WIRELESS FATIGUE DAMAGE SENSOR NETWORK FOR ELEVATOR AND ESCALATOR STRUCTURES APPLICATIONS

A novel wireless enabled intelligent fatigue damage sensor network for monitoring of the health state of critical parts of structural members of the elevators and escalators

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Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (INTRODUCTION)

- **In recent years, the global installation and retention of ESCALATORS have continued to grow steadily. Accompanied by the ever-increasing economic level in many countries, the process of continuous urbanization, and the ever-increasing quality of people's lives, the escalator industry has been continuously growing. With the development of society, people's requirements for MODERN ESCALATORS AND ELEVATORS are getting higher in everyday.**
- **ESCALATOR TRUSS is the support of the entire escalator system and is the key component of the entire escalator system. The reliability of the TRUSS STRUCTURE of the escalator directly determines safety and reliability of escalator and therefore becomes the focus of escalator research.**
- **Considering safety factors, if excessive parameters are selected in the calculation of the truss structure, excessive safety factors cause huge waste of steel materials, while not enough of them may lead to premature failure of the escalator.**
- **The cost reduction of escalators and improving product reliability have become the key to the continuous development of elevator companies.**

Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (PROJECT OBJECTIVE)

- **The main objective of this Project** is to develop a smart fatigue damage sensor for structural health monitoring of Fatigue Critical Components of ELEVATOR AND ESCALATOR STRUCTURES. The Proposed Fatigue Sensor System is targeting to increase not only the Safety and Reliability but also to Increase the expected SERVICE LIFETIME of Structures used in Transportation Sector.
- **The developed INTERNET OF THINGS (IoT) BASED INTELLIGENT FATIGUE DAMAGE SENSOR SYSTEM** is designed for early detection and prediction of the total cumulative fatigue damage level(THE LIFETIME or REMAINED USEFULL TIME(ACCORDING TO SENSOR DATA, ESTIMATED LIFETIME OF 10,15,20,25,30,35 and more YEARS) or REMAINED STRENGTH of STRUCTURE) of the monitored structure() and wirelessly transferring the collected fatigue damage level information by using an active or passive RFID integrated system.
- **ONE OF THE MOST IMPORTANT OBJECTIVES OF THIS PROJECT IS DEVELOPING INTELLIGENT REAL EXPERIMENTAL DESIGN BY USING THE RFID FATIGUE DAMAGE SENSOR DATA.** The structural fatigue health conditions of critical parts of structures are given according to the RFID Fatigue Sensor Network data. These data also provide a lot of information for new fatigue design improvements and also new design concepts. For this reason, the sensor data could affect the fatigue design regulations and methodologies since it is representing an extended periodic or real lifetime fatigue data for a unit and fleet of structures with SHM system.

Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (PROJECT OBJECTIVE)

- **The System also is capable of monitoring fatigue cracks in HOT SPOTS of BUILDING STRUCTURE.** One of the important outcomes of the project is to design and develop a SMART PREDICTIVE or CONDITION BASED MAINTENANCE MODEL for a single Structural Unit or a Complete Fleet System to reduce MAINTENANCE AND MANAGEMENT COSTS while increasing SAFETY and RELIABILITY of FATIGUE CRITICAL PARTS of STRUCTURES.
- **Among the key achievements of the Fatigue Sensor, one of the most important is the extension of expected lifetime or the service lifetime (the FATIGUE LIFETIME) of Critical Structures around 3 TIMES** when an Intelligent Sensory Predictive Lifetime Design Methodology is applied to fatigue critical structures instead of Statistical-Probabilistic Model.
- **The required maintenance decisions and the health state of critical parts of structures are given according to the RFID Fatigue Sensor Network data.** The RFID Fatigue Sensor network information is mandating, the time of the fatigue damaged parts or locations should be repaired or replaced. Therefore, the proposed RFID Fatigue Sensor based Intelligent Predictive-Condition Based Maintenance Model is very efficient and effective strategic system since it increases service life and reliability and reduces maintenance and operations expenses.

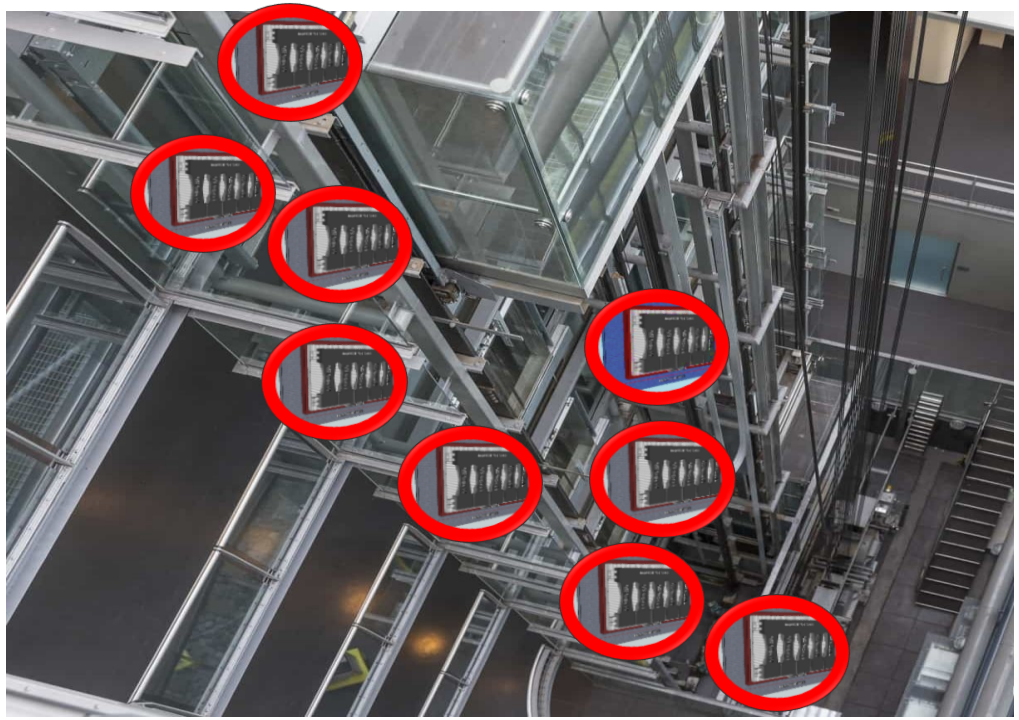
Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (PROJECT OBJECTIVE)

To ACHIEVE ALL THESE OBJECTIVES,

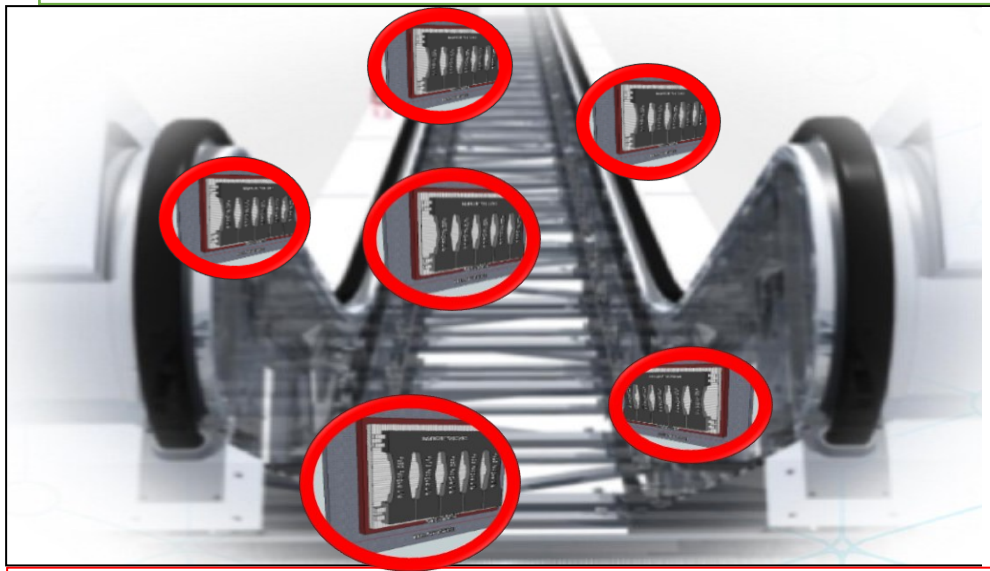
- **A novel wireless enabled smart RFID Structural Fatigue Damage Sensor and IoT integrated wireless smart fatigue sensor network system for fatigue health monitoring of the state of critical parts or locations of mechanical and structural members of BUILDING STRUCTURE Systems was developed and patented in several countries.**
- **A Smart Predictive-Condition Based Maintenance System Model will be applied for not only for a single Complex Structural Unit but also a Complex Complete Fleet System to reduce Maintenance and Management Costs while increasing Safety and Reliability of Fatigue Critical Parts of Structures.**
- **Among the key achievements of the Fatigue Sensor, one of the most important is the extension of expected lifetime or the service lifetime (the Fatigue Lifetime) of Critical Structures around two-three times of standard designed life when an Intelligent Sensory Predictive Lifetime Design Methodology is applied to fatigue critical structures instead of conventional strain gage design model methodology.**

