Determination of Destruction Levels Caused by Earthquakes Using Grip RADIUS 99 Program

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Abstract

The most universal and basic damages caused by an earthquakes are buildings damage and human casualties. A simplified method, the RADIUS 99 Tool is used to calculate seismic intensity (shaking) distribution, buildings damage, number of casualties and lifelines damage, due to assumed earthquake scenario. In this study, Al - Kadhmiya sector in Baghdad city was chosen for assessing seismic risk, for this purpose, this area was divided into mesh of $1*1$ km^2 cell size, and a scenario of (Manjil) earthquake (that struck Iran in 1990) was utilized with following earthquake magnitudes (5 and 7), with epicenter distance (3, 10 and 100 km), and depths (2 and 5 km). It was found that, the best soil types for constructions are those with medium and hard soils, where they can resist the earthquake. The areas with soft soils should be avoided when we want to choose the sites to build the life saving establishments and general public buildings like schools and hospitals, in addition, the seismic building code should be followed for structures to be built on soft soils areas.

Keywords: Al – Kadhmiya, Earthquake hazard, RADIUS 99, PGA.

تحديد مستويات الدمار الناتج عن الزلازل باستخدام برنامج Grip RADIUS 99

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الخلاصة

ان الأضرار الأكثر شيوعا والأساسية الناجمة عن حدوث الزلازل هي ألاضرار في المباني ووقوع الخسائر البشرية. في هذه الدراسة استخدم برنامج RADIUS 99 كوسيلة مبسطة لحساب شدة الزلازل (الاهتزاز) و توزيعها، وتضرر المباني، وعدد الإصابات وتحطم خطوط مرافق الحياة، ولتقييم المخاطر الزلزالية. وقد تم اختيار قضاء الكاظمية في مدينة بغداد كموقع لهذه الدراسة حيث تم تقسيم هذه المنطقة إلى شبكة خلايا ببعد (1 *1 كم^2) للخلية الواحدة ، واستخدم سيناريو زلزال مانجل (الذي حدث في ايران 1990) بمقادير زلزالية (5 و 7)، وعلى ابعاد بؤرة (3 و 10 و 100) كم ، وأعماق بؤرة (2 و 5) كم. وقد وجد أن أفضل المناطق الصالحة للأعمار هي :المناطق ذات التربة المتوسطة الصلابة والصلبة ، حيث أنها قادرة على مقاومة الزلزال،كما يجب تجنب المناطق ذات التربة الهشة عندما نريد اختيار مواقع لبناء المؤسسات والمباني العامة مثل المدارس والمستشفيات، وبالإضافة إلى ذلك، ينبغي إتباع الكود (المدونة) الزلزالي في البناء للمنشآت التي سيتم بناؤها في مناطق التربة الهشة.

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Introduction:

In order to establish proper management plans for earthquake disaster reduction, it is imperative that city planners have an understanding of the extent of possible damage to their city in the event of a future earthquake. The first step in ensuring the safety of cities against earthquake disaster is to have an understanding of the susceptibility of the area or city under consideration to future earthquakes [1].

A large scale earthquake can affect a wide area in many different aspects. In such an earthquake, for example, the area near the epicenter will be shaken severely and some slopes may fail. The direct disaster of the ground shaking caused by earthquakes is called Earthquake Hazard. Earthquake Hazard can inflict damage on a wide variety of structures. The damage to buildings is the most obvious. Casualties can be a result of building damage as well as fires which may ignite after an earthquake. The main cause of deaths during earthquakes is building collapse.

Earthquake Hazard also affects lifeline facilities such as railroads, highways, bridges and water, sewage, electric power and gas networks. Lifeline damages can significantly hamper recovery efforts aimed at the damaged area. Moreover, damage sometimes causes indirect economical losses in addition to direct physical damage [2].

Previous works:

An evaluation of seismic zoning of Iraq is carried out by Alsiniwai and Almosawi in (1980) [3]. Also Al- Alabasy and Fahmi used in (1985) an extreme value statistic for the estimation of maximum magnitude of earthquake in Iraq [4]. In addition to, Mahmood & Alomary in (1985) used probabilitic methods for evaluating the seismic design parameters for Baghdad city [5], and they carried out in (1986) a preliminary estimation of earthquake probable zone for Iraq , where the geological arrangements , longitudinal faults ,transverse faults, crossing roads and earthquake occurrences [6].

Data sources and methodology:

The RADIUS 99 program [2] is executed by choosing scenarios of an earthquake that had taken place in Iran in (1990) called Manjil earthquake, where different epicenter location, focal depth, direction, magnitude values and occurrence time (day or night) are given. Al - Kadhmiya area in Baghdad city / Al-Karkh has been chosen as a target for such earthquake senarios.

