GENERAL ASPECTS OF SEISMIC RISK REDUCTION IN THREATENED REGIONS

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We would agree on the fact that **modern earthquake engineering was born** this century in 1906 in San Francisco with its magnitude 8 major quake. But more than 60 years of **groping in the dark** and 30 years of hard work were needed to build up real know-how in this field. We can be proud because almost all structures designed according to our new regulations withstood perfectly recent major earthquakes. Our Codes and Regulations, stated by our Grand Masters and continued by ourselves, contribute also to protecting human life against an unavoidable natural catastrophe.

Here 2 examples of uncommon bridges near San Francisco in 89.

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But such know-how did not come about suddenly in one package. Each event brought its surprises and we had to reappraise very often, with modesty, our own understanding and go back on what we had already said and written. The case of bridges in California is a significant example of how we had to question our fundamental beliefs : while the UBC code was considered as covering all types of structures, Niigata Japan (3), Sylmar California (4), and other major events, pushed Caltrans to elaborate modern regulations for bridges in 73. This was the beginning of a new period.

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It would be even more significant to have a look at the permanent review of the Californian Retrofitting Policy :

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◆ after Sylmar 71 with serious damage to the San Fernando interchange during its construction, independent multi-span bridges were considered as very vulnerable structures. Many bridges were « retrofitted » by linkage of independent spans either by cables (5) or by bolts (6). The 89 Loma Prieta quake showed the inefficiency of such systems.

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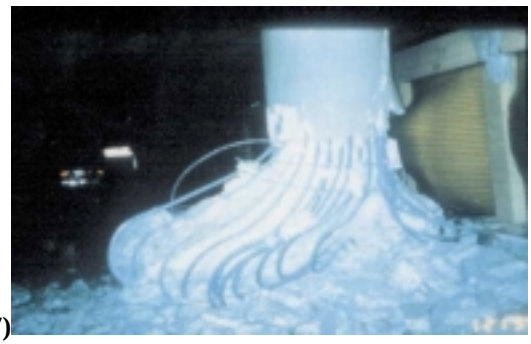
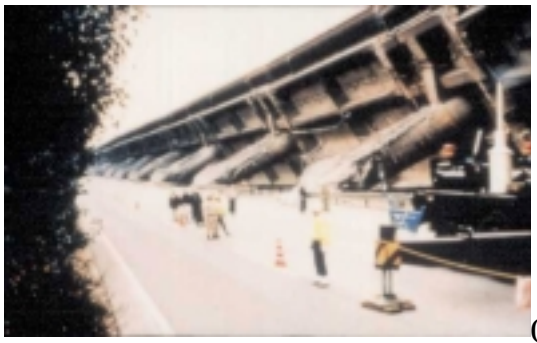
◆ with the 87 - **Whittier** quake, a large retrofit programme on single-pier-supported bridges was undertaken by using steel jackets. Here 2 examples of vulnerability of such bridges : Los Angeles 94 (7) and Kobé 95 (8).

(7)   **(8)**

◆ but with the 89 - **Loma Prieta** - quake (9), double-column-pier-supported bridges were proved to be sensitive too, and 5 years later, the **Northridge** quake confirmed this view (10).

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A large retrofitting program was undertaken in California 18 years after Sylmar. The right policy was finally found under the pressure of dramatic events, and Northridge proved the efficiency of this policy : none of about a 100 retrofitted bridges were damaged ; On Freeway 10, 2 Bridges collapsed, while the similar Cadillac Bridge, retrofitted just before, withstood perfectly the quake. Northridge was a useful full scale laboratory for Earthquake Engineering. But it showed also **3 more sources** of failure for reinforced concrete structures :

spiral hoops might be dangerous (11) yet the use of such confining reinforcement has been recommended in all codes including EC 8 ; A **missed detail** can bring failure (12) even if the overall seismic design is correctly conducted ; and finally Northridge rather than other quakes, proved the **vulnerability of short-stiff** piers (13)**.**

