Aienleh village, the horizontal axis of frequency is based on Hz/m and vertical axis is domain of seismograph based cant. In this spectrum domains achieved from 6 explosions are available within domain of frequency 10 to 20Hz that is generally lower than 20Hz. According to figure 9 the effectiveness of different structures is based on observing 2 factors including maximum velocity of displacement and domain for frequency of explosions. Where rural structures are made of structure class III, therefore they are able to tolerate maximum velocity of displacement 8mm/m within domain of frequency 10 to 50Hz. Thus according to achieved domain of frequency for Gelvich and Aeinleh(0 to 100Hz) the maximum velocity of displacement will be observed as 3mm/s as threshold of destructing aforesaid rural structures. Whereas maximum velocity of displacement is 3mm/s and according to relation of displacement velocity based on scale distance for Gelvich and Aeinleh village (*), the amount of charge for each authorized delay for maximum velocity of displacement 3mm/s at Gelvich village within distance 760m from RC mine is 536kg and also this amount for Aeinleh village within distance 1317m from RC mine is 1222kg. Therefore amount of this charge per delay in explosions shall not be higher than aforesaid amount. By referring to 8th column at table 4 it is indicated that total charge as per delay for registered explosion in Gelvich village is lower than charge as per authorized explosion(536) and for all explosions registered at Aeinleh village the amount of charge as per delay is lower than charge as per authorized delay(1222). According to mathematical relations among maximum velocity of displacement of particles and scale distance for explosions at RC mine of Jamishan reservoir dam, the following table offers amounts for controlling explosions and lack of destructive impacts on Gelvich and Aeinleh village within domain of RC mine Jamishan reservoir dam. As it is indicated from table for 700m distance from place of explosion i.e. studying lack of effectiveness of structures at Gelvich and Aeinleh village from explosion at RC mine the amount of 474kg explosive material was applied as per delay i.e. as 10Hz delay it is possible to apply from 4740 explosive material (maximum 190 bore holes each having 9m altitude). Therefore for having safe explosions and lack of damage to structures at Gelvich and Aeinleh village it is necessary to observe amounts of charge as per delay in accordance with table 8.

Studying Vulnerability of Gelvich and Aeinleh village:

Locating Jamishan and Pirsoleiman villages adjacent to RA mine of Jamishan reservoir dam and necessity of lack of vulnerability of these 2 villages in comparison to explosions at this mine, it is necessary to conduct required studies for safe explosive patterns. Thus seismic data related to 4 explosions on Dec.19 and 3 explosions on Jan.7, 2011 at RA mine of Jamishan reservoir dam in Sangher city were analyzed for studying effect of seismic vibrations as a result of explosions at this mine on Jamishan and Pirsoleiman villages. After processing registered seismographs in seismography stations STA1 to STA4 so that STA3 in Pirsoleiman village and STA4 at Jamishan village was installed and launched, 3 components for maximum velocity of displacement (PPV) were specified for them. Results of specifying maximum velocity of displacement of particles in offered in table 3. As it is indicated from this table the maximum velocity of displacement of particles achieved from Jamishan village is 0.056mm/s at Pirsoleiman village as 0.082mm/s. Based on amounts of table 3 that are achieved for velocity of displacement under influence of velocity of displacement of particles based on scale distance for 2 models *, * they are calculated in accordance with section 5. Results of calculating relation indicates that the second model * has the best compatibility conditions with geology of region under study; thus in order to study vulnerability of Jamishan and Pirsoleiman village we have applied from this model. The velocity-displacement diagram based on scale distance for second model is offered at figure 20. Figure 20 indicates changes for maximum velocity of displacement of particles based on scale distance for suitable model of region. The equation of this diagram is offered at top right corner of it. In this relation the PPV as maximum velocity of displacement of particles is based on mm/s, D is distance from place of explosion based on meter and Q is amount of charge as per delay based on kg. Upon studying achieved seismographs within domain of frequency the domain of dominant frequency in explosions as a result of RA mine in station located at Jamishan and Pirsoleiman village was achieved. Spectrum for domain of registered seismographs at Jamishan and Pirsoleiman village is offered at figures 21 and 22. As it is indicated from these 2 figures the domain for dominant frequency for 7 registered explosions at Jamishan and Pirsoleiman village is among 5Hz to 15Hz and dominant domain

