

# Messages from Departments and Centers of NILIM

## Structural Measures That Promote Non-structural Measures

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*Keywords: comprehensive disaster prevention measures, non-structural measures, structural measures, durability, resident participation*

### 1. Introduction

Damage from the massive earthquake and tsunami in the Great East Japan Earthquake revealed the limit of conventional disaster prevention measures, which were too much dependent on tide embankments, etc. Consequently, two levels of tsunami were newly established as a magnitude basis for disaster prevention / mitigation measures, i.e., "Level 2" tsunami, which is the maximum level, and "Level 1" tsunami, which is more frequent and lower in height than Level 1 but causes major damage.

For a Level 1 tsunami, countermeasures focus on structural measures such as tide embankments, while countermeasures for a Level 2 tsunami focus on non-structural measures place a priority on protecting the safety of people thus center on the evacuation of local residents, etc.

For disaster prevention and other infrastructure, it is possible to maintain the original disaster prevention function when the infrastructure manager provides maintenance. In contrast, non-structural measures that mainly constitute the countermeasures for a Level 2 tsunami are premised on the evacuation of residents, which gives rise to uncertainties, such as whether people can remain aware of disaster prevention or whether it is possible to establish a system that lasts for 1,000 years.

So far, disaster prevention education and other efforts have been made to reduce such uncertainties. This paper introduces and discusses a number of cases concerning the possibility of reducing such uncertainties of non-structural measures by using structural measures.

### 2. Green tide embankment

Figure 1 shows the cross-section adopted in the Iwanuma Coast Restoration Project on the southern coast of Sendai Bay. This is called a "Green Tide Embankment," where an embankment is constructed on the slope of a "resilient coastal dike," as studied by NILIM, covered with trees, and further provided with means for increasing the effect of disaster mitigation.

In building this dike, the project owner (Tohoku Regional Bureau) constructed the embankment, while other concerned organizations and associations undertook the initiative of planting trees and many local people from wide areas actively participated in the planting.

It is important to provide local residents opportunities to actively participate in the development of disaster

prevention infrastructure in order to keep the aware of disaster prevention and future developments of disaster prevention infrastructure.

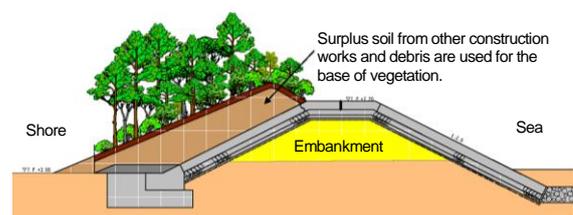


figure 1: Greed Tide Embankment (Future image with grown trees)<sup>1)</sup>

### 3. Hill of Hope for One Thousand Years

Iwanuma City, Miyagi Prefecture, suffered serious damage and 181 deaths, when about 48% of the city area was flooded by the tsunami of the Great East Japan Earthquake. In addition, many trees planted for protecting the shoreline were also swept away.

As a restoration project and effort in disaster reduction, Iwanuma City developed the "Hill of Hope for One Thousand Years", which built a tsunami breakwater that reduces the force of tsunamis as new social infrastructure for protecting multiple coastal areas. The City is also proceeding with a plan<sup>2)</sup> to develop the area including the "Hill of Hope for One Thousand Years" as a memorial park with the aim of educating future generations about the magnitude of the tsunami that hit and what they thought about it.

According to Iwanuma City, "it is necessary to construct hills using earthquake debris (recycled material) and planting trees to reduce / disperse the force of tsunamis and to develop, grow, and maintain them as evacuation areas and a base for biodiversity. Also, the Hill of Hope for One Thousand Years is an opportunity to realize an advance model of restoration as well as a historical project for conveying the thoughts and prayers of individual citizens and the many lessons learned from this disaster to children one thousand years from now."<sup>2)</sup>

According to the plan, 15 hills, each T.P.+8.0-10.0 m in height, and a garden road extending about 10 km will be constructed as a disaster prevention park with the functions to reduce the force of tsunamis, serve as an evacuation area, etc.. For the first hill and garden road

were constructed using donations from across the country, and trees were planted by about 4,500 volunteers.

