Preliminary Invitation and Call for Papers

Safety, Risk and Reliability – Trends in Engineering

Mdina, the ancient capital of Malta

International Conference

Malta **March 21–23, 2001**

Organised by the International Association for Bridge and Structural Engineering (IABSE)

On behalf of

CIB	International Council for Research and Innovation in Building and Construction
ECCS	European Convention for Constructional Steelwork
fib	International Federation for Structural Concrete
IABSE	International Association for Bridge and Structural Engineering
RILEM	International Union of Testing and Research Laboratories for Materials and Structures

and

JCSS	Joint Committee on Structural Safety
ESRA	European Safety and Reliability Association
CERRA	Civil Engineering Risk and Reliability Association

MALTA'S RISK MINIMISATION TO EARTHQUAKE, VOLCANIC, TSUNAMI DAMAGE

Malta cannot run the risk of being unprepared for the effects of a medium-sized, earthquake-related hazard. With the economy concentrated in a small region, a high dependency on real estate due to the high price of land, the situation is even worse than in other localities, as help from other parts of the country cannot remedy the situation. The current rebuilding cost under normal conditions of only the residential market works out at twice the National GDP.

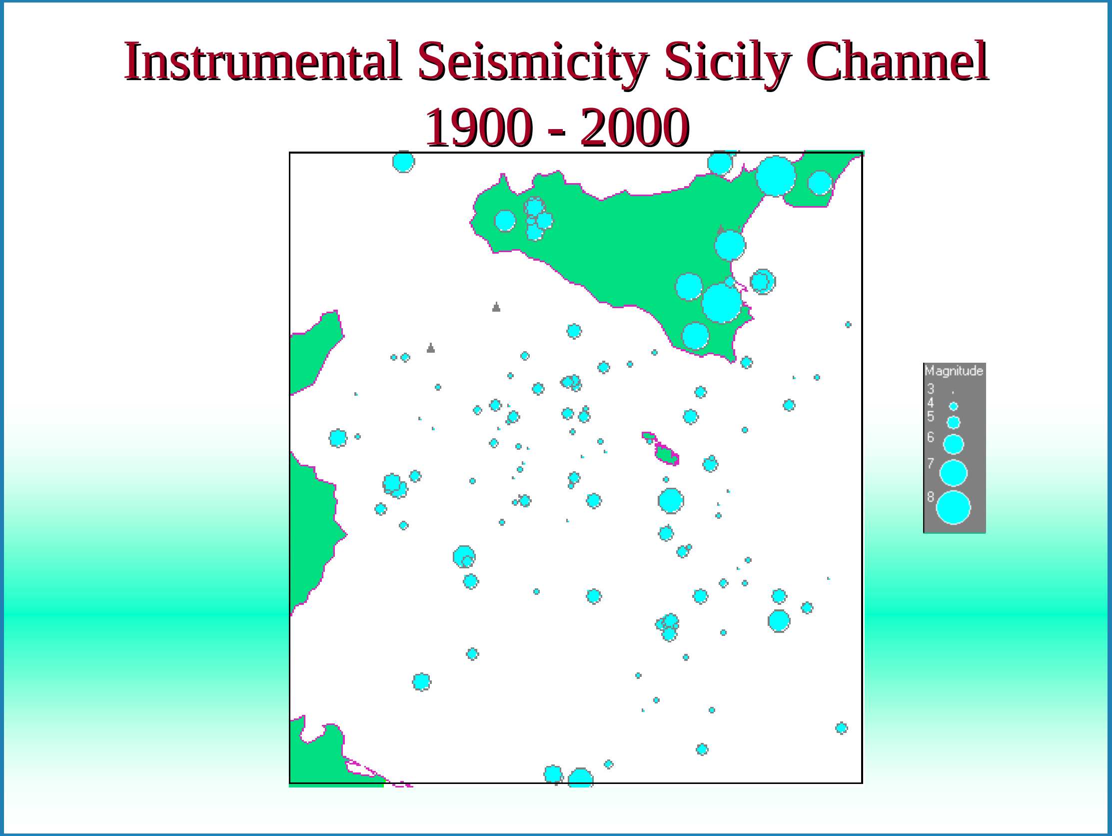
Defining Disaster Risks:

A disaster occurs when 1 or more occur in an event

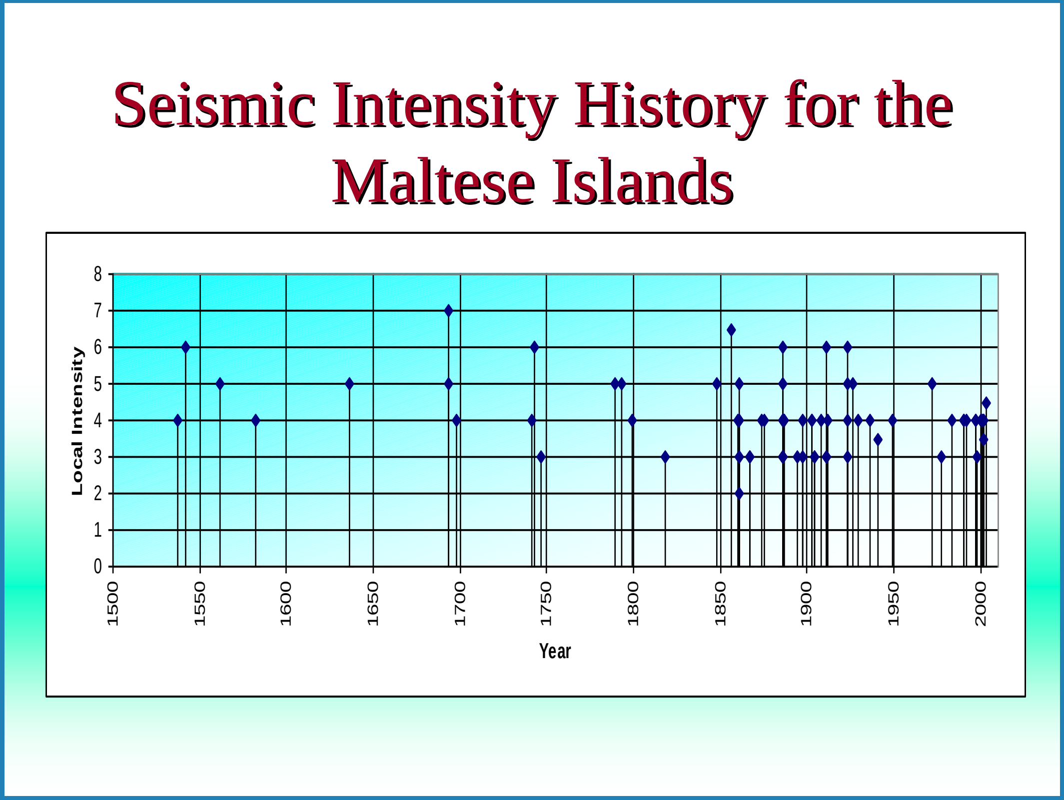
- 10 or more fatalities
- damage costs exceed $ 1 million
- 50 or more people evacuated

The fatal accident rate (FAR) is defined as the risk of death per 100 million hours of exposure to the activity