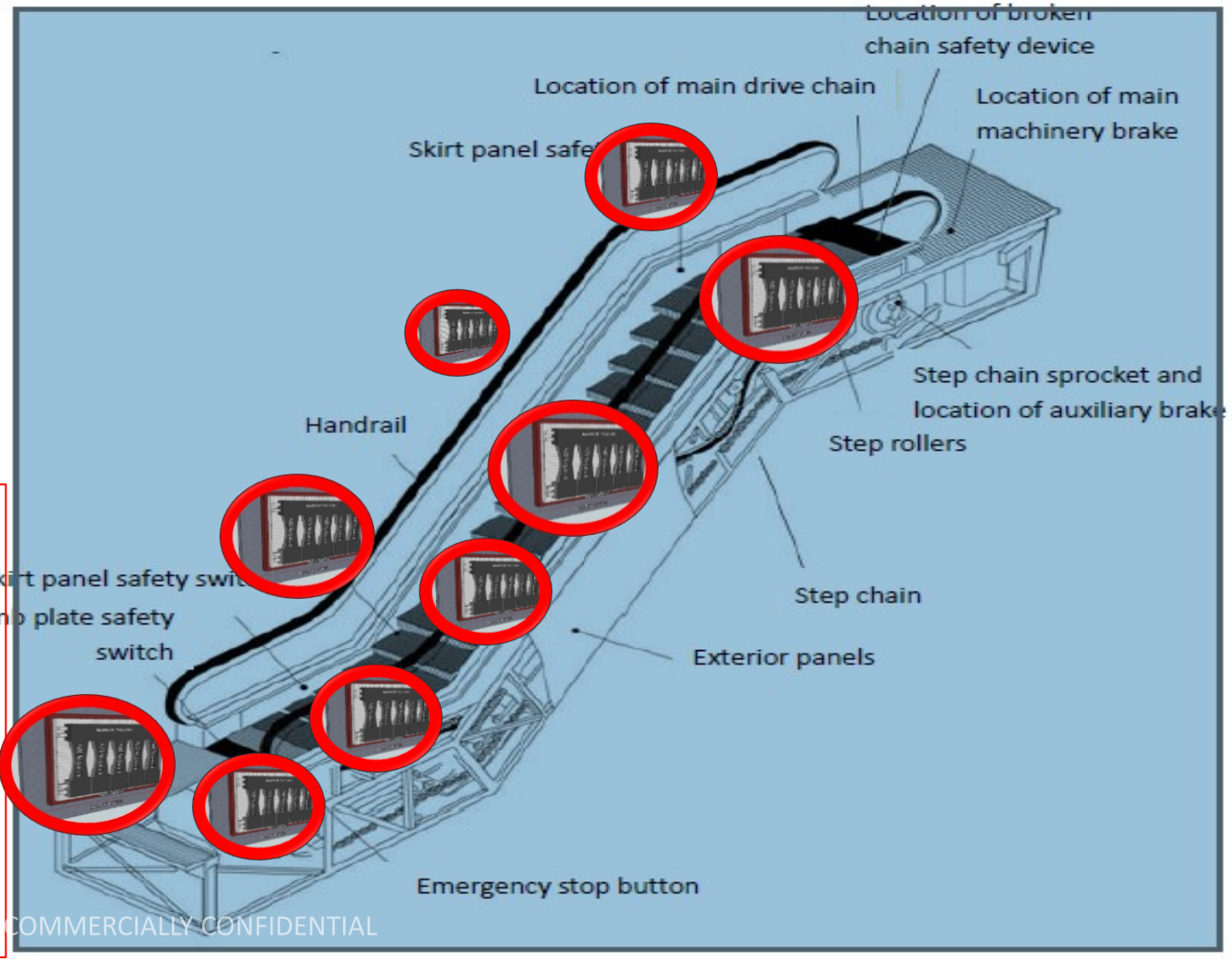
Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network
(SENSOR NETWORK MODEL)

IDENTIFY ALL THE FATIGUE CRITICAL HOT SPOTS IN STRUCTURES FOR THE APPLICATIONS OF SMART FATIGUE DAMAGE SENSORS IN ORDER TO MONITOR THE RESIDUAL FATIGUE STRENGTH OR FATIGUE LIFETIME. SPECIFIC AND FATIGUE SENSITIVE REGIONS, LOCATIONS UNDER HIGH LOADS, PREDETERMINED AND FORMERLY KNOWN-EXPERIENCED CRITICAL SPOTS ON ELEVATOR AND ESCALATOR STRUCTURES AND MECHANICAL COMPONENTS SUCH AS RIVETED, BOLTED, STEEL ROPES AND HOLE TYPE CONNECTIONS ETC..



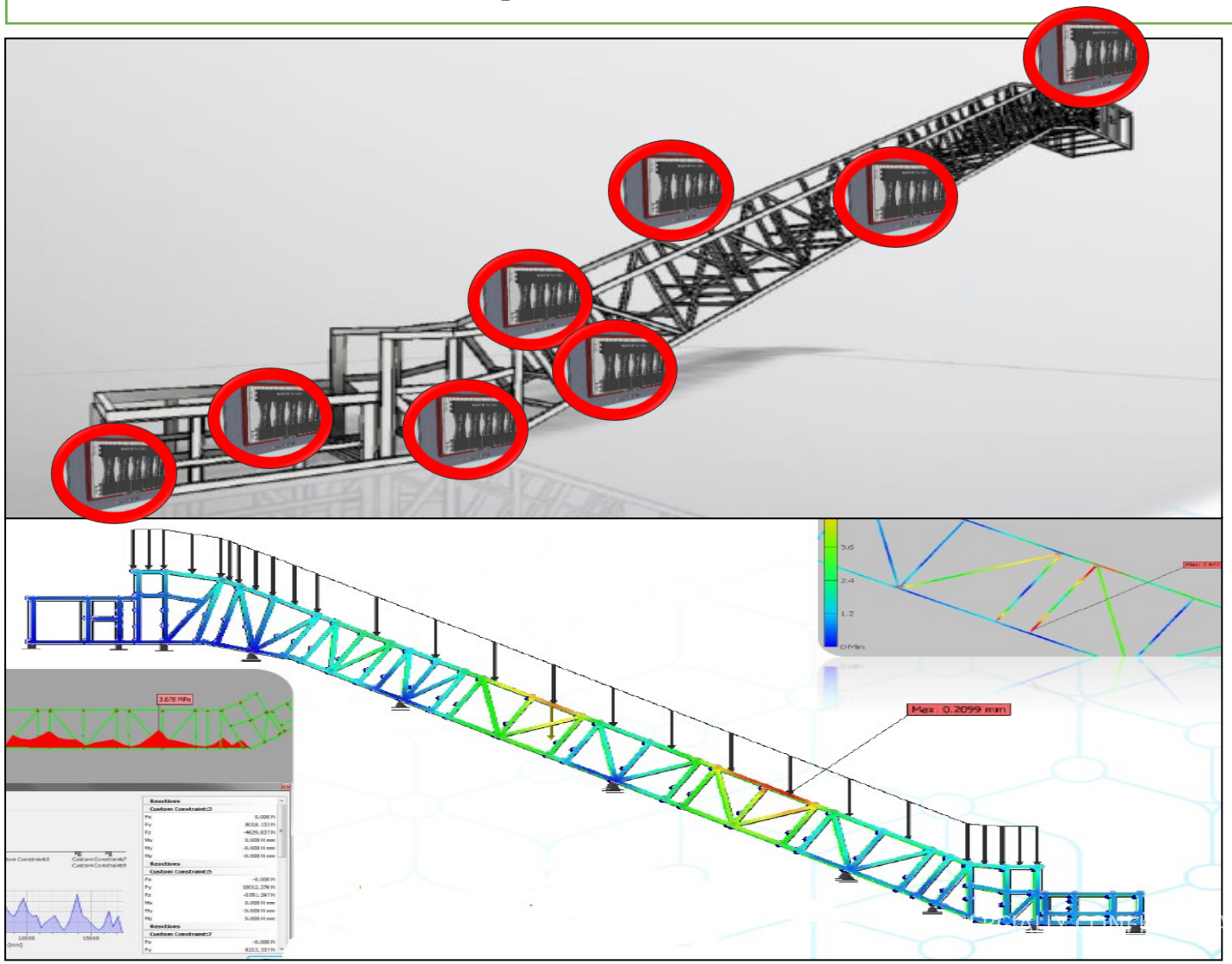
Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (FATIGUE CRITICAL LOCATIONS)





IDENTIFY ALL THE FATIGUE CRITICAL HOT SPOTS IN STRUCTURES FOR THE APPLICATIONS OF SMART FATIGUE DAMAGE SENSORS IN ORDER TO MONITOR THE RESIDUAL FATIGUE STRENGTH OR FATIGUE LIFETIME. SPECIFIC AND FATIGUE SENSITIVE REGIONS, LOCATIONS UNDER HIGH LOADS, PREDETERMINED AND FORMERLY KNOWN-EXPERIENCED SPOTS ON THE STRUCTURES AND MECHANICAL COMPONENTS SUCH AS RIVETED, BOLTED AND HOLE TYPE CONNECTIONS ETC..

Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (FATIGUE CRITICAL LOCATIONS)



DETERMINE OF MAXIMUM CRITICAL STRESSES IN ALL THE FATIGUE CRITICAL HOT SPOTS IN STRUCTURES(BOLTED AND WELDED JOINTS) BY USING FEA NUMERICAL MODEL OF THE STRUCTURE FOR THE APPLICATIONS OF SMART FATIGUE DAMAGE SENSORS IN ORDER TO MONITOR THE RESIDUAL FATIGUE STRENGTH OR FATIGUE LIFETIME MONITORING.