Data required to carry out the seismic risk analysis were obtained from Ministry of Planning [7], they include: statistics of Population distribution, lifeline distribution, buildings types distribution and industrial facilities. Al –Kadhmiya area has been gridded into a mesh of (41) cells of (1) km squared Figure-1.
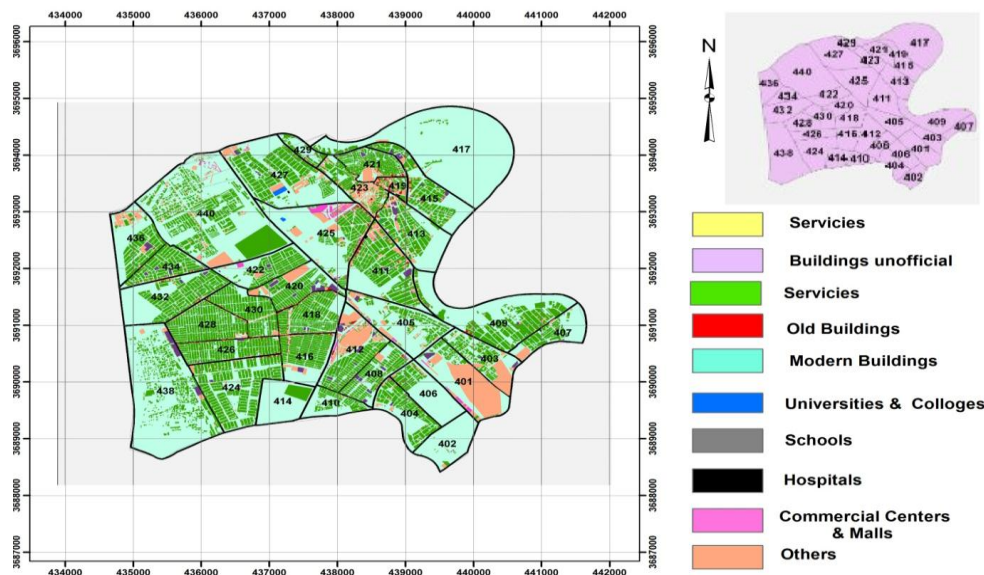
Figure 1- Study area of Al – Kadhmiya Qadha

Each sector was coded from 1 to 6 as follows: AL-Hurriya (1), Al-Zahraa (2), Al-Kadhmiya (3), Al – Salam (4) , AL- Utaifiya (5) , Al- Fager (6), Figure-2.

Color ID	Area Name
1	Al huria
2	Al zahraa
3	Al kadhima
4	Al salam
5	Al utaifya
6	Al fajer

Figure 2- Area ID distribution map

The grid units of the area are often zoned according to existing ground conditions (soil type) and administration boundaries (city block, city sector, etc.). Thus, Earthquake Hazard will be estimated from the parameters of the scenario earthquake and ground conditions [2]. Al-Kadhmiya area lies in the north western part of Baghdad city , to west of Tigris river where it's soil type ranged between soft and medium soil, the eastern regions have soft soil because it is near the river, such as in the sectors of Al-Kadhmiya ,Al –Salam, AL- Utaifiya, Al- Fager, while the western regions has a medium soils such as the sectors of AL-Hurriya, Al-Zahraa, Figure-3.
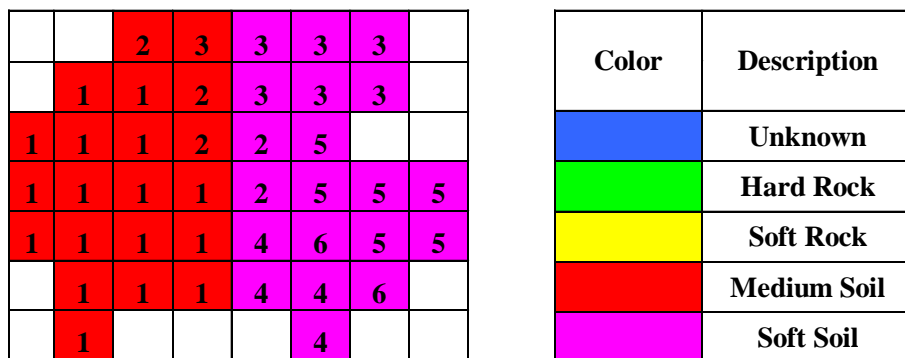
Color	Description
	Unknown
	Hard Rock
	Soft Rock
	Medium Soil
	Soft Soil

Figure 3- Soil Type Distribution Map of Al – Kadhmiya area, numbers refer to area ID

In addition to soil type, Al –Kadhmiya statistical data were used (that were obtained from the ministry of planning)[4] which include the population, numbers and distribution of lifelines facilities (roads (local and highway), bridges, tunnels, electrical and telecommunication supply (towers and sub-stations), water supply and sewage (trunk and distribution lines, pumping stations and treatment plants), reservoirs, dams and tanks, and gasoline stations), numbers of different types of building (residential, industrial, commercial, schools, hospitals) and their distribution in the area. Buildings may be also classified according to various parameters such as, their material types, usage, age, structural types and local building codes, because earthquake damage to buildings is greatly influenced by the types of buildings, we also specify the "Mesh Weight," which is defined as the relative density of buildings in each mesh unit. Thus, combining the above factors with the estimated seismic intensity distribution, building damage can be estimated. By using the maps of main and secondary roads in Al- Kadhmyia area, the types and the lengths of the roads were determined utilizing the GIS and Global Mapper programs. These data were used as input for executing the RADIUS 99 program. It was noted that the building distribution is concentrated in the central parts of the area especially the areas of medium soils and it is found in less concentration in regions of soft soils while it is not found in the outside regions of the area, so the building distribution varies in each neighborhood according to its soil condition, Figure-4.