is nearly 10Hz. Therefore in order to study vulnerability of structures at Jamishan and Pirsoleiman village the dominant domain is 1 to 10Hz for explosions at RA mine. Figure 21 indicates nature of frequency of waves as a result of explosions at RA mine with domain of Jamishan reservoir dam in Sangher city which was registered at seismography station installed at Jamishan village, the horizontal axis indicates frequency based on Hz and the vertical axis indicates domain of seismograph based on cant. The domain of dominant frequency is among 5 to 10Hz and generally it is lower than 10Hz. Figure 22 indicates nature of frequency of waves as a result of explosions at RA mine within domain of Jamishan reservoir dam in Sangher city which was registered at seismography station installed at Pirsoleiman village, the horizontal axis indicates frequency based on Hz, the vertical axis indicates domain of seismograph based on cant. The spectrum of 7 explosions at this mine within domain of dominant frequency is 5 to 10Hz and generally it is lower than 10Hz. According to figure 9 the effectiveness of different structures is achieved by observing 2 factors including maximum velocity of displacement of particles and domain of frequency of explosions. Whereas rural structures are made of structure class III, therefore tolerating maximum velocity of displacement is 3mm/s within domain of frequency 0 to 10Hz and also tolerating maximum velocity of displacement is 8mm/s within domain of frequency 10 to 50Hz. Thus according to achieved domain of frequency for Jamishan and Pirsoleiman village(0 to 10Hz) the maximum velocity of displacement is observed as 3mm/s as threshold for destructing rural structures. According to maximum velocity of displacement (3mm/s) and velocity-displacement relation based on scale distance for Jamishan and Pirsoleiman village (*) the amount of charge at Jamishan and Pirsoleiman village at distance 100m from RA mine is achieved as 695kg. Therefore the amount of this charge as per delay in explosion shall be higher than aforesaid amount. By referring to 8^{th} column at table 3 it is indicated that all of the achieved charge for all explosions in RA mine registered at Jamishan and Pirsoleiman village is lower than charge as per authorized delay (695). Based on mathematical relations that are achieved for maximum velocity of displacement of particles and scale distance for explosions in RA mine Jamishan reservoir dam, the following table is offered for controlling explosions and lack of destructive impacts at Jamishan and Pirsoleiman village within domain of RA mine Jamishan reservoir dam. According to his table it is indicated that for distance 1000m from place of explosion i.e. in order to study lack of effectiveness of structures at Jamishan and Pirsoleiman village as a result of explosions at RA mine it is applied from 695kg explosive material as per delay or i.e. for 10Hz delay it is possible to apply from 6950kg explosive materials. Therefore it is observed that for explosions at RA mine according to authorized amounts at table 6 there is no threat against Jamishan and Pirsoleiman village and these 2 villages are located in safe region.

Studying Vulnerability of Diversion Tunnel & Cutoff Wall at Jamishan Reservoir Dam:

Non standard and incorrect blasting operation at constructive activities may have destructive impact on structures. Having diversion tunnels and cutoff wall of Jamishan dam adjacent to blasting operation and at spill way and RA mine of Jamishan dam and lack of vulnerability of these 2 structures, it is necessary to conduct study for designing suitable explosive patterns. Thus seismic data related to 7 explosions at spill way on Dec.17.18 and also 7 explosions at RA dam on Dec.19, 2010 and Jan.7, 2011 were analyzed for studying effect of seismic vibrations as a result of spill way explosions and RA mine on diversion tunnel and cutoff wall. By drawing changes at maximum velocity of displacement of particles based on scale distance for 3 different models and specifying frequency content and also according to health limit in explosion of roofless mine, it is studied that whether diversion tunnel and cutoff wall with respect to seismic point of view are located ay safe region or not in which their description is offered. After processing registered seismographs at seismography station STA1 to STA4 so that location of these stations are indicted at figures 11 and 13, the STA1 station inside of diversion tunnel and STA2 station adjacent to cutoff wall were installed and launched; 3 components of maximum velocity of displacement during time of reading were studied and therefore the maximum velocity of displacement of particles (PPV) was specified. Results of specifying charge parameters as per delay, scale distance and maximum velocity of displacement of particles for explosions at spill way and RA mine is offered at table 7. As it is indicated from this table the achieved maximum velocity of displacement of particles in diversion tunnel and cutoff wall of dam is 3.28mm/s which relates to third explosion with deep of bore hole as 9m in RA mine. As it is indicated from this table the maximum velocity for displacement of particles is very low. By observing table 1 for distance 90 to 1500m the authorized velocity of displacement of particles suggested by US Department of Roofless Mines, is 24.5 meanwhile all of the amounts of scale distance in table 7(4^{th} column) is higher than from this amount. Thus by complete certainty it is possible to say that the explosions at spill way and RA mine do not have any destructive impacts on tunnel and cutoff wall. Also by studying achieved seismographs at domain of frequency the vibrations as a result of spill way explosions and RA mine in station located at diversion tunnel and cutoff wall was achieved. Difference at nature of frequency may be due to different amounts of charge, different distance from bore holes, different distance from seismography and other factors. Some spectrum for domain of registered seismographs inside of diversion tunnel and cutoff wall is indicated at figure 23. As it is indicated from figure 23 the domain of frequency for 6 selected explosions at diversion tunnel and adjacent to cutoff wall is at domain of 10 to 30Hz and its dominant domain is nearly 20Hz. Therefore in order to study vulnerability of structures of tunnel and cutoff wall of dam the domain 10 to 30Hz is observed for explosion at spill way and RA mine. Figure 23 indicates frequency of waves as a result of explosion at spill way and mine RA within domain of Jamshishan reservoir dam at Sangher city registered at installed seismography stations inside of diversion tunnel and adjacent to cutoff wall of dam; the horizontal axis of frequency based on Hz and vertical axis of domain of seismograph is based on cant. It in indicated that within spectrum of domain related to 6 explosions, the dominant domain of frequency is among 10 to 30Hz. According to figure 9, the effectiveness of different structures is specified by observing 2 factors including maximum velocity of displacement of particles and domain of frequency for explosions. Whereas structure of diversion tunnel and cutoff wall is made of structure class I, therefore they are able to tolerate maximum velocity of displacement as 25-30mm/s within frequency of 10 to 30Hz. Therefore according to domain of frequency achieved from diversion tunnel and cutoff wall of dam (10 to 30Hz) the maximum velocity of displacement is observed as 25mm/s for threshold of destructing structure. Based on diagram for changes of maximum velocity of displacement of particles is based on scale distance for explosions at spill way and RA mine and also based on authorized amounts the suggested distance by US Department of Roofless Mines is 24.5 for distance as 90 to 1500m from place

of explosion. The achieved amounts of charge as per delay for different distances from place of spill way explosion and RA mine are offered in table 8. Therefore in order to prevent from destructive impacts of explosion in diversion tunnel and cutoff wall it is necessary to observe maximum amount of charge as per delay in table 8. Table 8 indicates amount of charge as per authorized delay in different distances of spill way explosions and RA mine in order to prevent from damage to diversion tunnel and cutoff wall of Jamishan reservoir dam at Sangher city and the total authorized amount of charge for 10 delays with type of Hs and different distances are offered in 3th and 6th column. According to this table it is indicated that for 200m distance from place of explosion i.e. studying lack of effectiveness of tunnel and cutoff wall structure it is applied from 55kg explosive material for spill way explosions and RA mine as per delay i.e. for 10 Hs delay it is possible to apply from 550kg explosive materials. By applying from mentioned amounts in table 8, it is indicated that for explosions at spill way and RA mine there is no threat for diversion tunnel and cutoff wall at Jamishan reservoir dam and these 2 structures are located among complete safe region.

