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Understanding and Improvement the Relation of Advanced Warning for Hazard and Structural Failure or Disaster; with Examples; 3.11 event and others

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INTRODUCTION . *<We know it, but--- > <I imagine it, even--- >*

Last Conference in US, the authors, Mr. Abe and I; Shibata tried to discuss how we should develop the future SMiRT (Ref.1), but this paper is still remaining rather older shape, even though he is trying to discuss about human action for structural engineering safety. We often met disasters by natural hazards without warning, but also we met them even though we had had the warning. Even though we know the potential disaster, which shall come, we could not avoid it, In the case of the 3.11 event (Ref.2) in Fukushima #1 Station, some problems have been never discussed, as far as the author knows through documents. In this short article, the author tries to discuss similar cases which the author has been experiencing his professional life in relation to structural mechanics.

Through the 3.11 event, we recognized the scale of disaster by Tsunami is huge, but the fear of volcanic hazard might be almost the same level through the world. Of course, such subjects have been discussed in officially or non-officially. In the Spring of 2015, there are many books discussed regarding to such subjects related to the 3.11 event. In some of them, even they had been received the warning in advance, but they ignored it, and reached to unfavourable states, we should discussed it. The author wants to focus to subjects related to structural safety or near to it including other problems in parallel to the above subject..

During the process to prepare this article, the author recognized that we need work to figure out how the situation would be if some of class B and C items would be failed, even no class A item failed. This should be figured out to get the idea about over-all plant safety. We should do it, but we have never done up to now in Japan. We thought that we know it but no one has made clear. Maybe, because of the following difficulty, it is almost impossible; how extent we should assume their failures. In the sense of a regulatory code, we should assume the worst case.. It might be our next job.

Also, it should be mentioned. The author summarized his scope on earthquake motions in 2006, approximately 10 year ago (Ref.0), however, he still has some problems, not clearly solved, and some of them would be discussed in this article.

1. OVERVIEW OF THIS ARTICLE

After an accident, which was induced by natural hazard, the following discussion would be made often; *"I know the possibility of occurrence of such a type of event, but we had had many cases only warning without event so and so ---."* The author is going to discuss this problem later, but it is the main reason to prepare this article. We have been experiencing the warning without event, and so almost every days, then, finally we got the disaster on some day finally, like so-called: *Aesop's tall Event.* But we should note this is almost all in relation to man-induced matter or disasters. ***"I know it, but I don't think it might come really"***

2. NATURAL HAZARDS AND WARNINGS

Earthquake prediction has been discussed in various occasion. The "Role of Pre-cursors" has been starting point of this problem. The weather forecast is very important as daily news for us, and we have been not discussing about their reliability anymore. But as far as earthquake prediction, there are still many. Even though, the responsibility of a scientist is heavily requested. Several years ago, the specialist, who failed to warn the coming event, was complained, or sued as the second murder in Italy (Ref.3).

As far as the earthquake prediction, it is the war between scientists and Fiction-story tellers. Illusion promoting stories are almost twice than the purely scientific descriptions in Web-site, if the author checks related sites. In Japan, Mr. Mukuhira, who predicted several events in mid-20 century is still famous. We can find some about him in Japanese URL still.

But the information, which will be presented by scientific organizations like the Japan Meteorological Agency, is important. Even though their information is ignored very often, and as a result, we experienced some tragedy. The author could point out that there is some tragedy still, almost every year and everywhere in Japan. These several days (May, 2015), Hakone, a hot-spring resort area near to Tokyo, a part of the area becomes active, and closed to public.

As far as a nuclear power plant, as known well, the troubles of Kashiwazaki-kariha NPS; Tokyo Electoric Co. (TEPCO) in 2008, by Nihonkai Chuetsu Oki (NCO: Off –Chuetsu Japan See) Earthquake, and Fukushima-daiichi NPS; TEPCO in 2011 occurred as unpredicted event. Even no information about the direct evidence observed by various observation systems by JMA, the National Institute for Earth science and Disastor, NIED, and other systems.

Since South-Hyougo-pref. Earthquake in 1995, it has been passed 20 years. The author experienced the following story. Just before the event, a news about a fault along Rokko mtn. range along Kobe city and the coast-line, and he wanted to visit the site. He reserved the hotel and train on Feb. 26, but the event came on Feb. 17, and finally he used his reserved ticket to Kobe from Tokyo for the survey trip after the event. And during stay in hotel in Osaka, I got the information about the pre-curser of the event observed in Onagawa, north east of City Kobe several days ahead the event (Refs.4 & 5). Later he had a chance to check its fault movement

through Jishinyochi Renrakukai Kaiho (Ref.6); and he found one report reported about the fault. In that paper, they reported the north-east part near to the city of Kyoto was active, but the part near to Kobe-Rokko area had been quiet at the time. It is almost sure that there were some numbers of evidence and minor events as its pre-curser in another paper (Ref.6), but they could not been utilized for reducing the disaster at all.