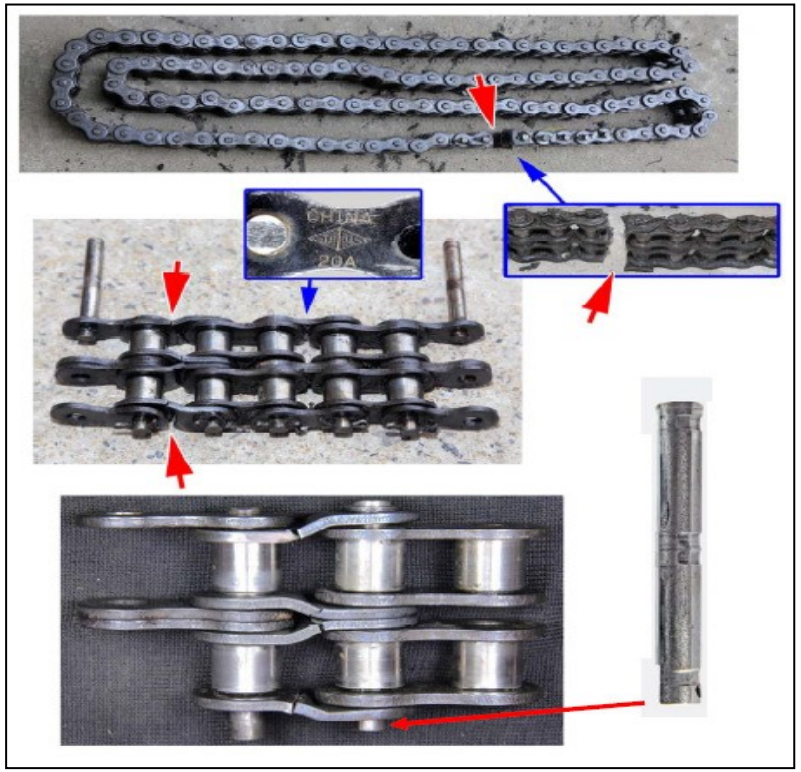
Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (FATIGUE CRITICAL COMPONENTS)

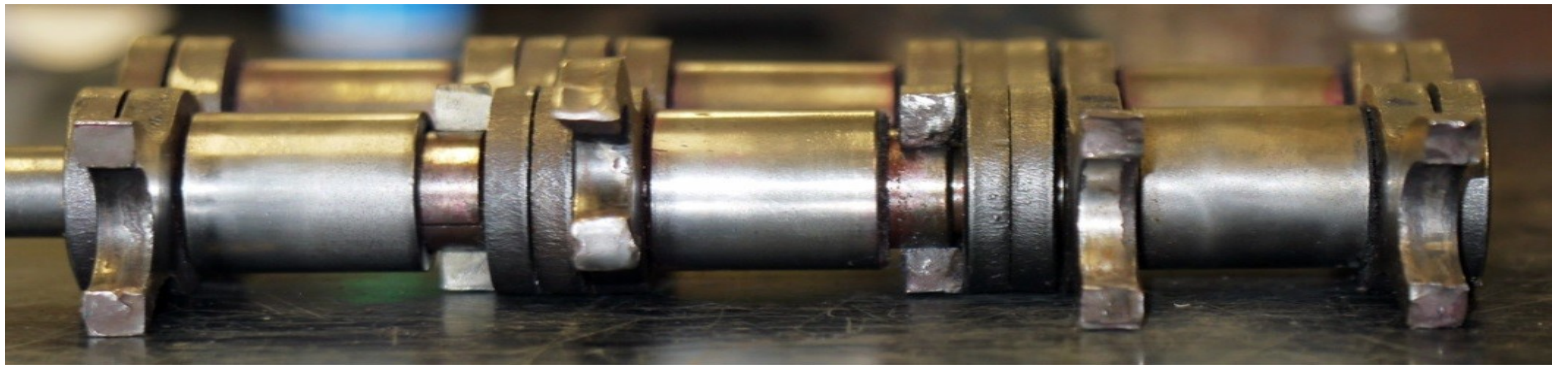
- it is known that the fracture of the drive chain is caused by the stress concentration effect of the bending stress of the transition plate, and the decarburization layer on the surface of the chain plate reaches 3. 5% of the plate thickness, which accelerates the occurrence of fatigue cracking.
- So in the process of design and manufacture, the rationality of material, manufacturing and assembly process should be fully considered. Also in the use of the drive chain due to FATIGUE, wear, impact, etc., to achieve the service life should be replaced in a timely manner.

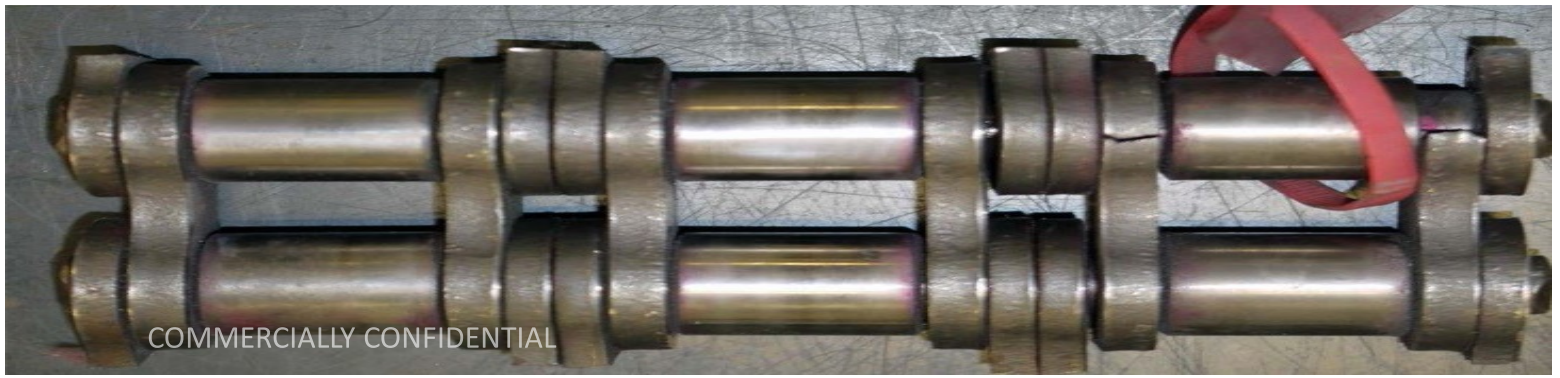
Figure 2.9 Step (Escalator) Chain

Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (FATIGUE CRITICAL PARTS)

The main drive chain of escalator is an important part of power transmission. In the process of design and manufacture, the rationality of material, manufacturing and assembly process should be fully considered. In the use of the drive chain due to FATIGUE, wear, impact, etc., to achieve the service life should be replaced in a timely manner.







Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (INTRODUCTION)

DETERMINE OF MAXIMUM CRITICAL STRESSES IN ALL THE FATIGUE CRITICAL HOT SPOTS IN STRUCTURES(BOLTED AND WELDED JOINTS, STEEL ROPES) BY USING FEA NUMERICAL MODEL OF THE STRUCTURE FOR THE APPLICATIONS OF SMART FATIGUE DAMAGE SENSORS IN ORDER TO MONITOR THE RESIDUAL FATIGUE STRENGTH OR FATIGUE LIFETIME MONITORING.

Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (SYSTEM MODEL)

A Novel Smart RFID Fatigue Damage Sensor aiming to the prediction of fatigue residual strength of critical mechanical and structural components for Structural Health Monitoring has been DEVELOPED and PATENTED (Patent N0. US 8,746,077 B2).

- **The proposed smart sensor system is designed for early detection and estimation of the structural health cumulative fatigue damage level and wirelessly transferring the information using an active or passive RFID integrated system.**
- **The developed RFID fatigue sensor system has a specially designed geometry with multiple parallel oriented unidirectional, bidirectional or multi directional breakable C, U or V type notched beams having different fatigue lifetimes to predict not only unidirectional or bidirectional fatigue damage but also multidimensional cumulative fatigue damage level of structural or mechanical elements including composite structures.**

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (SYSTEM MODEL)

- **Whenever a particular beam of the sensor exceed the engineered number of fatigue cycles, the beam fails and sensor electronics detect that failure and transmit this information wirelessly.**
- **Having multiple beams that are designed to fail after precise number of fatigue cycles enables the health state of the structural member to be monitored. It gives ample warning about the health of the component so that necessary corrective measures can be taken.**
- **The sensor is quite lightweight with only several grams of weight and small in size slightly bigger than a credit card.**

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (SYSTEM MODEL)

- **Fatigue plays a critical role for design of structures or critical mechanical systems under cyclic dynamic loads. Several fatigue design methodology are used for fatigue design of mechanical components or structures. All these techniques are relied on STOCHASTIC MEDHODOLOGIES.**

- **Any failure in one of the structural members of the system causes catastrophic failure with serious consequences costing lives and property.**

- **Health status of structural members which undergo cyclic stress need to be monitored continuously and fatigued parts need to be replaced well before the failure limit is reached. ESCALATOR AND ELEVATORway Systems, Aircrafts, Helicopters, Wind Turbines, Mega Cranes, Highway Bridges and Marine Vessels are especially considered as systems vulnerable to this sort of fatigue damage accumulation.**

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (SYSTEM MODEL)