To understand the effect of the earthquake and to determine which scenario is the most causative of damages and destructions according to the input parameters of the area, Manjil earthquake scenario was simulated by using the Joyner & Boore (1981) [8] attenuation equation of seismic magnitude and with different directions, distances, depths of the epicenters and time of happening.

The following input parameters were used to simulate the effect of earthquakes at different magnitudes (5, 7) and distances (3, 10 and 100) km and epicenter's.
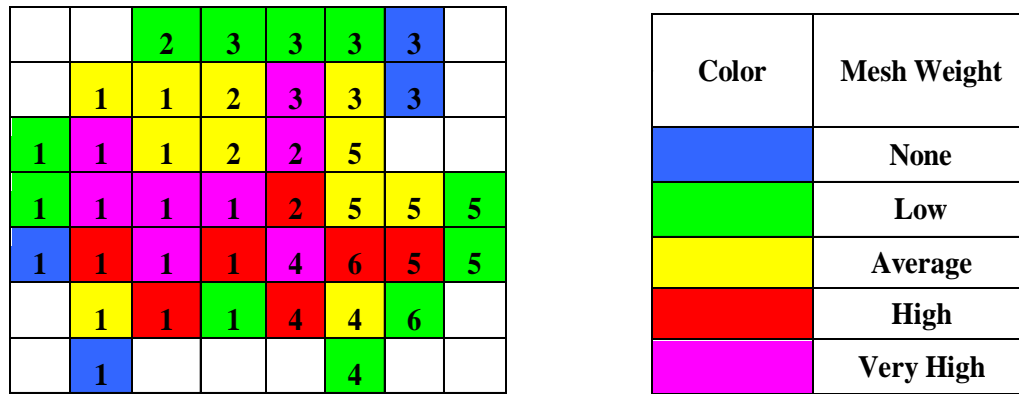
Color	Mesh Weight
	None
	Low
	Average
	High
	Very High

Figure 4 - Mesh Weight Distribution Map

Results and Discussion:

Analysis and Interpretation of results depend mainly on the accuracy of the input data for executing the RADIUS 99 program, in spite of that, the results are still approximate due to the presence of many variable factors and inputs that could not be obtained accurately like population and their presence during day and night, as well as the accurate engineering characteristics of buildings.

The average of Modified Mercalli Intensity (MMI) which is one of the most widely used definitions of the severity of an earthquake and is used as an earthquake damage scale, the Mesh Damage Ratio (MDR%) which is defined as the percentage of damage building in each mesh , the (PGA) (Peak Ground Acceleration) which represents the ground shaking acceleration , the suspected numbers of people injuries and deaths and the ratio of lifelines damage, can be determined by running the program with many scenarios with variable (Earthquake magnitude, depth, distance and direction) , which could help in the analysis and evaluating the destruction that was caused due to earthquake.

Input data and results are shown in Appendix. Summary of all results is given in Table-1. It is clear that the most susceptible areas by the earthquake magnitude are the areas with soft soils such as Al-Kadhmyia, Al – Salam, AL- Utaifiya, Al- Fager sectors where the values of MMI are higher in the areas of medium soils such as AL-Hurriya and Al-Zahraa. For example, in scenario (1), Table-1, the MMI values range between (6.8- 7.1) in soft soil areas and range between (7.2-7.5) in medium soil areas. The (MDR%) value entirely depends on soil's condition . It's found that central part area has the highest MDR% Values, Figure-4, that is directly correlated with soft soils areas. For example, in scenario (2), Table-1, these values range between (38.1- 40.7) while it's between (31.5- 40.7) in medium soils areas. As the population number is proportional to building density, the number of casualties will increase where the MDR% value will increase. The lifelines will, also, be affected proportionally with the earthquake magnitude**,** depth and distance. The values of peak ground acceleration (PGA) increase also by increasing of earthquake magnitude and their value vary according to variation in other seismic parameters.

Table (1) The summary of the results from all scenarios.