Thus, developing the hill as a memorial park and providing citizens with an opportunity to participate in tree-planting are expected to keep people aware of disaster prevention.



**Figure 2: Image of Hill of Hope for One Thousand Years (Taking a walk in "Hill of Hope for One Thousand Years")<sup>2)</sup>**

#### **4. Hiromura Embankment**

After the tsunami caused by the 1854 Ansei Nankai Earthquake, Goryo Hamaguchi, famous for setting rice sheaves on fire as a beacon that guided residents to safe ground, started the construction of a tide embankment 5 m high and 600 m long in 1855 at his own expense. He employed village residents, and completed it in 1858. Consequently, village residents were directly involved in the construction of the embankment.

Then, in 1903, 50 years after the Ansei Nankai Earthquake, volunteers of Hiromura started to the ceremony by piling up the soil on the embankment in order to remember the tsunami victims and honor the achievements and virtue of Goryo Hamaguchi, who constructed the embankment. This is said to be the beginning of the current "Tsunami Festival."<sup>3)</sup>

This festival cements the relationship of residents with the Hiromura Embankment that was built more than 100 years ago.

#### **5. Comprehensive tsunami disaster prevention measures**

In 1983, 50 years after the Showa Sanriku Earthquake, the Ministry of Construction and the Fisheries Agency reviewed the disaster prevention measures for Sanriku Region and formulated "Guidelines for Comprehensive Disaster Prevention Measures for Tsunami-Prone Areas (Draft)." These guidelines presented the concept of prevention by means of structural measures for earthquakes equivalent to the Showa Sanriku Earthquake and non-structural measures for the Meiji Sanriku Earthquake; these concepts are similar to the concepts of Level 1 and 2 tsunamis introduced herein. Furthermore, in 1997, the Cabinet Office, Fire Defense Agency, Meteorological Agency, and coastal authorities formulated the "Guide for Reinforcing Tsunami Disaster Prevention Measures in Local Disaster Prevention Plans."

In 2011, the "Law for Development of Tsunami Disaster Prevention Regions" was established, stipulating comprehensive tsunami disaster prevention as a combination of structural and non-structural measures.

In the future, improvements to evacuation and non-structural measures will be essential to prevent large-scale damage by tsunamis, high tides, and flooding as well as to restore the areas stricken by the Great East Japan Earthquake. The issue will be how to keep awareness of disaster prevention high among residents.

Meanwhile, structural measures have been supposed to demonstrate the effect of the designed external forces. However, since the Great East Japan Earthquake, tide embankments are expected to be resilient to excess external forces in order to gain as much time as possible to mitigate disaster.

The example introduced herein speaks to a disaster mitigation system that can be sustained for a thousand years through maintenance of structural measures. In order to ensure evacuation, which is an important factor of major flood events, it is essential to strengthen the relationship between structural and non-structural measures, in which more development in study and on-site approach is expected.

- 1) Website of Sendai Office of River and National Highway: "Leading to Tomorrow," Southern Sendai Bay Embankment Restoration Project ---- "Green Tide Embankment" Iwanuma Coast Tree Planting Ceremony  
[http://www.thr.mlit.go.jp/sendai/kasen\\_kaigan/fukkou/pdf/130711syokujyu.pdf](http://www.thr.mlit.go.jp/sendai/kasen_kaigan/fukkou/pdf/130711syokujyu.pdf)
- 2) Website of Iwanuma City: Tsunami Breakwater "Hill of Hope for One Thousand Years"  
[http://www.city.iwanuma.miyagi.jp/kakuka/040700/sennnenni\\_bounooka.html](http://www.city.iwanuma.miyagi.jp/kakuka/040700/sennnenni_bounooka.html)
- 3) Website of "Inamura No Hi No Yakata": Data room, tsunami disaster prevention  
[http://www.town.hirogawa.wakayama.jp/inamuranohi/siryo\\_bo\\_usai.html](http://www.town.hirogawa.wakayama.jp/inamuranohi/siryo_bo_usai.html)