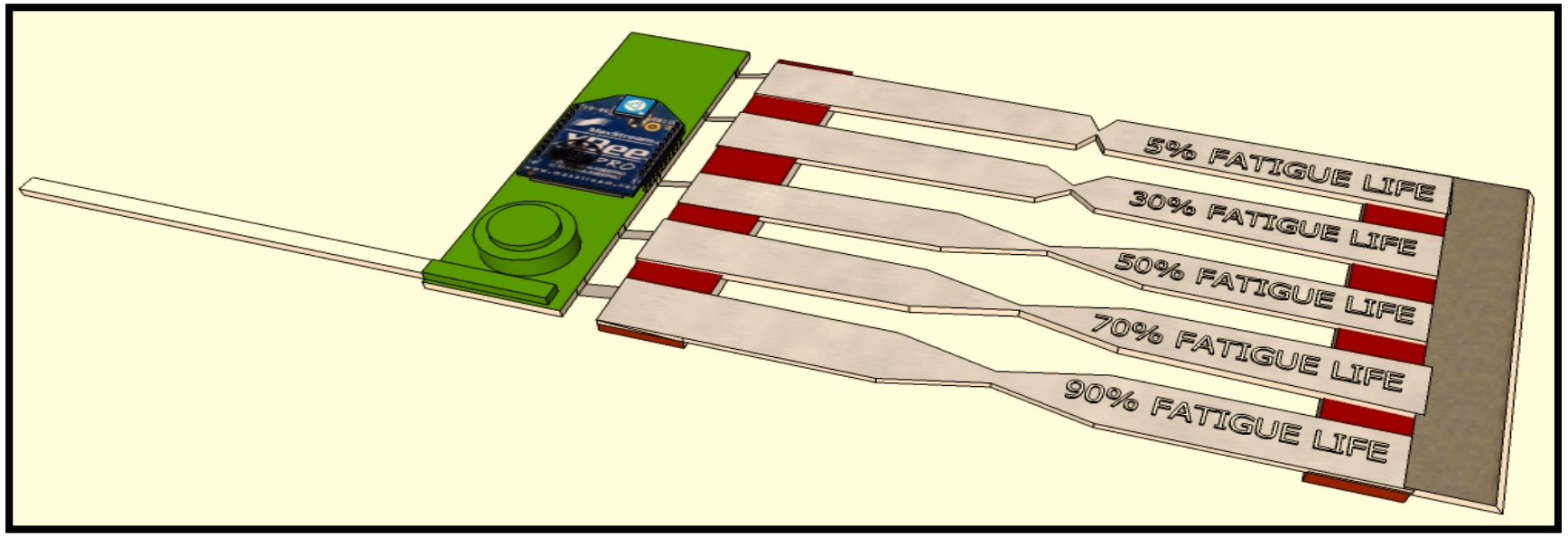
- **It is foreseen that the proposed RFID-IoT Smart Fatigue Sensor will revolutionize the concept of fatigue design and also will revolutionize the fatigue inspection and maintenance management methodologies by using the RFID-IoT Smart Fatigue Sensor Network Data.**

- **Since the distributed fatigue sensor network system periodically or continuously is monitoring the fatigue health state conditions of structures, the database of the sensor network system will be used for condition based inspection, sensor based maintenance management and development of new fatigue design tools for fatigue sensitive complex and large engineering structures or mechanic systems.**

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (SYSTEM MODEL)

- **The Figure shows the RFID FATIGUE DAMAGE SENSOR with 5 sacrificial beams members with fatigue life ranging from 10 % to 90 %.**
- **The 5-10% fatigue life mini-micro beam member is designed to be a "prediction-projection" mechanism and designed to fail quickly if installed properly.**
- **Any sensor with 5-10 % finger not failing within reasonable time of installation is an indication of improper installation or faulty sensor.**
- **Failure-Fracture detection of the mini beams is done by sensing continuity of current passing through the beams.**

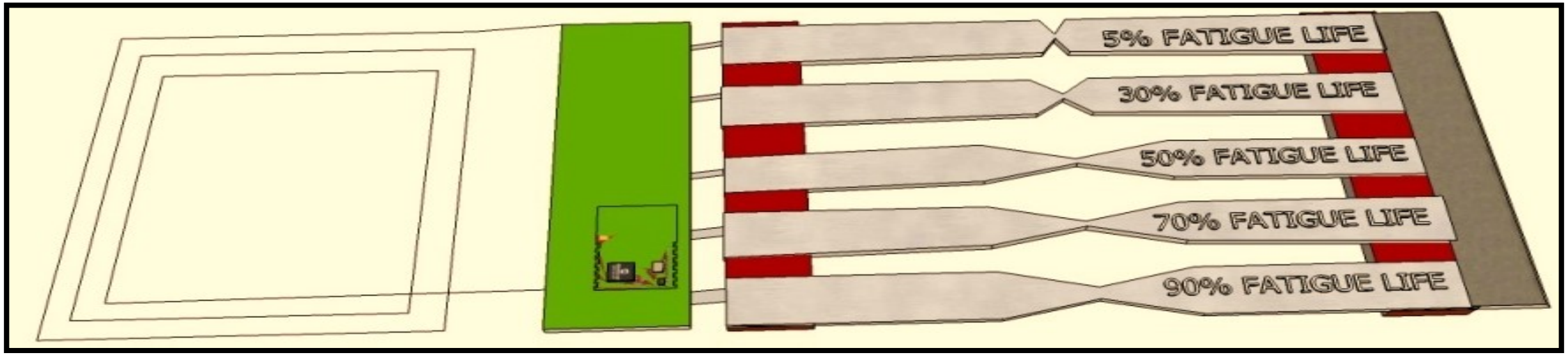
A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (ACTIVE SENSOR MODEL)



FATIGUE SENSOR (PATENT N0. US 8,746,077 B2)

There are two versions of the fatigue sensor, one with a battery version and another one which works with RF power. The one with the battery uses Zigbee or similar low power sensor networking to interrogate the sensor about the state of breakable fingers. The sensor nodes relay information from one node to the other to communicate with the master node.

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (PASSIVE SENSOR MODEL)



Fatigue Sensor (Patent N0. US 8,746,077 B2)

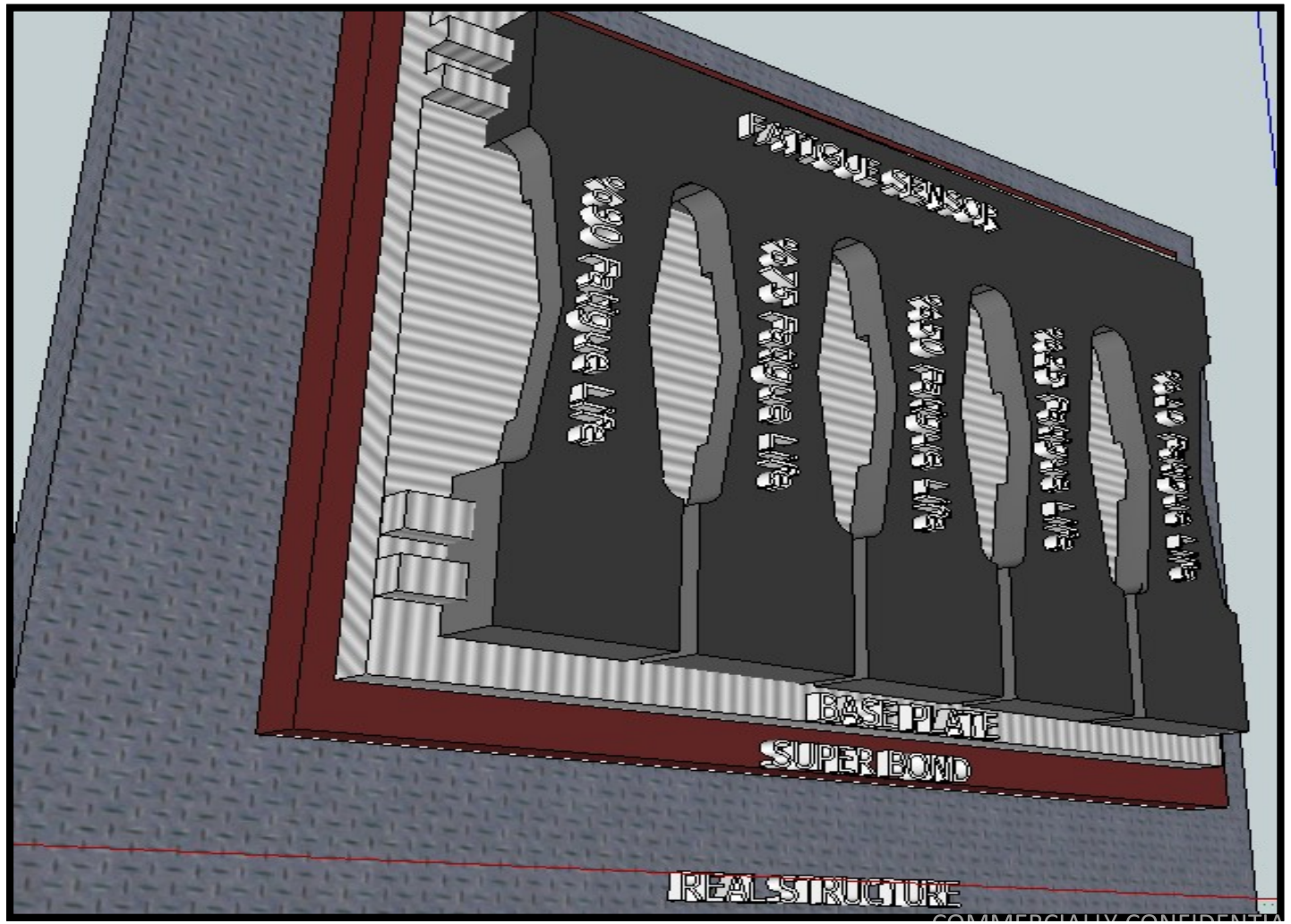
The sensor with no battery is shown in figure. This type is powered by RF power emitted by the interrogation wand. Interrogation distance of RFID type devices depend on both transmitter power and the coil size of the receiver.