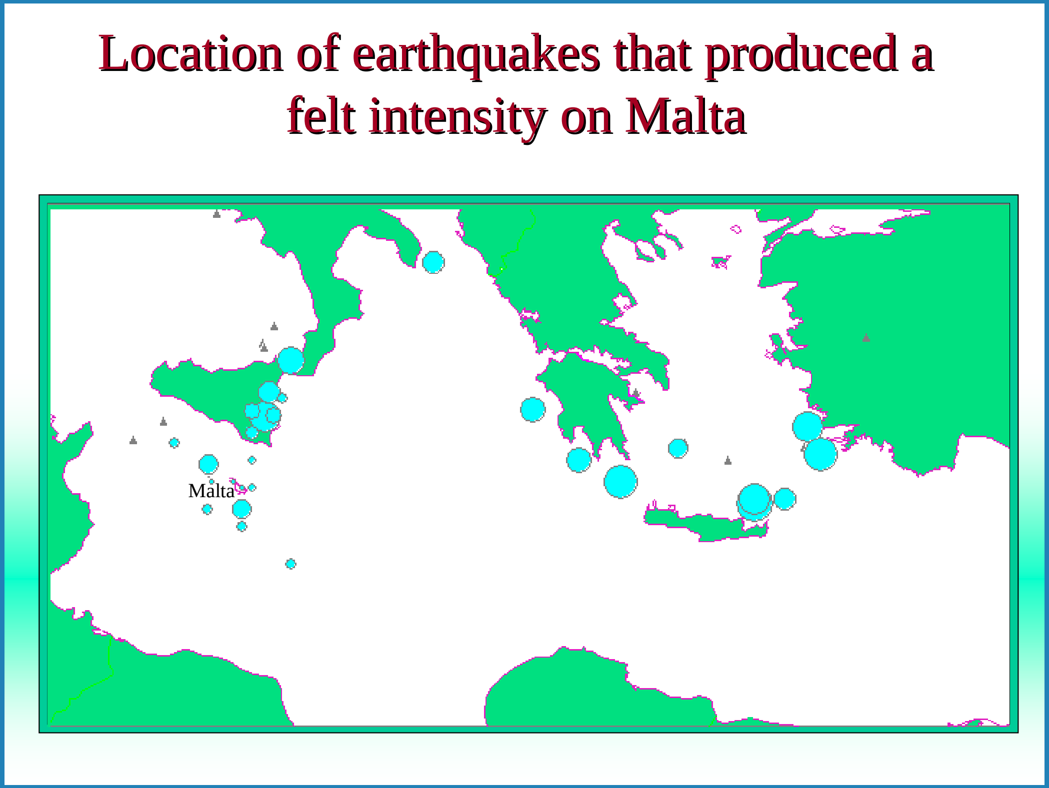
INSTRUMENTAL SEISMICITY SICILY CHANNEL 1900-2000



SEISMIC INTENSITY HISTORY FOR THE MALTESE ISLANDS



LOCATIONS OF EARTHQUAKES THAT PRODUCED A FELT INTENSITY ON MALTA



MALTA'S EARTHQUAKE RELATED HAZARDS DATA

- A seismic risk analysis has not yet been drawn up for the Maltese Islands
- Parker defines a rule of thumb as a shot in the dark tempered by experience, judgement or raw ingenuity which works 4 out of 5 times
- Further considering historical data & noting that earthquake striking Malta in 1693 had a MMVII, the following return periods for Earthquake Intensity are assumed

Table 2 – *Return Periods for Earthquake Intensity*

MM-Earthquake Intensity	Return Period (years)	% of gravity	RISK CLASSIFICATION *
VI	333	2-5	-
VII	1,800	5-10	Negligible (0.0077)
VIII	100,000	10-20	Insignificant (0.00073)

* High Risk – rock climbing (4000)
Tolerable risk - travelling by car & plane (15)
Low risk - travelling by bus (1)
Minimal risk - terrorist bomb (0.1)

Table 3 – Classification of Building according to anticipated Earthquake Intensity Damage

Type	Description	Base shear design % of gravity
A	**Building of fieldstones, rubble masonry, adobe and clay**	**0.5%**
B	***Ordinary unreinforced brick buildings, buildings of concrete blocks, simple stone masonry and such buildings incorporating structural members of wood;***	***0.7%***
C	***Buildings with structural members of low-quality concrete and simple reinforcements with no allowance for earthquake forces, and wooden buildings, the strength of which has been noticeable affected by deterioration;***	***0.9%***
D_1	***Buildings with a frame (structural members) of reinforced concrete***	***2-3***

Buildings found in Malta are mostly found in types B & D, shown in italics. Further buildings classified as D_2 up to D_5 with a D_5 building frame able to withstand a 20% gravity base shear.