Conclusion:

The most important factors of explosion which plays important role on land vibration include: amount and type of explosive material, geometrical array of explosion and delay between explosions of bore holes. These factors shall be selected so that the highest energy percentage as a result of explosion will be spent on mine and up to possible level the least amount will be changed to seismic energy. Adjacency of Jamishan reservoir dam at Sangher city with sensitive structures including diversion tunnel and cutoff wall of dam and also villages including Jamishan, Pirsoleiman, Gelvich, Aeinleh has creates some problems for explosion operation. Therefore in the research project, designing safe explosive patterns and studying destructive impacts of aforesaid explosions on structures and villages in this region was studied. In the present study the operation of registering seismographs was performed in 5 days within 2 stages as first stage was from Dec.17, 2010 until Dec.19, 2010 and the second stage was from Jan.7, 2011 to Jan.8, 2011. In the first stage within 3 days there were 7 explosions at spill way and 4 explosions at RA mine. The second stage of operation was within 2 days in which on first day there was 3 explosions at RA mine and one the second day there was 6 explosions at RC mine. In this study upon registering and processing seismograph related to seismic data as a result of 20 explosions at Jamishan reservoir dam at Sangher city(spill way, RA and RC mine) the status of vulnerability of Jamishan, Pirsoleiman, Gelvich, Aeinleh villages were studied. Operation of registering seismograph as a result of these explosions was performed by 4 seismographs type CMG-6TD machine made in Corlap England Co. 3 seismography networks including 4 machines were designed to register data as a result of explosion. Vulnerability of diversion tunnel and cutoff wall of dam and also Jamishan, Pirsoleiman, Gelvich, Aeinleh villages were studied within 3 stages.

* Studying vulnerability of Gelvich and Aeinleh villages as a result of explosions at RC mine
* Studying vulnerability of Jamishan and Pirsoleiman villages as a result of explosions at RA mine
* Studying vulnerability of diversion tunnel and cutoff wall for dam as a result of spill way explosions and mine RA

Summary of characteristics of explosions besides velocity of displacement of particle as a result of each explosion is offered at tables 2 to 4 and also complete blasting information of these explosions are offered at appendix 1.

A) Studying Vulnerability of Gelvich and Aeinleh villages as a Result of Explosions at RC Mine:

Seismic data related to 6 explosions on Jan.8, 2011 at RC mine of Jamishan reservoir dam, Sangher city were analyzed to study seismic vibrations as a result of this mine on Gelvich and Aeinleh villages. By specifying maximum velocity of displacement of particles, drawing maximum changes for velocity of displacement of particles based on scale distance and changes of frequency and health limit in explosion of roofless mine, it is studied that whether Gelvich and Aeinleh villages are located at safe region with respect to seismic energy and its description was mentioned.

* Maximum velocity of displacement of particles for Gelvich village was achieved as 0.125mm/s and for Aeinleh village as 0.029 mm/s
* Results of calculating relations indicate that model * has the best condition for adapting with geological characteristics of land under study and relation for maximum velocity of displacement of particles based on scale distance for Gelvich and Aeinleh villages will achieve through following equation:
* Whereas relation of maximum velocity of displacement based on scale distance that is achieved for this region, the amount of charge as per authorized delay for maximum velocity of displacement was 3mm/s as Gelvich village and within distance of 760m from RC mines was 536kg and within distance of Aeinleh village it was 1317 from RC as 1222kg. By referring to 8th column at table 4 it is indicated that total amount of charge as per delay for total registered explosions at Gelvich and Aeinleh villages was less than charge as per authorized delay(536). Thus with respect to maximum velocity of displacement of particles that is achieved from total explosive patterns, it is possible to conclude that suitable explosion array is designed and even in accordance with threshold of destructing rural structures, the selected characteristics are observed lower than standard level
* By studying seismograph achieved from domain of frequency, the dominant domain of frequency for vibrations as a result of explosions in RC mine at stations of Gelvich village was within 1 to 30Hz so that the dominant frequency was lower than 10Hz. Also dominant domain of frequency for 6 registered explosions at Aeinleh village was within 1 to 30Hz and the dominant domain is lower than 20Hz. Therefore in order to study vulnerability of structures at Gelvich and Aeinleh villages the dominant domain was achieved within 1 to 10 Hz for explosions at RC mine.