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (AS A NEW TYPE FATIGUE DAMAGE SENSING NDT MODEL)

- **Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor is a novel smart methodology of Non-Destructive-Inspection (NDI) in order to monitor the structural integrity.**
- **Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor will be used for intelligent inspection, maintenance and maintainability. E.g. studies are predicting a maintenance cost reduction by up to 75% on Service Bulletin (SB) level and a clear increasing of the aircraft availability [1].**
- **Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor will be used to develop new methods and concepts for fatigue structural design, which can reduce the weight of structure for metal and composite structures up to 15% on component level [1].**

- **[1] Assler, H., Telgkamp, J. , "Design of aircraft structures under consideration of NDT", WCNDT-World Conference of Non-Destructive Testing, October 2004, Montreal, Canada**

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network (APPLICATIONS TO STRUCTURES)



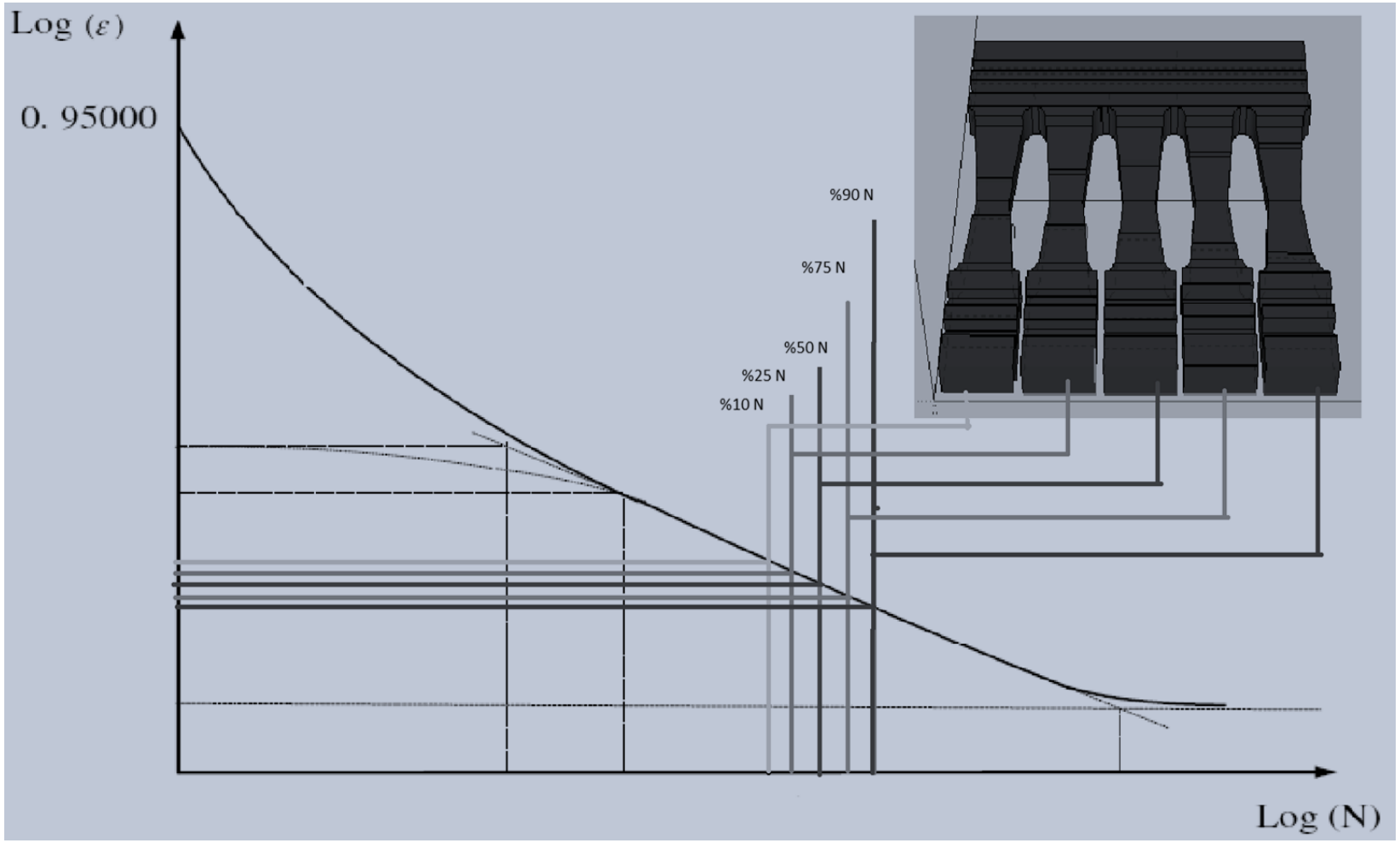
The intelligent fatigue sensor is designed to be attached to the surface by a special super bond very similar to strain gage attachments.

The sensor is mimicking the strains-stresses encountered by the structural member during its entire lifetime, and gives a live indication of remaining lifetime in a wireless manner depending upon the level of the fatigue cumulative damage indexes (Fatigue Life Cycles %10 N, %25 N, %50 N, % 75 N, %90 N)

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (APPLICATIONS TO STRUCTURES)

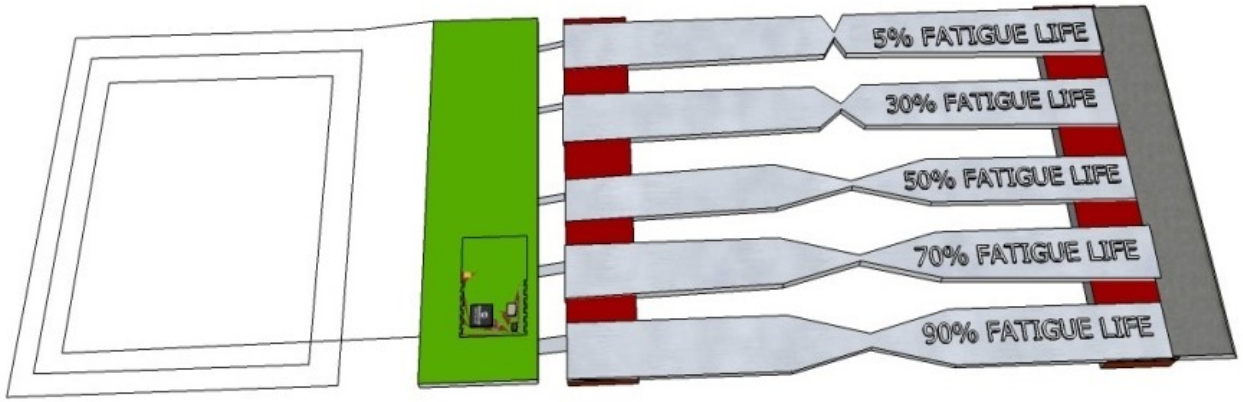
- **Identify all the Fatigue Critical HOT SPOTS in STRUCTURES for the applications of Smart fatigue damage sensors in order to monitor the RESIDUAL FATIGUE STRENGTH or Fatigue Lifetime. Specific and Fatigue sensitive regions, locations under high loads, predetermined and formerly known-experienced spots on the structures and mechanical components such as Riveted, Bolted and Hole Type Connections etc..**
- **Determine of maximum critical STRESSES in all the Fatigue Critical HOT SPOTS in STRUCTURES(Bolted and Welded Joints) by using FEA numerical model of the structure for the applications of smart fatigue damage sensors in order to monitor the RESIDUAL FATIGUE STRENGTH or Fatigue Lifetime Monitoring.**
- **Development of Fatigue Model or Models of the selected FATIGUE SENSITIVE HOT SPOTS and Virtual FEA-Numerical Modeling and Analysis of the whole structure.**
- **Determine also the multi axial stresses acting locations and Find the principle stresses and directions for the applications of the sensors.**

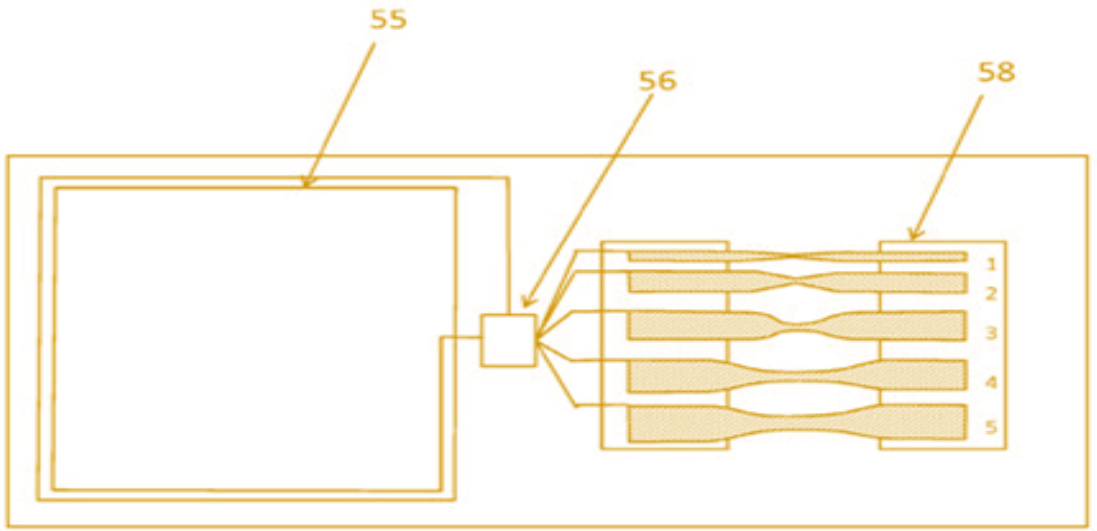
A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (STRAIN BASED FATIGUE DESIGN)



The FATIGUE DAMAGE SENSOR mini beams are designed according to STRAIN BASED FATIGUE DESIGN APPROACH.
The fatigue sensor with parallel mini beams having different fatigue lifetimes %10 N, %25 N, %50 N, % 75 N, %90 N-Total Lifetimes.