Scenario No.	Earthquake Magnitude (Richter)	Earthquake Depth (Km)	Earthquake Distance (km) to Ref. Mesh	Occurrence Time	Earthquake Direction relative from Ref. Mesh	Average PGA (g)	Average MDR (%)	Average MMI	Total Injury	Total Death
1	5	5	10	11.5 day time	NE	0.14	9.0	7.1	18554	929
2	7	5	10	11.5 day time	NE	0.5	35.5	8.8	86105	12794
3	5	2	10	11.5 day time	NE	0.15	10.3	7.2	22483	1244
4	5	5	100	11.5 day time	NE	0.01	0.0	3.4	34	2
5	5	5	3	11.5 day time	NE	0.2	16.5	7.6	33732	2577
6	5	5	10	2.5 night time	NE	0.14	9.0	7.1	18630	1079
7	5	5	10	11.5 day time	SE	0.13	7.8	7.0	15963	611

From Table-1, scenario (1 and 2), it can be noted that as earthquake Magnitude increases, the (PGA) value increases and the human sensing for it increases , so the average of (MMI) value will be greater, and the average of (MDR%) with the lifelines ratio and injuries will be proportionally increased. It can be noted also that as average of (MMI) value increases as the earthquake depth decreases ,where the effect of the surface seismic waves increases, scenario (1,6,7 and 3), the average of (MDR%) and the lifeline ratio and injuries will be increased when the earthquake depth is shallow (near the surface). While these averages and ratios will decrease as distance between the earthquake location and the affected area increase, in which the seismic waves intensity decreases because of attenuation, as a result of the reflections and refractions of seismic waves along path, scenario (1, 4 and 5).

Values of (MMI) are equal when the area is attacked by earthquake at day time (6:00 am – 18:00 pm) or attacked by earthquake with a same magnitude at night time (18:00 pm – 6:00 am), as the time has no effect on the MMI , but the effect of time manifest itself only in the number of injuries and deaths, where the deaths   number increases when the earthquake happened at night in which the night population is higher than day population in residential buildings. As school and office populations are higher during the day and almost non-existent during the night so the deaths number is lower in comparison with at night earthquake, while the injuries are higher at day time, scenario (1 and 6). In addition , the change of earthquake direction has no effect on the averages of (MMI) values , because it depends on the nature of the wave path, while the (MDR%) ratio change depending on the direction   of building distribution relative to the earthquake direction, in which the ratio increase, when the two directions are parallel . For example, buildings in Al utaifya and Al – Salam sectors are in SE direction, so the (MDR%) as shown in scenario (7) where the earthquake direction is SE is greater than it's ratio in scenario (1) where the earthquake direction is NE scenario (1 and 7).
From above results, it can be concluded that the best areas for construction are those with medium soils.

Conclusions:
For the study area (al-kathmia), the followimg conclusion has been found :
1. The (MMI) value increases (ftom 6.8 to 7.1) in soft soils areas in comparison with other soil types (medium and hard soil) that range between (7.2 – 7.5) .
2. For the same earthquake magnitude (5 Richter scale) and earthquake distance (10 km), the average (MMI) value increases (from 7.0 to 7.2) as the earthquake depth decreases for all soil types.
3. The Life line destruction ratios increase as the earthquake magnitude increases, scenario (1 &2) in appendex.
4. The injury and death number during any earthquake magnitude is higher at night than at day.
5. The best areas for constructions are those that have medium and hard soils, where it can resist the earthquake. Area with soft soils should be avoided when we want to choose the sites to build the life saving establishments and general public buildings, like schools and hospitals.
6. The seismic building code should be followed for structures to be built on soft soils areas.

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APPENDEX

Region (City) Name : Kadhmia	**Earthquake Name : Manjil Earthquake**
Total Population Counts : 1000000	**Earthquake depth : 5**
Total Building Count : 129417	**Occurrence Time : 11.5**
Total Mesh : 41	**EQ Magnitude : 5**
Spacing of Mesh(km) : 1	**EQ Direction relative from Ref. Mesh : North East**
Reference Mesh : 20	**EQ Distance(km) to Ref. Mesh : 10**

Scenario 1

Used Attenuation Equation : Joyner & Boore - 1981

Building Damage Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	0	227	0	227
b	227	454	227	454
c	454	681	454	681
d	681	908	681	908

The total building count are 129417 and 9% damaged

Sr.No	AreaID	Area Name	Bldg Counts	Damaged Counts	MDR (%)
1	1	alhuria	60194	3016	5.0
2	2	alzahraa	18058	2039	11.3
3	3	alkadhmia	13544	2013	14.9
4	4	alsalam	15048	1540	10.2
5	5	alutaifia	16553	2370	14.3
6	6	alfajer	6019	692	11.5
Summary Information			**129417**	**11671**	**9.0**

MMI Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	6.6	6.8	6.6	6.8
b	6.8	7.1	6.8	7.1
c	7.1	7.3	7.1	7.3
d	7.3	7.6	7.3	7.6

Average MMI is 7.09

Sr.No	AreaID	Area Name	Average Distance	Average PGA (g)	Average MMI
1	1	alhuria	11.9	0.1	6.8
2	2	alzahraa	9.8	0.1	7.1
3	3	alkadhmia	8.2	0.2	7.5
4	4	alsalam	11.0	0.2	7.2
5	5	alutaifia	9.0	0.2	7.4
6	6	alfajer	10.2	0.2	7.3
Average Information			**10.4**	**0.14**	**7.1**