A) Studying Vulnerability of Jamishan and Pirsoleiman Village as a Result of RA Mine Explosion:

Seismic data related to 4 explosions on Dec.19, 2009 and 3 explosions on Jan.7, 2011 at RA mine for Jamishan reservoir dam at Sangher city, was analyzed to study seismic vibrations as a result of explosions at this mine on Jamishan and Pirsoleiman village. Upon specifying maximum velocity of displacement of particles, drawing changes for maximum velocity of displacement based on scale distance and specifying content of frequency and also according to health limit in explosion of roofless mine, it is studied that whether Jamishan and Pirsoleiman village are located at safe region with respect to seismic energy and its description was mentioned.

* Maximum velocity of displacement of particles in Jamishan was achieved as 0.056mm/s and at Pirsoleiman village as 0.082 mm/s
* Results of studying relations indicate that mode * has the best conditions of adaptation with geology of region under study and the relation for maximum velocity of displacement of particle based on scale distance for Jamishan and Pirsoleiman village is achieved through following formula:

* Whereas the maximum velocity of displacement is 3mm/s and according to velocity displacement relation based on scale distance for Jamishan and Pirsoleiman village, amount of charge as per authorized delay for maximum velocity of displacement was 3mm/s at Jamishan village and Pirsoleiman village within distance 1000m from RA mine as 695kg. By referring to 8th column at table 3 it is indicated that all charge as per delay for all of the explosions in RA mine which was registered at Jamishan and Pirsoleiman village was lower than authorized delay of 695. Thus with respect to destructive interference in formation of seismic waves and according to maximum velocity of displacement of particles achieved from explosive patterns, it is possible to conclude that suitable explosive arrays are designed and according to threshold of destructing rural structures, the selected characteristics are observed lower than standard level
* Upon studying seismography achieved from field of frequency, the dominant domain of frequency for vibrations as a result of explosions in RA mine in stations located at Jamishan and Pirsoleiman village were within 5 to 15Hz and dominant domain was nearly 10Hz. Therefore in order to study vulnerability of structures at Jamishan and Pirsoleiman village the dominant domain was achieved as 1 to 10Hz in explosions at RA mine

A) Studying Vulnerability of Diversion Tunnel and Cutoff Wall of Dam as a Result of Spill Way & RA Mine Explosions:

Seismic data related to 2 explosions on Dec.17, 2010 and 5 explosions on Jan.17, 2011 at spill way and also 7 explosions at RA mine on Dec.19, 2010 and Jan.7, 2011 were studied in order to analyze impact of seismic vibrations on diversion tunnel and cutoff wall. Upon drawing changes for maximum velocity of displacement of particles based on scale distance, it was studied to specify frequency content and also health limit at explosions of roofless mine and to find out that whether diversion tunnel and cutoff wall are located in safe region with respect to seismic energy and its description was offered.