Table 4 – Mean Damage Ratio (MDR) & Death Rates for building types B & C

Building Type	**B**			**C**		
Earthquake Intensity MM	MDR	Death Rate	Mean damage costs as % of re-building costs	**MDR**	Death Rate	Mean damage costs as % of re-building costs
5	2%	-	2.5%	**-**	-	-
6	4%	-	6%	**1%**	-	1.25%
7	20%	0.03%	40%	**10%**	-	15%
8	45%	1%	135%	**25%**	0.4%	62.5%

For a type 'B' building non structural damage would amount to 50% of MDR, increasing to 70% for a type 'C' building

As the quality of a building goes up, the contribution of non-structural damage increasing, the death rate reduces, but a higher number of injuries occur

Table 5 – Quantification of losses for Earthquake Intensity

Earthquake Intensity	Loss to residential premises only	Total Losses	No of Casualties
MMV	Lm4,500,000	1% GDP	0 persons
MMVI	Lm35,000,000	6% GDP	0 persons
MMVII	Lm400,000,000	70% GDP	45 persons
MMVIII	Lm1,600,000,000	300% GDP	2,370 persons

- Total losses are calculated as tending towards double the amount, together with a business interruption loss as much as the direct losses.
- The above fatalities & staggering financial losses classify event as a disaster
- To be noted that losses amounting to 2% of GDP for large modern economies are crippling

RECORDED MEDITERRANEAN TSUNAMI DAMAGE

- 20% have been damaging
- Height exceeding 20m has been reached in Eastern Mediterranean (latest 1956 Greek Coastline)
- MESSINA EARTHQUAKE MM 7.5, 1908 caused waves of more than 10m height, washing up 200m inland

RETURN PERIOD FOR APPROXIMATE TSUNAMI RUN-UP HEIGHT

- 100 years - 1.5m high
- 500 years - 4.0m high
- 1,000 years - 7.0m high

Source: Swiss Re (1992)

In the 1693 Malta earthquake it is reported how the sea at Xlendi rolled out to about a mile and rolled back a little later with great force and movement.

MEDITERRANEAN VOLCANIC DATA

- There are 13 active volcanoes in the Central Mediterranean
- This equates to a chain density of 68km as compared to: 37km in Central America

  42km in Japan

  & 88km in North New Zealand
- Mount Etna is situated 220km due North of Malta, the Aeolian Islands are 340km away with the Vesuvius further up at 570km

RETURN PERIODS FOR THE VOLCANIC EXPLOSIVELY INDEX (VEI) OF THE CENTRAL MEDITERRANEAN

VEI	2	3	4	5	6	7	8
R-YRS	80	750	5,000	45,000	650,000	16.10^6	8.10^{10}

Source: Swiss Re (1992)

- Mount Etna over the past 3,500 years, has not exceeded VEI 3, but it has the capacity of much larger explosions
- Damage that may be caused appears limited to a reduction on visibility, temperature effects, ashfall and/or build-up of corrosive & noxious gases

Table 7 – Characteristics of the Sub-Divided Regions of the Maltese Islands

Region – km^2	Population Density Person/km	Age Structure of dwellings - % built after 1960	% Substandard & inadequate occupied dwellings	% of poor households earning < Lm2,500 p.a.	% of vacant dwellings- bracketed % bad condition
A - 158.7	2126	56	6.4	24	17.17 (8.11)
B - 33.0	476	56	6.1	24	11.6 (19.4)
C - 54.6	298	76	3.6	22	61 (1.6)
Gozo - 68.7	422	60	5.9	33	39.3 (5.86)

- Earthquake damage due to high population densities would effect mostly the building infrastructure
- Due to a large number of vacant dwellings in a good condition outside the Harbour Area (Region A) would help relocation of evacuated population
- Present population is housed at 0.65 persons/room, well below the overcrowding statistic of 4 persons/room