Life Line Inventory and Damage

Earthquake Time is 11.5

LifeLine	Note	Total Count	Damage Number	Unit	Damage Ratio (%)
Road1	Length of Local Roads (in km)	462	11.4	km	2.5
Road2	Length of major roads such as Freeways/ Highways (in km)	34	0.5	km	1.5
Bridge	Number of major Transportation Bridges (road and railway)	1	0.0	Count	5.0
Tunnels	Number of major Transportation Tunnels	0	0.0	Count	0.4
Electric1	Number of major Electrical & Telecommunication transmission towers	1	0.0	Count	1.5
Electric2	Number of Electrical & Telecommunication sub-stations	2	0.2	Site	11.6
Water1	Length of major Water & Sewage trunk and distribution lines (km)	250	2.2	km	0.9
Water2	Number of Water & Sewage pumping stations	1	0.1	Site	6.7
Water3	Number of Water & Sewage treatment plants	1	0.0	Site	3.8
Reservoir1	Number of Storage Reservoirs or Dams	0	0.0	Count	4.3
Reservoir2	Number of Terminal Reservoirs or Elevated Storage Tanks	0	0.0	Count	2.0
Gasoline	Number of Gasoline stations	4	0.4	Count	9.6

EQ Name is Manjil Earthquake
EQ Magnitude is 5
Earthquake Time is 11.5

Region (City) Name : Kadhmia	Earthquake Name : Manjil Earthquake
Total Population Counts : 1000000	Earthquake depth : 5
Total Building Count : 129417	Occurrence Time : 11.5
Total Mesh : 41	EQ Magnitude : 7
Spacing of Mesh(km) : 1	EQ Direction relative from Ref.Mesh : North East
Reference Mesh : 20	EQ Distance(km) to Ref.Mesh : 10

Scenario 2

Used Attenuation Equation : Joyner & Boore - 1981

Building Damage Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	0	604	0	604
b	604	1209	604	1209
c	1209	1813	1209	1813
d	1813	2417	1813	2417

The total building count are 129417 and 35% damaged

Sr.No	AreaID	Area Name	Bldg Counts	Damaged Counts	MDR (%)
1	1	alhuria	60194	18949	31.5
2	2	alzahraa	18058	6712	37.2
3	3	alkadhmia	13544	5418	40.0
4	4	alsalam	15048	5734	38.1
5	5	alutaifia	16553	6736	40.7
6	6	alfajer	6019	2378	39.5
Summary Information			129417	45928	35.5

MMI Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	8.3	8.5	8.3	8.5
b	8.5	8.8	8.5	8.8
c	8.8	9.0	8.8	9.0
d	9.0	9.3	9.0	9.3

Average MMI is 8.75

Sr.No	AreaID	Area Name	Average Distance	Average PGA (g)	Average MMI
1	1	alhuria	11.9	0.3	8.4
2	2	alzahraa	9.8	0.5	8.8
3	3	alkadhmia	8.2	0.6	9.1
4	4	alsalam	11.0	0.5	8.9
5	5	alutaifia	9.0	0.6	9.1
6	6	alfajer	10.2	0.5	9.0
Average Information			10.4	0.5	8.8

Life Line Inventory and Damage

Earthquake Time is 11.5

LifeLine	Note	Total Count	Damage Number	Unit	Damage Ratio (%)
Road1	Length of Local Roads (in km)	462	53.6	km	11.6
Road2	Length of major roads such as Freeways/ Highways (in km)	34	1.8	km	5.2
Bridge	Number of major Transportation Bridges (road and railway)	1	0.2	Count	23.2
Tunnels	Number of major Transportation Tunnels	0	0.0	Count	3.3
Electric1	Number of major Electrical & Telecommunication transmission towers	1	0.0	Count	4.3
Electric2	Number of Electrical & Telecommunication sub-stations	2	0.6	Site	30.4
Water1	Length of major Water & Sewage trunk and distribution lines (km)	250	11.2	km	4.5
Water2	Number of Water & Sewage pumping stations	1	0.2	Site	18.6
Water3	Number of Water & Sewage treatment plants	1	0.1	Site	11.8
Reservoir1	Number of Storage Reservoirs or Dams	0	0.0	Count	10.0
Reservoir2	Number of Terminal Reservoirs or Elevated Storage Tanks	0	0.0	Count	8.2
Gasoline	Number of Gasoline stations	4	1.2	Count	28.9

EQ Name is Manjil Earthquake

EQ Magnitude is 7

Earthquake Time is 11.5

Region (City) Name : Kadhmia	**Earthquake Name : Manjil Earthquake**
Total Population Counts : 1000000	**Earthquake depth : 2**
Total Building Count : 129417	**Occurrence Time : 11.5**
Total Mesh : 41	**EQ Magnitude : 5**
Spacing of Mesh(km) : 1	**EQ Direction relative from Ref. Mesh : North East**
Reference Mesh : 20	**EQ Distance(km) to Ref. Mesh : 10**

Scenario 3

Used Attenuation Equation : Joyner & Boore - 1981

Building Damage Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	0	261	0	261
b	261	522	261	522
c	522	783	522	783
d	783	1044	783	1044