3. FAULT MOVEMENT and SEISMIC MOTIONS

Recently, the following matter has been discussing rather often; if some structure, near to faults observed in the surface, they might been failed or not by the event. The author has had two cases of field survey on such events, one is the visit the town Irouzaki at Off-Izuhanto earthquake 1974 earthquake (Ref.7), and the area of the east Thessaloniki Greece at 1978 earthquake (Ref.8). Failures, induced by acceleration near to or across the surface fault observed minor. And he reported this fact on journals several times, and revisited the area to observe the situation again. Recently he made the reason be clear. In the report on Chi-chi earthquake (Ref.9) in Taiwan 1999, the acceleration recode was found as a single pulse one, and no any tail. At the area of Greece, someone reported to the author at the field survey, one shock he felt in his head through pillow, so as the author reminded.

4. PREDICTION of NATURAL HAZARDS and its SCALE

The author wants to develop his discussion wider than not only seismic event, but the point is how it induces the disaster in the view point of engineering or social event. If we find the fault or some fault-like structure near to the ground surface, the discussion would be made the possibility of inducing the hazardous event to the structures in the area recently. This type of discussions have been made after the 3.11 event rather frequently, especially between the nuclear safety commission and utilities. The point of discussion is whether or not this soil-structure might be the only structure appearing on the surface or structure near to the surface layer of mass with active earthquake fault. The possible mechanism has been discussed sometimes very seriously, but he believes that they might cause the movement, the earthquake fault would be existing under neath; several kilometer depth. So the discussion on their surface fault might be different matter, and the actual point might be the discussion on the nature/characteristics of the fault mechanism in the deeper structure. The author made his discussion about the seismic scale for the simplicity, but estimation of coming hazard is very difficult matter in general, tornado, typhoon, as well as tsunami. Maybe, it should be mentioned that tsunami might be some different from other disasters, and the point might be discussed later.

Isewan typhoon in 1955 killed more than 5,000 (Ref.10), even predicted almost exact, the author's friend experienced very serious situation at the night in his dormitory near to the coastline of Ise-bay, even he had almost exact information. As

far as tornado, the warning system has not been developed in Japan like USA. No experience the disaster on NPS by either typhoon or tornado in Japn .

Local thunder storm might cause the trouble on NPS, but not well reported, as far as the author knows, some plant should be operating as stand-along induced by total black-out of connected transmission lines. But this type of trouble usually not reported in public domain, and the author does not know about the event what is the exact cause; whether or not related to natural hazards. They, power companies have their own radar or observation systems for local thunder storm, and they are working to preventing the large scale total black-out, and almost they are succeeding.

5. SYSTEM FAIURE by NOT WELL=KNOWN PROCESSES

There are some numbers of phenomena, which have been mentioned by the specialists. However, those mechanisms have not including in ordinary design processes, and only some specialist pointed out.

One of them is the effect of strain-rate to the brittle failure of steel structures which have welded joints in the system. Some reports regarding to the failure of welded structures induced by Kobe earthquake in 1995 were discussed in the journal, but several examples were observed in the bolted structures like polar crane also. Connecting bolts, lay-outed on a circle at the basement of the column to connect the base, of unloading crane, were broken step by step from outer one; we call this failure effect as zipping failure. We experienced in Kobe earthquake in 1995, at the construction site. Another case was recorded in a port of Central-America on the event about an unloading crane for a steam power generation plant. Both cases can be called as zipping effect of connecting bolts of the polar-type crane. And it might occur at the connecting bolts using high-tension steel. So, use of *high-tension steel bolt* should be prohibited very often.

6. WELL-KNOWN FAILURE MECHANICS of GROUND MOTIONS

6.1 Long Period Ground Motions

In 1963, we experienced Niigata earthquake. the author was in his office in Tokyo, and observed a flexible tower was swinging for concrete-bucket out-side. And he felt slow ground motion at the desk. During shaking, he reminded a story which he experienced. Back to 1943, in the evening of June, his father lets me know overflowing a pond near their home in Tokyo. This was the ground motion of Fukui Earthquake, which destroyed the city of Fukui, approximately *XXX* km apart from Tokyo. Soon, the redio reported the fire of oil tanks in the City of Niigata. Since that I have been trying to set up the design code of oil tanks for petero-chemical industry. Last year, 2014, the design guideline has been completed.

6･2 Torsional Ground Motions

At the Switching Station in San Fernando Valley (Ref.11), we observed the vertical cracks of porcelain columns caused by the 1963 earthquake. This type of

failure modes are often observed at earthquakes in China (Ref.12). There are many towers, made by stone or brick in China, and they have vertical crack, some are very famous towers in their history, the Tower in Xian as known Xiǎoyàn Tǎ, Some remains only the half of the tower in Showhan?; a west city in Sichuan-prov., China. Damage of porcelain insulator might be a typical failure mode of switching station and yard in NPP. The criteria for failure might be a momentum change. I tried to proof it by a small shaking table, and we got a certain result. The small shaking table still remains in Chiba field station. Anyway, for the porcelain column in NPP we should pay much attention in this type failure, especial for the arrester column at the entrance point of main transmission lines. In the case of Chuetsu-oki Earthquake-2007 (Ref.13), an arrester connected to the main transmission-line was failed. This is a critical point for keeping the electric power to the plant. By the way, another one power line has been kept fortunately, then no black-out occurred at the event.