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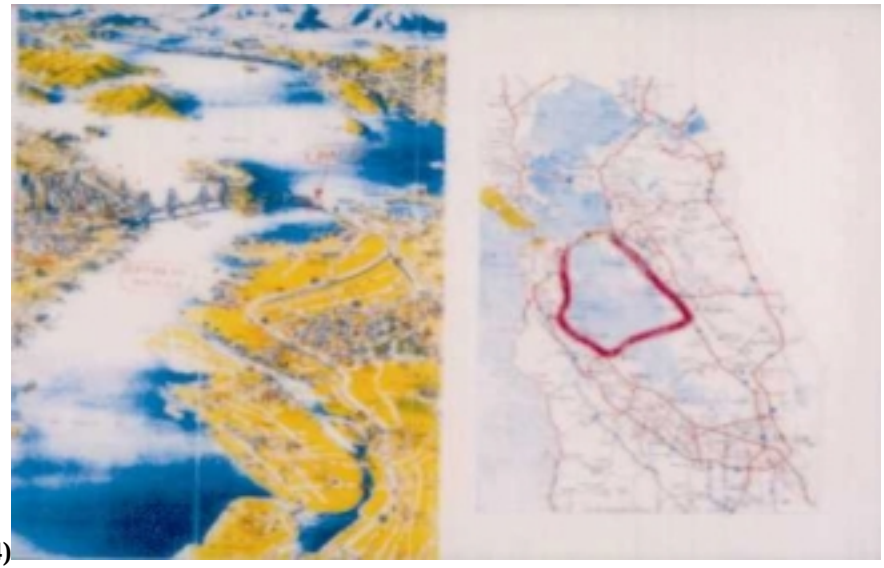
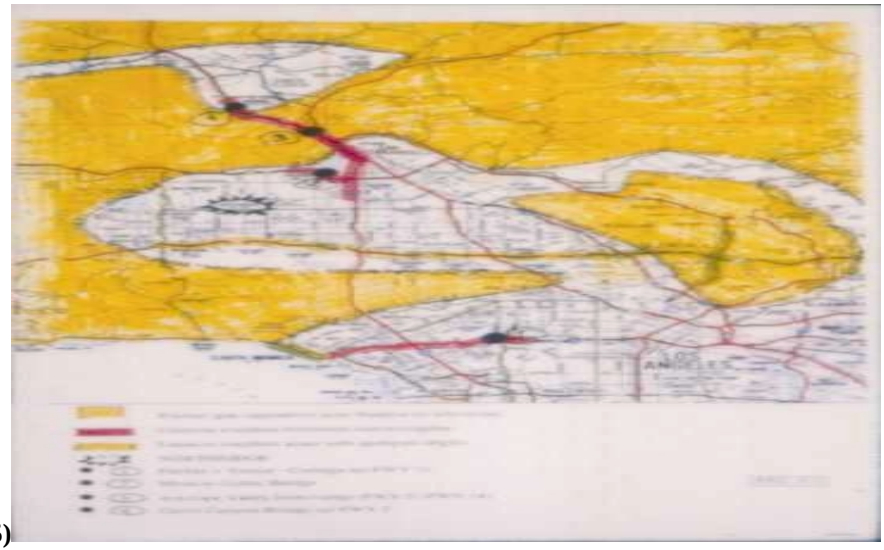
finally, in 95, **Kobe** also brought its own surprises such as the failure of welds and other connections in **steel structures**.

After each of these recent events, we all did our best to learn from the experience, but without being able to predict all major effects of the next event. **Our existing know-how** needs to be **improved by model tests and numerical simulations** permanently. The fees will be unsignificant if all countries involved in that field collaborate closely, together, and with the International Competent Commissions. But such programmes also need a very close collaboration between decision takers, researchers, insurance companies and professionals such as Designers, Architects and Contractors. Some programmes already exist but, what moral authority, better than the Earthquake Engineering Associations of different countries, to list the priorities in research in order to be sure of the usefulness of the final results and to help to **prevent rather than cure**.

Even so our problems will not be over. With recent earthquakes **a new kind of vulnerability** : **socio-economic vulnerability** of **MEGACITIES** have been dramatically demonstrated :

◆ In 89 in San Francisco, only a few bridges were damaged. It was the same in Los Angeles in 94 where only 9 bridges out of 3000 collapsed. The overall behaviour of bridges was then excellent during both events. But in San Francisco one of the damaged bridges was the **Bay Bridge** (14) with its 260 000 car/day traffic and another was the Cypress Bridge, an important element of Motorway Network through Oakland and Berkeley. In **Los Angeles** (15) all 9 damaged bridges were located on Freeways with their 350 000 car/day traffic for each.

(14) 

(15) 

In **Kobe** (16), all connections with the country were cut because of collapsed bridges. Even for the emergency services, Kobe was accessible only by sea.

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One can easily imagine what would happen in **Nice** - South of France - (17) if a major quake occures. For the moment nothing in our codes addresses such cases. There is a real need for **scenario analysis**, at least for specifying priorities for the upgrading of strategic structures.