The total building count are 129417 and 10% damaged

Sr.No	AreaID	Area Name	Bldg Counts	Damaged Counts	MDR (%)
1	1	alhuria	60194	3216	5.3
2	2	alzahraa	18058	2381	13.2
3	3	alkadhmia	13544	2332	17.2
4	4	alsalam	15048	1831	12.2
5	5	alutaifia	16553	2761	16.7
6	6	alfajer	6019	826	13.7
Summary Information			**129417**	**13346**	**10.3**

MMI Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	6.7	6.9	6.7	6.9
b	6.9	7.2	6.9	7.2
c	7.2	7.5	7.2	7.5
d	7.5	7.8	7.5	7.8

Average MMI is 7.2

Sr.No	AreaID	Area Name	Average Distance	Average PGA (g)	Average MMI
1	1	alhuria	11.0	0.1	6.9
2	2	alzahraa	8.6	0.2	7.2
3	3	alkadhmia	6.8	0.2	7.6
4	4	alsalam	10.0	0.2	7.3
5	5	alutaifia	7.8	0.2	7.6
6	6	alfajer	9.1	0.2	7.4
Average Information			**9.3**	**0.15**	**7.2**

Life Line Inventory and Damage

Earthquake Time is 11.5

LifeLine	Note	Total Count	Damage Number	Unit	Damage Ratio (%)
Road1	Length of Local Roads (in km)	462	12.8	km	2.8
Road2	Length of major roads such as Freeways/ Highways (in km)	34	0.6	km	1.7
Bridge	Number of major Transportation Bridges (road and railway)	1	0.1	Count	5.5
Tunnels	Number of major Transportation Tunnels	0	0.0	Count	0.5
Electric1	Number of major Electrical & Telecommunication transmission towers	1	0.0	Count	1.6
Electric2	Number of Electrical & Telecommunication sub-stations	2	0.3	Site	12.6
Water1	Length of major Water & Sewage trunk and distribution lines (km)	250	2.5	km	1.0
Water2	Number of Water & Sewage pumping stations	1	0.1	Site	7.2
Water3	Number of Water & Sewage treatment plants	1	0.0	Site	4.1
Reservoir1	Number of Storage Reservoirs or Dams	0	0.0	Count	4.6
Reservoir2	Number of Terminal Reservoirs or Elevated Storage Tanks	0	0.0	Count	2.2
Gasoline	Number of Gasoline stations	4	0.4	Count	10.8

EQ Name is Manjil Earthquake
EQ Magnitude is 5
Earthquake Time is 11.5

Region (City) Name : Kadhmia	**Earthquake Name : Manjil Earthquake**
Total Population Counts : 1000000	**Earthquake depth : 5**
Total Building Count : 129417	**Occurrence Time : 11.5**
Total Mesh : 41	**EQ Magnitude : 5**
Spacing of Mesh(km) : 1	**EQ Direction relative from Ref. Mesh : North East**
Reference Mesh : 20	**EQ Distance(km) to Ref. Mesh : 100**

Scenario 4

Used Attenuation Equation : Joyner & Boore - 1981

Building Damage Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	0	-3	0	-3
b	-3	2	-3	2
c	2	6	2	6
d	6	11	6	11

The total building count are 129417 and 0% damaged

Sr.No	AreaID	Area Name	Bldg Counts	Damaged Counts	MDR (%)
1	1	alhuria	60194	-72	0
2	2	alzahraa	18058	13	0.07
3	3	alkadhmia	13544	22	0.2
4	4	alsalam	15048	12	0.08
5	5	alutaifia	16553	24	0.14
6	6	alfajer	6019	4	0.07
Summary Information			**129417**	**4**	**0.003**

MMI Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	3.1	3.3	3.1	3.3
b	3.3	3.4	3.3	3.4
c	3.4	3.5	3.4	3.5
d	3.5	3.7	3.5	3.7

Average MMI is 3.38

Sr.No	AreaID	Area Name	Average Distance	Average PGA (g)	Average MMI
1	1	alhuria	100.8	0.009	3.2
2	2	alzahraa	98.3	0.01	3.4
3	3	alkadhmia	96.4	0.01	3.6
4	4	alsalam	99.8	0.01	3.6
5	5	alutaifia	97.4	0.01	3.6
6	6	alfajer	98.7	0.01	3.6
Average Information			**99.0**	**0.01**	**3.4**

Life Line Inventory and damage

Earthquake Time is 11.5

LifeLine	Note	Total Count	Damage Number	Unit	Damage Ratio (%)
Road1	Length of Local Roads (in km)	462	0.0	km	0.0
Road2	Length of major roads such as Freeways/ Highways (in km)	34	0.0	km	0.0
Bridge	Number of major Transportation Bridges (road and railway)	1	0.0	Count	0.0
Tunnels	Number of major Transportation Tunnels	0	0.0	Count	0.0
Electric1	Number of major Electrical & Telecommunication transmission towers	1	0.0	Count	0.0
Electric2	Number of Electrical & Telecommunication sub-stations	2	0.0	Site	-0.1
Water1	Length of major Water & Sewage trunk and distribution lines (km)	250	0.0	km	0.0
Water2	Number of Water & Sewage pumping stations	1	0.0	Site	-0.2
Water3	Number of Water & Sewage treatment plants	1	0.0	Site	-0.1
Reservoir1	Number of Storage Reservoirs or Dams	0	0.0	Count	0.0
Reservoir2	Number of Terminal Reservoirs or Elevated Storage Tanks	0	0.0	Count	0.0
Gasoline	Number of Gasoline stations	4	0.0	Count	0.0

