Will the rail be safe to travel on?

By Dennis Mitsunaga

NOTE: *This memorandum is written in the interest of Public Safety and is addressed to all the news media outlets in hopes that they can help to ensure the Life safety of any resident or visitor who may travel on the Rail between Kapolei and the Ala Moana Center in the future.*

My name is Dennis Mitsunaga. I am not anti-rail. i am a structural engineer, registered in the State of Hawaii for the past 47 years. I am President and CEO of Mitsunaga & Associates, Inc. (MAI) and MM International (MMI). I am also a licensed Contractor and a partner in Mitsunaga Construction Incorporated.

MAI is a multi-discipline A&E firm incorporated in Hawaii in 1980. MMI is a Status of Forces (SOFA) Contractor in Korea since 2001. Along with two other SOFA Contractors, MMI is tasked with the consolidation of the U.S. military bases on the Korean peninsula, including the relocation of Yong San, the main U.S. Army Garrison in Seoul to Camp Humphrey in Pyeongtaek. The construction cost of the entire project is over $15 billion U.S.

The purpose of this memorandum is to make the public aware of the future dangers of allowing the Rail Project to proceed on the same track that it is now, and to encourage the news media to follow up to see that the responsible parties rectify the situation. I have worked on many, many projects during my 47 years in practice and I have never come across a more mismanaged project than this Rail Project.

I was motivated to come forth by the excellent reporting of Marcel Honore' in the September 30, 2016 Star-Advertiser (SA) article "Rising costs, defective materials". According to the article, "strands in three of the tendons that help keep the guideway structure in place have snapped apart," and "six tendons stretch through each concrete span of the guideway, providing tension to hold it together." In my professional opinion, this is a very serious issue. A failure could be catastrophic and the liability unbearable for the City.

Description of the tendon system: A tendon is actually a group of probably 10 to 20 steel post tension cables (0.5" or 0.6" in diameter) bunched together and housed in a flexible conduit or duct and installed in the concrete guideway beam or box girder. The "flexible" tendons are draped in a natural catenary[1], near the bottom of the girder at mid-span, near the top over at the supports, and at the centroid of the girder section at the free ends to eliminate any eccentricity.

> FOOTNOTE NO. 1: Imagine or try holding a string at both ends and allow it to naturally sag in the middle. This natural sag is called a "catenary". If you then pull each end of the string tight, the string will straighten into a horizontal profile.

After the concrete is poured and cured (probably to 75% of its design compressive strength, in 3 or 4 days), the tendons are then jacked or pulled from each end (could be pulled from only one end on shorter spans) and locked in place with bearing plates or custom made anchors at the free ends.

Like the string described in footnote no. 1 above, when the tendon is pulled (jacked) from each end, the tendon will try to straighten to a horizontal profile; However; unlike the string, the tendon cannot straighten because it is embedded and restrained by the concrete, and it will instead create an "upward force" that will "lift" the girder to a horizontal profile. Without this internal upward force, the girder will sag and collapse when the shores (supports for concrete forms) are removed. The individual post tensioned cables are then anchored and locked in place at each end.

In cases where the superimposed loads are heavy, additional post tension cables may be added to camber (upward deflection) the girder to support a percentage of the superimposed loads; but superimposed loads are primarily carried by the reinforcing steel bars installed in the girder.

Modes of failure. As one can see from the description of the tendon system described above, if enough of the tendons or their anchors fail, the entire box girder system will fail and could very well collapse. According to the SA news article, water had seeped into some of the tendon anchors causing them to corrode and fail. This problem seems to be analogous to the railing section at Ala Moana Center that collapsed and caused the death of a 21 year old person and injury to another who happened to lean on the railing. According to Gordon Pang's SA article on 10/15/16, "Mall's owner cited over rusted railings", railing posts embedded in concrete had rusted[(2)] and caused an entire railing section to fail and fall to the ground below. The oxidation process (rusting) must have been going on for a long time but no one noticed because the posts were embedded in concrete, similar to the tendon anchors in the Rail Guideway box girders. If water penetrates the concrete and cause the cables or their anchors to rust, no one will notice since they are completely embedded in concrete.

Footnote No. 2: When steel rusts in concrete, it expands and flakes, causing the concrete to spall (break apart).

Other modes of failure are: lower strength concrete and less reinforcing bars than required or specified, understressing cables[(3)], and improper tendon profiles[(4)].

Footnote No. 3: The post tensioning force is directly proportional to the carrying capacity of the girder. 0.5" diameter cables are normally stressed to 31,000 lbs. each and 0.6" diameter cables to 44,000 lbs. each. Understressing the cables will proportionately reduce the carrying capacity of the girder.

Footnote No. 4: At mid span, the distance from the top of the girder to the centroid of the tendon is directly proportional to the capacity of the girder. Conversely, so is the distance from the bottom of the girder to the centroid of the tendons over the supports.

Questions to raise: The SA article reports that 57 of 1,586 tendons already installed were tested and one dozen defective tendons were replaced. Question: What about the other 1,529 tendons that were not tested? Also, how can we know that water has not infiltrated into any of the untested tendons, and that the tendons are not slowly corroding like the collapsed railing at Ala Moana Center? Other questions:

1) When was the concrete for each section poured, the tendons stressed, and the tendons grouted? The Contract Documents must specify a time limit to grout the tendons to prevent the infiltration of rain water.

2) To what load was each individual cable stressed to?

3) Did someone qualified check the profile of the tendons before the concrete was placed, the specified 28-day compressive strength of the concrete, and the quantity and placement of the reinforcing bars?

4) In the SA article, a HART official says that if one of the six tendons in each span of the guideway breaks, it will cause stress and cracking, but not catastrophic failure. The question is: how many of the six tendons need to fail to cause catastrophic failure? Also, how can we know when cracks appear? Is someone going to continuously inspect and monitor the entire 20 mile Rail route?

Statue of repose on latent defects: Hawaii Revised Statute, HRS § 657-8, specify a Statute of Repose on Latent defects of 10 years after posting of the Notice Of Substantial Completion of a project. In other words, if the Rail Guideway collapses 10 years and one day after the contractors post their Notice of Substantial Completion, will the City be left holding the bag to repair or replace the system? Also, what about the loss of revenue while the Rail System is shut down? (See also HRS § 507-41)

Going forward: Going forward, it is my personal belief that Third Party Oversight is solely needed to oversee this project to completion. Perhaps the City can request the Hawaii Structural Engineers Association to put out an RFP and select an appropriate Structural Engineering firm to oversee this project, to check on the work already completed and also going forward. In my professional opinion, some action of this sort is necessary to ensure the public peace of mind that riding on the Rail will be safe.

The news media can play an important role by raising the questions herein to the appropriate people. They can also check on the qualifications and resume of the government personnel running this project, to verify that they have Structural Engineering knowledge and private practice design experience, and are not just career government engineers with only Civil Engineering licenses.

The news media can perhaps also raise the question of the Statute of Repose on Latent Defects with the City's Corporation Counsel.

It is my sincere hope that the appropriate government agencies will take measures to correct this problem and ensure the public that the Rail will be safe to travel on. My personal feeling is that traveling on the Guideway without assurance that it is structurally sound is like flying on a plane and wondering if the wings will fall off before landing at your destination.

Thank you for taking time to read through this very lengthy narrative. Being a Structural Engineer practicing in Hawaii many years, I considered it to be my fiduciary responsibility to contribute what little I can to ensure that the Rail is constructed properly so its riders can travel safely all the way between Kapolei and the Ala Moana Center.

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Published in the Star Advertiser on 10/30/16.