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But what about **existing buildings** ? The **equality of all citizens,** pushes the public authorities, to upgrade existing buildings in seismic regions in order to give them the same resisting capacity as new construction. The **cost** of such an ambition, is likely to be so high that it is already considered to be economically unfeasible, at least when compared to **other strong priorities such as health, education**, etc. But the opposite solution of **doing nothing**, **or full protection for some**, is no more acceptable. The public authorities and legislators need our advice in order to choose **a feasible policy consisting on an equal partial reasonable protection for all**. The **investment** for such an operation might be covered easily : in France, for instance, an **insurance tax** of **9%** for natural disasters is applied since 87 to all construction. Rather than taking the tax now and **waiting for the disaster**, it would be more appropriate to invest this tax immediately in **prevention**. The policy will also have the advantage of bringing some activity to our profession which needs it all around Europe.

This item left for the next century will be indeed a very hard **challenge** for us, but before going too far in this subject, we will have to answer to the **disturbing question** :

while **alluvial basins** are already recognized as being **more vulnerable** to earthquake than expected from **most standards**, *why*, despite this **underestimation**, do structures, none of which would survive in our analyses, withstand, better than expected, actual earthquakes ? In **other words**, what is surprising is not the *structures that collapse* during an earthquake, but rather, *those that don't*.

All this, might be the priority for us - Western Countries - during the early years of the next century. But from a human point of view, **developing countries, subject to a greater threat**, constitute the actual emergency. Optimal solutions for such countries are not necessarily the same as in Europe, and have to be devised with respect to local practices and in collaboration with their specialists. But this will not be the most difficult step of the road.

The **worst problem** will surely be the **protection of millions of threatened people living in dangerous accommodations**.

It is out of question for developed countries to take in hand such reconstruction programmes directly, and none of the developing countries even ask for it. For a long time these countries had their **eyes turned towards developed countries technology**, and **their ears heard our slogans about freedom, human rights, equality**, and brotherhood. Disappointed, they turned to communism and its mirages. Our answer to this double disillusion cannot only come from Wall Street, the City, la Bourse de Paris and so on.

We must build a partnership with them. What about the idea of building a modest seismic designed **International Culture and Science House** in some of these regions. The aim would be to transmit seismic construction practice to them respecting their local materials and habits, and to build a cultural bridge between developed countries and emerging ones.

But to achieve such an ambition, we need to better value our own **technical background.**

The **stocks and share markets** are using the discoveries and inventions of our Intellectual Models.

Information Highways are the result of the theories of Maxwell, Thomson, Chadwick, Dirac, Einstein, Heisenberg, Mach, Bohr, de Broglie, Feynman, etc,

exploited by some industrial geniuses. We exploit this technology now, but must leave something to the new generation, to exploit during the next century.

The current type of investor would encourage our ideas on the condition of knowing where we are going before starting. But **Thomson had no exact idea about the electron before discovering it**, neither Einstein about Relativity, nor Heisenberg about the consequences of his Uncertainty Principle on quantum physics. Both Heisenberg and Einstein reached their scientific theories only by aesthetic and philosophical feelings. No investor, with short term goals, would have backed such « mad » considerations at their beginning. Scientists can « feel » the right way for the future thanks to their long term perspective, but they need more effective power.

We have to assign **talent with its proper value** in our society again. Yesterday Europe was famous thanks to its technology and Prestigious Universities. Today she is prouder of its financing centres : The City in London, la Bourse de Paris, Franckfort, etc. The evolution is even more spectacular in North America and other so called G8 countries. Liberals would defend this system as the only credible one which brings back social justice and prosperity. That's surely right in the so-called « **Silicon Valley model** », in which the financing partner brings power for innovation and development, the share markets act as « **referees** » and **stock options** bring prosperity, but not in the case of pure **speculating paper market**.

The only way to take part in the future development of the world is to care about **creation and innovation,** and **not** only **services and utilities,** in our Universities and Firms. It is not just a matter of scientific innovation. Let's take as another model what two men of genius, the stylist Yves Saint Laurent and the business-man Pierre Berger, built together : a modern dynamic and still successful business around Y. Saint Laurent's talent and genius.

3 centuries of science and culture following the 7^{th} century brought **the Arab Civilization peace, justice and prosperity**. 3 centuries of easy going with just market prosperity, using stone and paper money, shifted the centre of the world from them to the emerging western countries.

The **road is still very long** but it would be a great pleasure to continue the journey all together in a peaceful world by taking as a model these physicist meetings of the beginning of the century.

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