EQ Name is Manjil Earthquake
EQ Magnitude is 5
Earthquake Time is 11.5

Region (City) Name : Kadhmia	**Earthquake Name : Manjil Earthquake**
Total Population Counts : 1000000	**Earthquake depth : 5**
Total Building Count : 129417	**Occurrence Time : 11.5**
Total Mesh : 41	**EQ Magnitude : 5**
Spacing of Mesh(km) : 1	**EQ Direction relative from Ref.Mesh : North East**
Reference Mesh : 20	**EQ Distance(km) to Ref.Mesh : 3**
Used Attenuation Equation : Joyner & Boore - 1981	

Scenario 5

Building Damage Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	0	332	0	332
b	332	664	332	664
c	664	996	664	996
d	996	1328	996	1328

The total building count are 129417 and 16% damaged

Sr.No	AreaID	Area Name	Bldg Counts	Damaged Counts	MDR (%)
1	1	alhuria	60194	7278	12.1
2	2	alzahraa	18058	3417	18.9
3	3	alkadhmia	13544	2795	20.6
4	4	alsalam	15048	3046	20.2
5	5	alutaifia	16553	3565	21.5
6	6	alfajer	6019	1252	20.8
Summary Information			**129417**	**21353**	**16.5**

MMI Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	7.2	7.3	7.2	7.3
b	7.3	7.5	7.3	7.5
c	7.5	7.7	7.5	7.7
d	7.7	7.8	7.7	7.8

Average MMI is 7.55

Sr.No	AreaID	Area Name	Average Distance	Average PGA (g)	Average MMI
1	1	alhuria	6.6	0.2	7.3
2	2	alzahraa	5.5	0.2	7.6
3	3	alkadhmia	5.3	0.2	7.8
4	4	alsalam	6.0	0.2	7.8
5	5	alutaifia	5.3	0.2	7.8
6	6	alfajer	5.7	0.2	7.8
Average Information			**5.9**	**0.2**	**7.6**

Life Line Inventory and Damage

Earthquake Time is 11.5

LifeLine	Note	Total Count	Damage Number	Unit	Damage Ratio (%)
Road1	Length of Local Roads (in km)	462	17.9	km	3.9
Road2	Length of major roads such as Freeways/ Highways (in km)	34	0.8	km	2.2
Bridge	Number of major Transportation Bridges (road and railway)	1	0.1	Count	7.2
Tunnels	Number of major Transportation Tunnels	0	0.0	Count	1.0
Electric1	Number of major Electrical & Telecommunication transmission towers	1	0.0	Count	2.1
Electric2	Number of Electrical & Telecommunication sub-stations	2	0.3	Site	15.8
Water1	Length of major Water & Sewage trunk and distribution lines (km)	250	3.6	km	1.4
Water2	Number of Water & Sewage pumping stations	1	0.1	Site	9.1
Water3	Number of Water & Sewage treatment plants	1	0.1	Site	5.2
Reservoir1	Number of Storage Reservoirs or Dams	0	0.0	Count	5.4
Reservoir2	Number of Terminal Reservoirs or Elevated Storage Tanks	0	0.0	Count	3.2
Gasoline	Number of Gasoline stations	4	0.6	Count	14.7

EQ Name is Manjil Earthquake
EQ Magnitude is 5
Earthquake Time is 11.5

Region (City) Name : Kadhmia	**Earthquake Name : Manjil Earthquake**
Total Population Counts : 1000000	**Earthquake depth : 5**
Total Building Count : 129417	**Occurrence Time : 2.5**
Total Mesh : 41	**EQ Magnitude : 5**
Spacing of Mesh(km) : 1	**EQ Direction relative from Ref .Mesh : North East**
Reference Mesh : 20	**EQ Distance(km) to Ref. Mesh : 10**
Used Attenuation Equation : Joyner & Boore - 1981	

Scenario 6

Building Damage Summary

Color ID	Automatic Range		Manual Range	
	From	**To**	**From**	**To**
a	0	227	0	227
b	227	454	227	454
c	454	681	454	681
d	681	908	681	908

The total building count are 129417 and 9% damaged

Sr.No	AreaID	Area Name	Bldg Counts	Damaged Counts	MDR (%)
1	1	alhuria	60194	3016	5.0
2	2	alzahraa	18058	2039	11.3
3	3	alkadhmia	13544	2013	14.9
4	4	alsalam	15048	1540	10.2
5	5	alutaifia	16553	2370	14.3
6	6	alfajer	6019	692	11.5
Summary Information			**129417**	**11671**	**9.0**

MMI Summary

Color ID	Automatic Range		Manual Range	
	From	**To**	**From**	**To**
a	6.6	6.8	6.6	6.8
b	6.8	7.1	6.8	7.1
c	7.1	7.3	7.1	7.3
d	7.3	7.6	7.3	7.6