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (PASSIVE SENSOR MODEL)

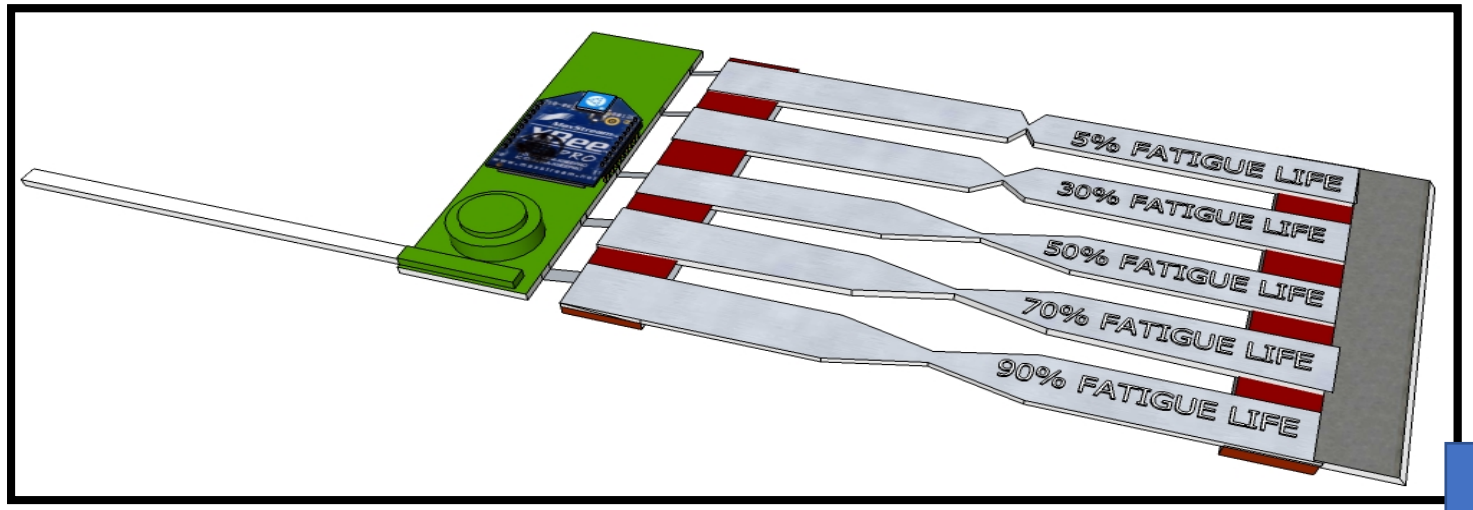




Fatigue Sensor (Patent N0. US 8,746,077 B2)

The sensor with no battery is shown in figure. This type is powered by RF power emitted by the interrogation wand. Interrogation distance of RFID type devices depend on both transmitter power and the coil size of the receiver.

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (ELECTRONIC UNIT)



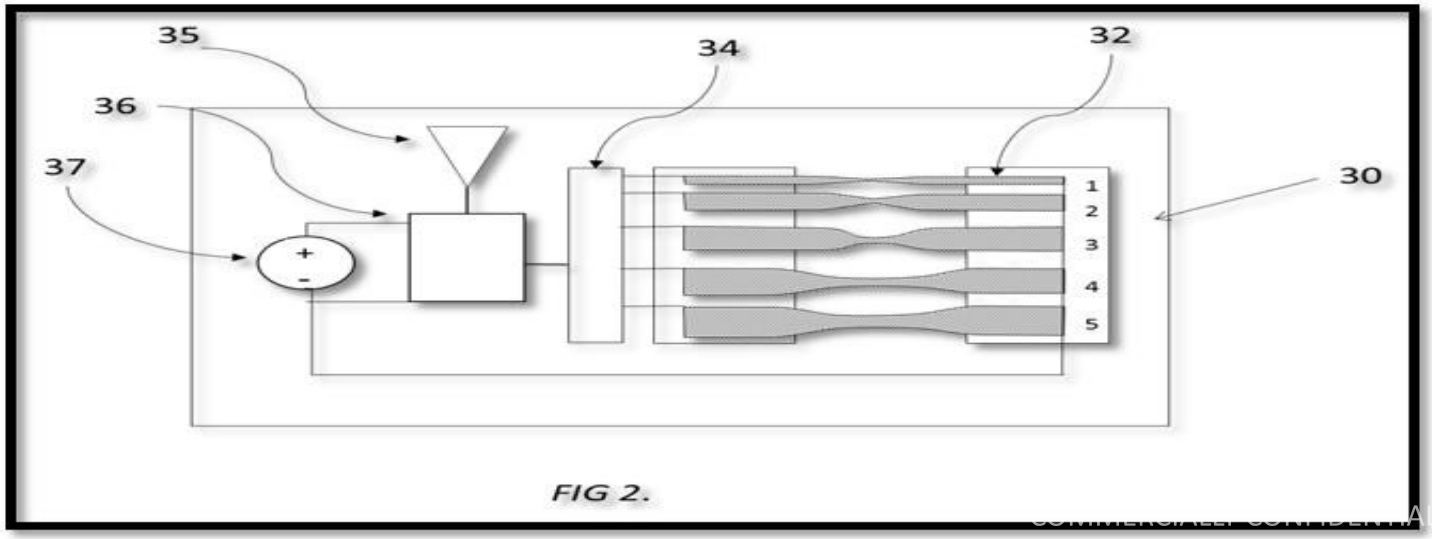
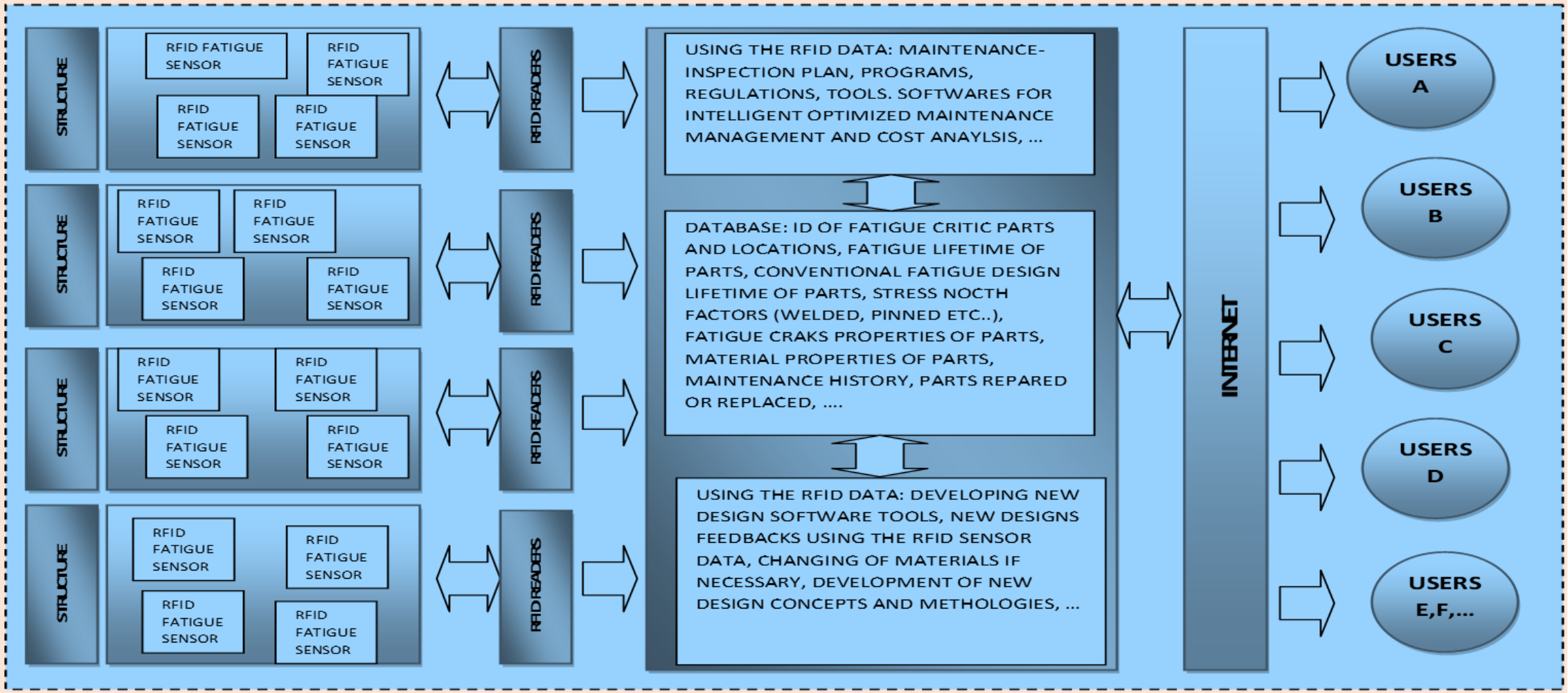


FIG 2.

The FATIGUE DAMAGE SENSOR mini beams are designed according to STRAIN BASED FATIGUE DESIGN APPROACH.
The smart fatigue sensor with parallel mini beams having different fatigue lifetimes %5-10 N, %25 N, %50 N, % 75 N, %80-90 N-Total Lifetimes.

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (IoT SYSTEM MODEL)



A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (DISTRIBUTEDSENSOR NETWORK DATABASE)

DATABASE:

The RFID Fatigue Sensor System collects;

The operational lifetime history of each fatigue critical component or location, the fatigue properties of the critical part, the type of fatigue cracks, the maintenance history, the fatigue maintenance history of each critical location or component, the fatigue sensitive details of the structure, the component manufactured time, the manufacturer of the part, the ID number of the component, the part and critical connections., the part expected scheduled repair time, the part material properties, the part redesign needs and design modification or revision, the part connection properties(rivet, welded, lap joints etc..), the parts repaired or replaced, the parts expected service lifetime, the parts crack lengths and many more useful information of structures.