Malta's Map

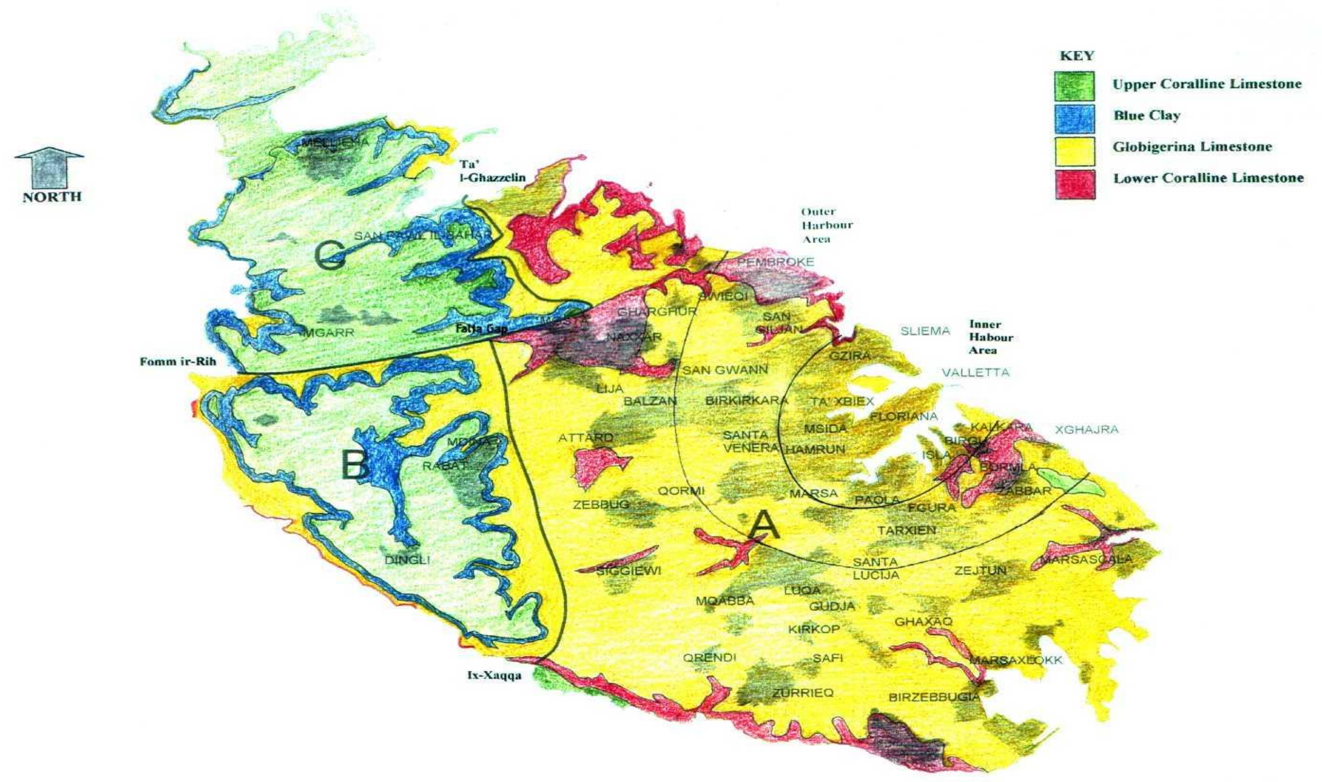


Fig. 1 Malta : A simplified geological map.