Average MMI is 7.09

Sr.No	AreaID	Area Name	Average Distance	Average PGA (g)	Average MMI
1	1	alhuria	11.9	0.1	6.8
2	2	alzahraa	9.8	0.1	7.1
3	3	alkadhmia	8.2	0.2	7.5
4	4	alsalam	11.0	0.2	7.2
5	5	alutaifia	9.0	0.2	7.4
6	6	alfajer	10.2	0.2	7.3
Average Information			**10.4**	**0.1**	**7.1**

Life Line Inventory and Damage

Earthquake Time is 2.5

LifeLine	Note	Total Count	Damage Number	Unit	Damage Ratio (%)
Road1	Length of Local Roads (in km)	462	11.4	km	2.5
Road2	Length of major roads such as Freeways/ Highways (in km)	34	0.5	km	1.5
Bridge	Number of major Transportation Bridges (road and railway)	1	0.0	Count	5.0
Tunnels	Number of major Transportation Tunnels	0	0.0	Count	0.4
Electric1	Number of major Electrical & Telecommunication transmission towers	1	0.0	Count	1.5
Electric2	Number of Electrical & Telecommunication sub-stations	2	0.2	Site	11.6
Water1	Length of major Water & Sewage trunk and distribution lines (km)	250	2.2	km	0.9
Water2	Number of Water & Sewage pumping stations	1	0.1	Site	6.7
Water3	Number of Water & Sewage treatment plants	1	0.0	Site	3.8
Reservoir1	Number of Storage Reservoirs or Dams	0	0.0	Count	4.3
Reservoir2	Number of Terminal Reservoirs or Elevated Storage Tanks	0	0.0	Count	2.0
Gasoline	Number of Gasoline stations	4	0.4	Count	9.6

EQ Name is Manjil Earthquake
EQ Magnitude is 5
Earthquake Time is 2.5

Region (City) Name : Kadhmia	Earthquake Name : Manjil Earthquake
Total Population Counts : 1000000	Earthquake depth : 5
Total Building Count : 129417	Occurrence Time : 11.5
Total Mesh : 41	EQ Magnitude : 5
Spacing of Mesh(km) : 1	EQ Direction relative from Ref.Mesh : South East
Reference Mesh : 20	EQ Distance(km) to Ref.Mesh : 10
Used Attenuation Equation : Joyner & Boore - 1981	

Scenario 7

Building Damage Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	0	164	0	164
b	164	327	164	327
c	327	491	327	491
d	491	655	491	655

The total building count are 129417 and 7% damaged

Sr.No	AreaID	Area Name	Bldg Counts	Damaged Counts	MDR (%)
1	1	alhuria	60194	2839	4.7
2	2	alzahraa	18058	1549	8.6
3	3	alkadhmia	13544	1111	8.2
4	4	alsalam	15048	1817	12.1
5	5	alutaifia	16553	2011	12.1
6	6	alfajer	6019	737	12.2
Summary Information			129417	10065	7.8

MMI Summary

Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	6.5	6.8	6.5	6.8
b	6.8	7.0	6.8	7.0
c	7.0	7.2	7.0	7.2
d	7.2	7.5	7.2	7.5

Average MMI is 6.95

Sr.No	AreaID	Area Name	Average Distance	Average PGA (g)	Average MMI
1	1	alhuria	12.7	0.1	6.7
2	2	alzahraa	12.7	0.1	6.8
3	3	alkadhmia	13.0	0.1	7.0
4	4	alsalam	9.7	0.2	7.4
5	5	alutaifia	10.2	0.2	7.3
6	6	alfajer	9.4	0.2	7.4
Average Information			11.9	0.13	7.0

Life Line Inventory and Damage

Earthquake Time is 11.5

LifeLine	Note	Total Count	Damage Number	Unit	Damage Ratio (%)
Road1	Length of Local Roads (in km)	462	9.6	km	2.1
Road2	Length of major roads such as Freeways/ Highways (in km)	34	0.4	km	1.3
Bridge	Number of major Transportation Bridges (road and railway)	1	0.0	Count	4.3
Tunnels	Number of major Transportation Tunnels	0	0.0	Count	0.2
Electric1	Number of major Electrical & Telecommunication transmission towers	1	0.0	Count	1.3
Electric2	Number of Electrical & Telecommunication sub-stations	2	0.2	Site	10.5
Water1	Length of major Water & Sewage trunk and distribution lines (km)	250	1.8	km	0.7
Water2	Number of Water & Sewage pumping stations	1	0.1	Site	6.0
Water3	Number of Water & Sewage treatment plants	1	0.0	Site	3.4
Reservoir1	Number of Storage Reservoirs or Dams	0	0.0	Count	3.9
Reservoir2	Number of Terminal Reservoirs or Elevated Storage Tanks	0	0.0	Count	1.6
Gasoline	Number of Gasoline stations	4	0.3	Count	8.2

EQ Name is Manjil Earthquake
EQ Magnitude is 5
Earthquake Time is 11.5