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (TANKER-BUILDING APPLICATIONS)

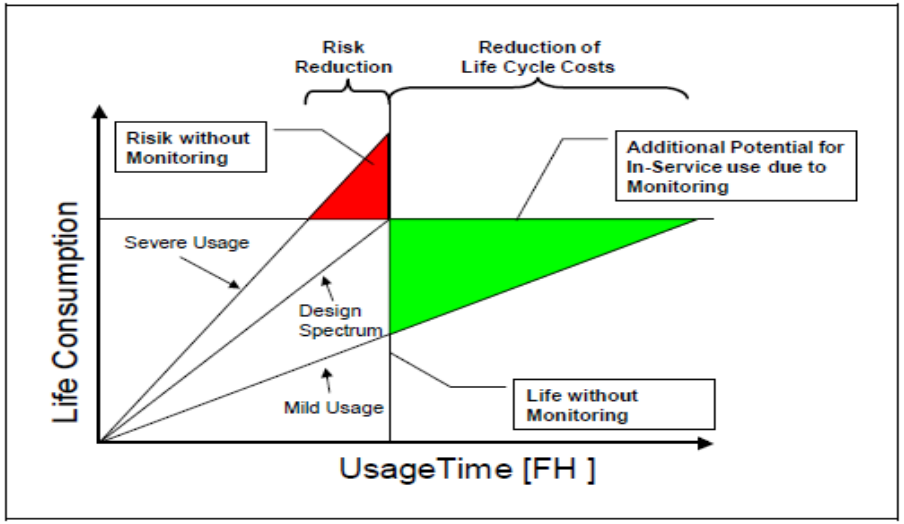
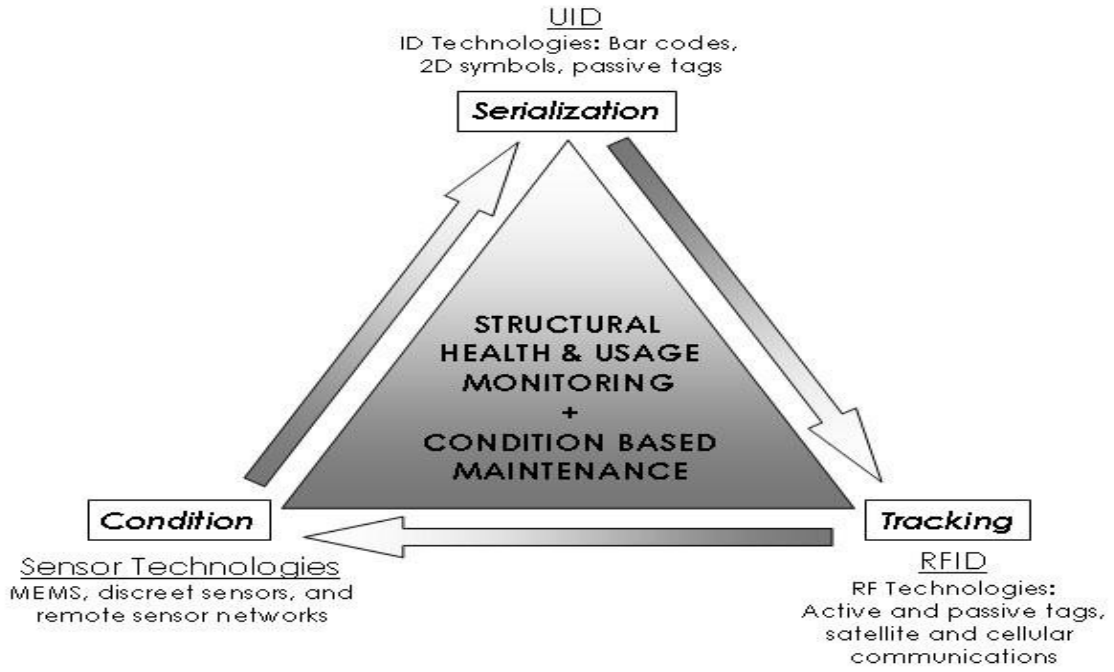


Figure 2: Benefit of Structural Health Monitoring



The Main Elements of the Smart Fatigue Damage Sensor for Structural Health Monitoring-SHM
(INTELLIGENT CONDITION BASED MAINTENANCE MODEL)
The Smart RFID Fatigue Sensor System for SHM

- **Condition Detection with Sensors**
- **Tracking RF Technologies**
- **ID Technologies**

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (INTELLIGENT CONDITION BASED MAINTENANCE MODEL)

CONVENTIONAL STRAIN GAGE USED FATIGUE DESIGN AND SCHEDULED-PLANNED BASED MAINTENANCE OF STRUCTURES

PERIODICAL SCHEDULED-PLANNED BASED INSPECTION-CHECK DURING NOT IN SERVICE. FOR FATIGUE INSPECTION OF STRUCTURES, CRACKS SHOULD BE VISIBLE OR DETECTABLE CHECKING FOR ANY REPAIR OR MAINTENANCE CASES.

FATIGUE INSPECTION OF STRUCTURES WITH CONVENTIONAL STRAIN GAGE BASED DESIGN, FATIGUE CRACKS SHOULD BE VISIBLE OR DETECTABLE. HEALTH STATE OF STRUCTURES IS NOT KNOWN. A FULL SCALE FATIGUE TESTING OF STRUCTURE REQUIRED TO IDENTFY THE CRITICAL AREAS AND FATIGUE LIFETIME OF CRITICAL PARTS.

CONVENTIONAL STRAIN GAGE BASED INSPECTION-MAINTENANCE RELIES ON PERIODICAL SCHEDULED-PLANNED INFORMATION OR INSPECTION. CHECKING HEALTH STATE OF STRUCTURES IS MEASURED BY VISIBLE OR DETECTABLE SIGNS OR INSPECTIONS AND ALSO PROJECTED LIFETIME INFORMATION

RFID FATIGUE SENSOR AND PREDICTIVE-CONDITION BASED STRUCTURAL HEALTH MONITORING AND PREVENTIVE MAINTENANCE OF STRUCTURES

RFID FATIGUE SENSOR BASED CONDITION MONITORING OF STRUCTURAL HEALTH STATE. CONTINUEOUS OR PERIODIC CHECK OF STRUCTURES DURING OPERATION (IN SERVICE) FOR ANY REPAIR OR MAINTENANCE CASES DO MIANTENANCE BASED ON SENSOR DATA WHICH SHOWS THE HEALTH STATE OF STRUCTURE.

CUMULATIVE FATIGUE DAMAGE INDEX OF RFID FATIGUE SENSORS IS MIMICKING STRUCTURAL HEALTH STATE (CUMULATIVE FATIGUE DAMAGE INDEX) OF STRUCTURES. % 90 USAGE OF LIFETIME OF STRUCTURES OR TOTAL CUMULATIVE FATIGUE DAMAGE INDEX REACHES TO 0.9. PARTS CAN BE REPAIRED OR REPLACED.

RFID FATIGUE SENSOR BASED CONDITION MONITORING SHM SYSTEM RELIES ON THE SENSOR DATA.WHEN THE RFID SENSOR LIFETIME REACHES TO % 90 CYCLES OR TOTAL CUMULATIVE FATIGUE DAMAGE INDEX REACHES TO 0.9. THE STRUCTURAL PARTS CAN BE REPLACED OR REPAIRED. INCREASES RELIABILITY AND REDUCES MAINTENANCE COSTS

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (INTELLIGENT CONDITION BASED MAINTENANCE MODEL)

SOFTWARE FOR INTELLIGENT MAINTENANCE MANAGEMENT FOR STRUCTURAL FATIGUE HEALTH MONITORING OF A UNIT AND A FLEET

- **The required maintenance decisions and the health state of critical parts of structures are given according to the RFID Fatigue Sensor Network data. The RFID Fatigue Sensor network information is mandating, the time of the fatigue damaged parts or locations should be repaired or replaced.**
- **Therefore, the proposed RFID Fatigue Sensor based Intelligent Predictive-Condition Based Maintenance Model is very efficient and effective strategic system since it increases service life and reliability and reduces maintenance and operations expenses.**
- **The proposed RFID Sensor Based Structural Health Monitoring and Maintenance Strategy are based on the periodic or real-time sensor information to optimize maintenance resources.**