Gozo's Map

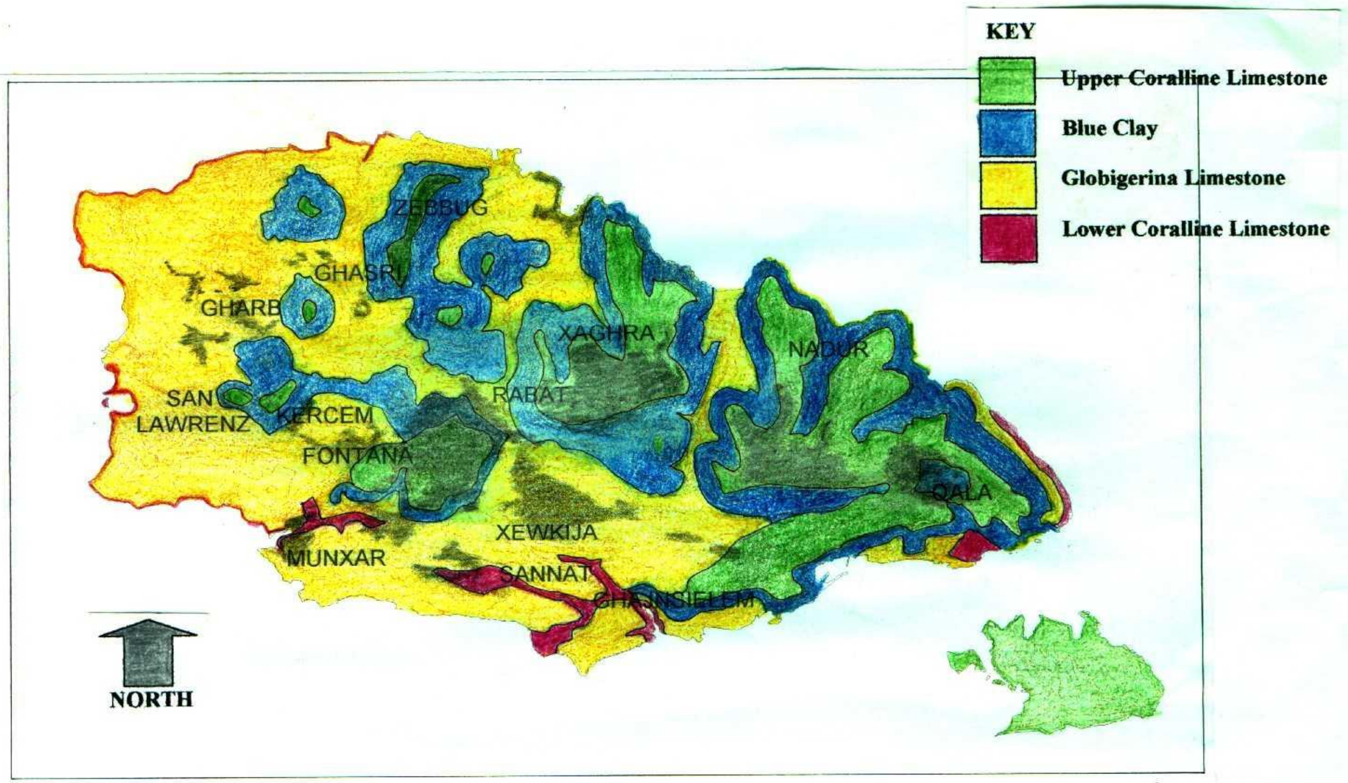


Fig. 2 Gozo: A simplified geological map.

HOMELESS STOCK ANALYSIS DUE TO AN EARTHQUAKE

- Households made homeless assumed when MDR exceeds 50%
- Households made homeless:

  MMVII estimated at 14,500

  MMVIII estimated at 30,000
- Stable vacant dwellings after an:

  MMVII estimated at 32,873

  MMVIII estimated at 28,723

DETERMINING THE APPROPRIATE LEVEL OF OUTSIDE RELIEF

- The ideal is for the community to get back on its own feet and not rely on a massive influx of misplaced, well-intentioned help
- For a community with % of casualties approaching 5% it is found to have crossed the threshold of system destruction
- For % casualties down to 0.00072% the community system remains largely intact
- For % of casualties at 0.7% systems are sufficiently damaged to require outside help
- At MMVII % of casualties estimated at 0.125% of population & at MMVIII % of casualties estimated at 3%

STRATEGIC PREPAREDENESS MANAGEMENT IN THE HEALTH SECTOR

- Casualties for an MMVII estimated at 450 persons

  MMVIII estimated at 11,000 persons
- The most prevalent earthquake injuries are fractures, cuts requiring orthopedists and plaster of Paris
- For Tsunami flooding anti-diarrhoeics and antibiotics required
- For a volcanic eruption skin diseases prevalent
- Not only should hospital be earthquake resistant, but access routes must be free from debris

RESCUE OF ENTRAPPED PERSONNEL

- The Maltese masonry building would collapse into a mould of rubble generating great quantities of dust, asphyxiating the victims
- Such loose rubble can, however, be easily removed with hand tools by survivors
- These type of rescue workers account for 97% of rescued victims
- Removal of the dead would have to be undertaken promptly

GOVERNMENT'S ROLE IN MITIGATION ACTIVITY

- Has the authority to regulate land use & building design
- Preparing planning tools before a disaster, which will ease the return to normality in an aftermath of a disaster, by not working under pressure
- Home-ownership rate (standing at 70%), together with **people's income, the building stock condition are all** important data for assessing the retrofitting of existing buildings before an event
- Furthermore higher educational standards help increase risk awareness, with residents being encouraged to purchase disaster insurance, for Government and effected people to have to bear less of the losses

CONCLUSION

It is strongly recommended that Malta does not await a major peril before seriously enhancing Strategic Preparedness and Mitigation Management for above perils