Damage of supporting structure of a spherical tanks have been observed several times through the world since the beginning. The first example were observed in the case of Kern county earthquake in 1954 (Ref.14). A spherical tank was failed down torsional way. Sometimes, the same types of failure were reported, and the most recent one was the case of the fire observed at oil refinery in Chiba area in the case of the 3.11 event. Such a failure mode comes from an exited torsional way or it comes from failure process, still not clear. The author tried to make clear the process, he got a certain result, but it was difficult to prove it through field observation by other way. In the occasion mentioned above some person observed the torsional response on some other-type of structure in the field, but it is difficult that the torsional motion of ground actually exist (Ref.15). "Existing of the torsional motions is the second subject similar to the long-period ground motions for the author

7 RESULT of ONE FAILURE ASSUMPTION and OTHERS

Almost all design on safety related system, its function requested for the design is quite simple, for example, the capacity of emergency battery is limited, and if it's completely consumed or run out, no way to survive the key function of supported safety system no more, in general.

7.1 Run-out and Lack of Battery Capacity

In Kobe earthquake in 1995, critical damage on chemical engineering plants was rather less found. One of them, which I visited for the survey, was reservation for oil and liquefied gas in the port of Kobe. All most all yard were liquefied, and the small building for the control room was tilted by the soil liquefaction, and battery was out after several days of the event, and all record had been out. In the 3.11 case, battery out is one of the causes of initiation of series of the disaster of the reactors, but we have never discussed on the length of time-available before. Maybe, we expect the temporal black-out only. The total length of battery in the

case of black-out has been discussed at the Shin-kansen, because to trigger the pantograph system, we need the power from the battery.

According to the records about details after the 3.11 event, how damages of plants had been developed, spending out their battery for controlling the equipment and instrumentations. The design of their capacity was made as under assumption of power supply might be normal in general, and black-out would be only temporal. So, with unrecoverable black-out case, butteries would be out in some hours. According to the report on details, the final catastrophic state might come based on the lack of electric power for their control from butteries, and all valves were automatically closed, even if the function of cooling water supply was surviving.

The author believe that missing the ability of control is one of the cause of the 3.11 event.

7.2 Final Back-up Emergency Power-line and Internal Buss-line; *On a Tohoku Transmission Line during their early construction period.*

As the author's memory, two lines from Tohoku Electric Power Co. system comes to the main switching yard, but the state was not clear, and at the time of accident, they reported that had been closed. According to a report on #5 and #6, they have the lines to Tohoku Electric Power Co's system, and also they have inter-connections to other units, but the details have not known.

We have been sometimes discussing about the necessity of lower voltage internal buss line, 400v, connected each units for operating each ECCS system in the Fukushima #2 NPS as their final back-up. .The author is feeling the necessity of more systematic planning on the emergency power supply system in such a large scale station.

INTRODUCTION§7.3 Un expected failure process; *Wind-effect on Salt particle in Switching devices*

As unexpected event, the fire from a switch board had been reported in Onagawa NPS. This was caused by the mist of salty, sea-water mist on insulator board for lower voltage switching. Even such an accident had never experienced before the 3.11 event, but it might be well known fact, salty mist on insulator is easy burnt (Ref.16).

8 One EVENT at the FUKUSHIMA #2 NPS

After the earthquakes, some numbers of troops were walking to watch the situation of their yard as their routine operation after the seismic event around 14:40, but they recognized the front of the tsunami wave behind them in several minutes later, and they rushed to a higher place of the yard, and they were survived. They might have the information on "Large Tsunami warning" in advance, but they were walking on lower stage of the yard at the time as usual seismic event. It is a typical response of us against the tsunami-warning. We have much experience tsunami warnings, s INTRODUCTION INTRODUCTION o we don't respond it directly, with possibility of real attack by This is reported by the head of the troop at that time, and the author reported (Ref.17).

9. LERNING from SEISMIC DISASTER: from Conventional Power Plant &. Petro-chemical Industrial Plants

The skeleton of our seismic design code was started from the document TID 7024 (Ref.18) prepared by Dr. Housner, in 1961 And through the experiences obtained by our field surveys obtained at the Niigata Earthquake in 1963 and the Tokachioki Earthquake in 1968, through the field trips in power plants, oil refinery and petrochemical industry plants. The first design guideline was published in 1970, as JEAG-4601 (Ref.19). In Japan, and the author worked for IAEA; SG-1 and SG-2 (Ref.20) in early 1970's. The details on the history, the author described in several papers, and they were quoted in the Reference 0.

10. CONCLUDING REMARKS and ACKNOLEDGEMENT

The author has been discussing about local events at our plants with assumptions; even if we imagine the final goal, but we violate it and got the disaster. How to avoid such unfortunate situation, it is very difficult situation in general through the world, but we *should* overcome its difficulty for the plant safety and our peace. A Japanese story related to the Tsunami in 1854 at the Philippine Sea trough might be mentioned.

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