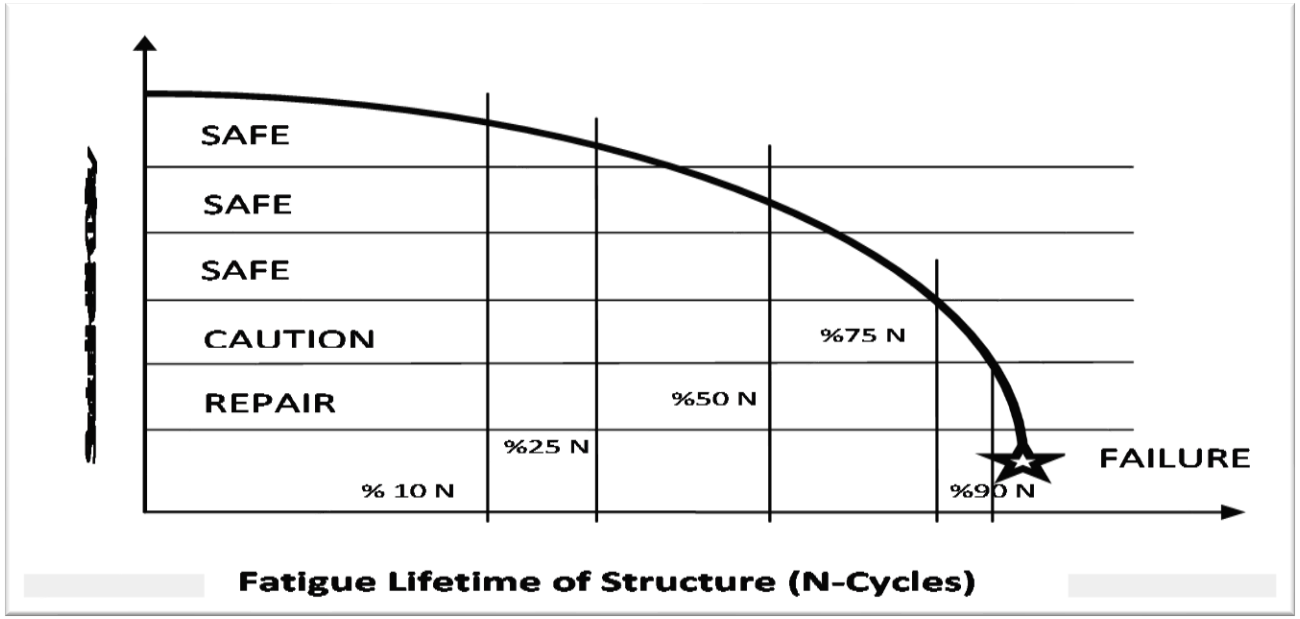
A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor
(INTELLIGENT CONDITION BASED MAINTENANCE AND LIFECYCLE MANAGEMENT MODEL)

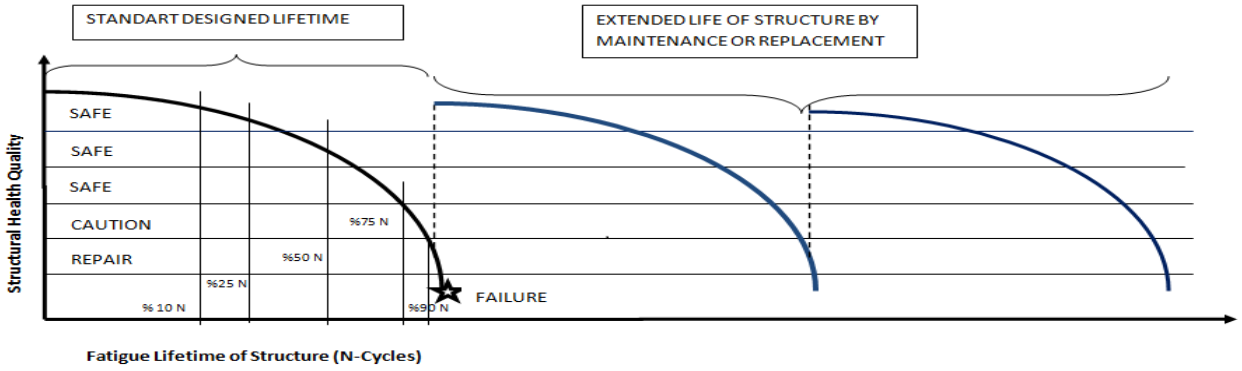
- **Do maintenance based on the state of the structure as need arises**
- **Increases availability**
- **Reduces maintenance costs**
- **Increases reliability**

THE LIST OF RFID CHIPS STORED STRUCTURAL FATIGUE MANAGEMENT INFORMATION OF EACH FATIGUE CRITICAL PART OF ESCALATOR AND ELEVATOR STRUCTURES

- **a) The operational history of each critical component**
- **b) The maintenance or fatigue maintenance history of each component**
- **c) The information related to the configuration of the AICRAFT PARTS in which the component is installed**
- **d) The date the component manufactured**
- **e) The name of the supplier of the component**
- **f) The serial number of the component**
- **g) The part number of the component.**
- **g) The part expected scheduled repair time**
- **h) The part material properties**
- **i) The part redesigns needs and design modification or revision**
- **k) The part connection properties (rivet, welded etc…)**
- **l) The part repaired or replaced**
- **m) The part expected service lifetime**
- **n) The part ……**

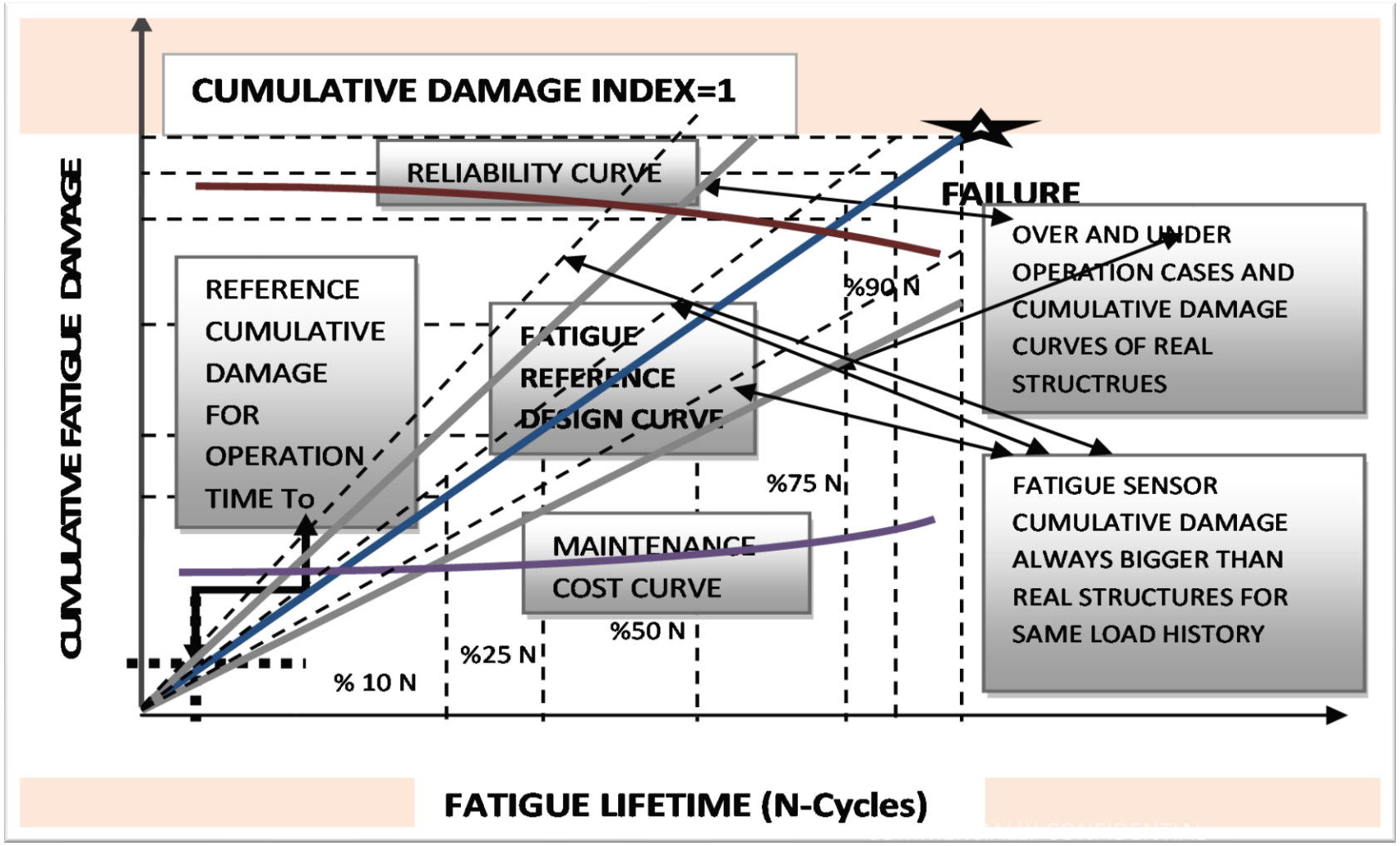
A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (HEALTH QUALITY AND LIFE EXTENSION)





- The required maintenance decisions and the health state of critical parts of structures are given according to the RFID Fatigue Sensor Network data.
- The RFID Fatigue Sensor network information is mandating, the time of the fatigue damaged parts or locations should be repaired or replaced.
- Therefore, the proposed RFID Fatigue Sensor based Intelligent Predictive-Condition Based Maintenance Model is very efficient and effective strategic system since it increases service life and reliability and reduces maintenance and operations expenses.

A Novel Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor (CUMULATIVE DAMAGE MODEL)



The proposed RFID Sensor Based Structural Health Monitoring and Maintenance Strategy are based on the periodic or real-time sensor information to optimize maintenance resources., INCREASES RELIABILITY, AVALIBILITY, SAFETY, AND EXTENT THE SERVICE LIFE OF STRUCTURES

Wireless Enabled SHM-RFID-IoT Smart Fatigue Damage Sensor Network

(WIRELESS FATIGUE DAMAGE SENSOR NETWORK FOR INTELLIGENT STRUCTURAL HEALTH MONITORING, MAINTENANCE AND DESIGN)

INTELLIGENT DESIGN SOFTWARE BY USING THE RFID FATIGUE DAMAGE SENSOR DATA FOR FATIGUE STRUCTURAL HEALTH MONITORING

The structural fatigue health conditions of critical parts of structures are given according to the RFID Fatigue Sensor Network data. These data also provide a lot of information for new fatigue design improvements and also new design concepts. For this reason, the sensor data could affect the fatigue design regulations and methodologies since it is representing an extended periodic or real lifetime fatigue data for a unit and fleet of structures with SHM system.