* Maximum velocity of displacement of particles for diversion tunnel and cutoff wall was achieved as 3.28mm/s which relates to third explosion with bore hole with depth of 9m in RA mine
* For distance 90 to 1500m the maximum authorized velocity of displacement of particles suggested by US Department of Roofless Mines was achieved as 25mm/s, meanwhile the maximum achieved velocity at this research was 3.28mm/s. Based on suggested amounts of US Department of Roofless Mines the authorized scale distance for 90 to 1500m is 24.5 meanwhile all of the amounts for scale distance which are offered in table 7(4th column) are higher than this amount. The lowest scale distance is 37.58, thus by complete certainty it is possible to say that the explosions in spill way and RA mine did not have destructive impact on tunnel and cutoff wall. Thus with respect to destructive interference in formation of seismic waves and whereas maximum velocity of displacement of particles achieved from all explosive patterns, it is possible to conclude that suitable explosion array was designed and even according to threshold of destructing structures of tunnel and cutoff wall, the selected characteristics were observed lower than standard level
* Also by studying seismographs achieved from field of frequency, the domain of dominant frequency for vibrations as a result of spill way and RA mine explosions in stations located at diversion tunnel and cutoff wall was within 10 to 30Hz and the dominant domain was achieved as 20Hz. Therefore dominant domain of 10 to 30Hz was observed for explosions at spill way and RA mine
* Whereas structures at diversion tunnel and cutoff wall is made of structure class I, therefore tolerating maximum velocity of displacement 25-30mm/s was within frequency domain of 10 to 30Hz. Thus according to achieved domain of frequency for diversion tunnel and cutoff wall of dam(10 to 30Hz) the maximum velocity of displacement was observed as 25mm/s for threshold of destructing these structures
* On the strength of diagram for changes of maximum velocity of displacement of particles based scale distance for explosions at spill way and RA mine and also authorized amounts suggested by US Department of Roofless Mines was 24.5 for distances 90 to 1500m from place of explosion and amounts of charge as per delay for difference distances from place of spill way explosions and RA mine was achieved that are offered in the table 8. Thus in order to prevent from destructive impacts of explosions at diversion tunnel and cutoff wall; it is necessary to observe amount of charge as per delay in accordance with table 8. According to table 8 it is indicated that for distance 200m from place of explosion i.e. in order to study lack of effectiveness from structures of tunnel and cutoff wall from spill way and RA mine explosions, it is possible to apply from 55kg explosive materials as per delay or as per 10 delay of hs it is possible to apply from 550Kg explosive materials

16- Suggestions:

* According to relations and calculations for explosions at RC mine, it is suggested that in order to prevent from lack of effectiveness of structures at Gelvich and Aeinleh villages from explosion at RC mine, it was applied from 470kg explosive materials as per delay i.e. as per 10hs delay it is possible to apply from 4700kg explosive materials (maximum 188 bore holes with 9m depth). Applying any other type of bore holes depends on observing maximum charge as per delay of 470
* On the strength of mathematical relations among maximum amount of velocity for displacement of particles and scale distance for explosions at RA mine, it is suggested that in order to prevent from lack of effectiveness of structures at Jamishan and Pirsoleiman village and for explosion at RA mine it is possible to apply from 695kg explosive materials as per delay i.e. as per 10 delay of hs it is possible to apply from 6950kg explosive materials. Applying any type of charge depends on observing maximum amount of charge as per 695 delays
* In order to prevent from lack of effectiveness at structures of tunnel and cutoff wall from explosions of spill way and RA mine, it is suggested that for distance 200m from place of explosion to apply from 55kg explosive materials as per delay i.e. as per 10 delay of hs it is possible to apply from 550kg explosive materials
* According to great difference for maximum velocity of displacement of particles achieved from bore holes 6m and 9m at RA mine explosions, it is suggested that to prevent from lack of vulnerability of cutoff wall and diversion tunnel to apply from 6m bore holes at this mine
* According to lack of suitable blocking which result in producing very powerful and disturbing acoustic waves for rural people, it is suggested to observe minimum 3m blocking for 9m and 2m bore holes for 6m bore holes
* Delay among explosions of bore holes plays important role in destructive interference of released seismic energy. Existence of explosive percussion cap with delay of hs may result in destructive interference of seismic waves and it is indicated from figure 3 the domain for velocity of displacement of particles is considerably decreased which is regarded as very important factor on decreasing velocity of displacement of particles registered as a result of explosions; thus it is suggested that in order to prevent from destructive impacts to apply from delay percussion cap type hs.

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