CLAIMS

We claim:

1. A system for monitoring restraint of one or more containers that have been restrainedly secured to a container ship by one or more restraint members, the system comprising:

the one or more containers;

the one or more restraint members for restraining respective ones of the one or more containers, wherein the one or more restraint members each comprise a turnbuckle member configured for fastening to a fixed point on the container ship via a shackle or fork member;

a plurality of sensors each configured for monitoring one or more of a compressive or tensile stress or strain in one of the one or more restraint members, wherein each of the plurality of sensors is attached to the shackle or fork member of the turnbuckle member for monitoring stress or strain in one of the turnbuckle members, and wherein each of the plurality of sensors comprise a Fiber Bragg Grating (FBG) sensor configured for measuring the stress or the strain in one of the turnbuckle members;

a controller optically coupled to the plurality of sensors and configured to periodically interrogate each of the plurality of sensors to ascertain a value of stress or strain detected by the respective sensor; and

a computing device electrically coupled to the controller and configured to monitor the stress or strain values ascertained by the controller and to determine whether each of the stress or strain values ascertained by the controller for the one or more restraint members satisfies a threshold condition in the FBG sensors for shipboard applications,

wherein the one or more restraint members monitored by the plurality of sensors are associated with only a subset of the one or more containers restrainedly secured to the container ship and are less than all restraint members restrainedly securing a container of the subset, the plurality of one or more containers in the subset selected in a selective manner based on container location.

2. The system of claim 1, wherein the plurality of one or more containers in the subset selected in the selective manner based on container location are selected for the subset based on the container being at a location more vulnerable as compared to locations of other containers in an immediate vicinity.

3. The system of claim 2, wherein the container being at a location more vulnerable as compared to locations of other containers in an immediate vicinity comprises the container being at an outermost container location in a row of containers.

4. The system of claim 3, wherein the containers on the container ship are stacked in longitudinally-oriented rows; and the outermost container location is a position on one of an outermost row with reference to a container ship longitudinal centerline.

5. The system of any of claims 2 to 4 wherein the container being at a location more vulnerable as compared to locations of other containers in an immediate vicinity comprises the container being part of a stack of containers having a highest stack weight as compared to stack weights of other stacks of containers in an immediate vicinity.

6. The system of any of claims 1 to 5, further comprising the container ship.

7. The system of any of claims 1 to 6, further comprising at least one temperature compensation sensor configured for adjusting stress or strain values detected by one or more of the FBG sensors.

8. The system of any of claims 1 to 7, wherein the controller is configured to interrogate each of the plurality of sensors at an interval having a frequency of one Hertz.

9. The system of any of claims 1 to 8, wherein the threshold condition in the FBG sensors for shipboard applications comprises a tensile or compression strain value in excess of a predetermined baseline value, and wherein the computing device is configured to set an alert condition when the value of stress or strain ascertained by the controller satisfies the threshold condition in the FBG sensors for shipboard applications.

10. The system of claim 9, wherein the alert condition is only set when the threshold condition has been satisfied continuously over each of a predetermined number of time-successive interrogations of one of the plurality of sensors.

11. A method for monitoring restraint of one or more containers each restrainedly secured in a container field on a container ship by one or more restraint members, the method comprising the steps of:

providing a plurality of sensors, each of the plurality of sensors configured for attachment to a shackle or fork member of a turnbuckle member of a respective one of the one or more restraint members, wherein the turnbuckle member is configured to fasten the respective one of the one or more containers to a fixed point on the container ship, and each of the plurality of sensors comprising a Fiber Bragg Grating (FBG) sensor configured for measuring one or more of a compressive or tensile stress or strain in the turnbuckle member of one of the one or more restraint members, wherein the plurality of sensors are associated with only a subset of the one or more containers that have been restrainedly secured to the container ship, the plurality of containers in the subset selected in a selective manner based on container location;

configuring a controller optically coupled to the plurality of sensors to periodically interrogate each of the plurality of sensors to ascertain a value of stress or strain detected by the respective sensor; and

configuring a computing device electrically coupled to the controller to monitor the stress or strain values ascertained by the controller and determine whether each of the values of stress or strain ascertained by the controller for the one or more restraint members satisfies a threshold condition in the FBG sensors for shipboard applications.

12. The method of claim 11, further comprising the step of:

providing at least one temperature compensation sensor configured for adjusting stress or strain values detected by one or more of the FBG sensors.

13. The method of claim 11, further comprising the step of:

configuring the computing device to set an alert condition when the threshold condition has been satisfied for at least one of the plurality of sensors.

14. The method of claim 13, wherein the computing device is further configured to set the alert condition only when the threshold condition has been satisfied continuously over each of a predetermined number of time-successive interrogations of the at least one respective sensor.

15. The method of claim 14 wherein configuring the controller further includes configuring the controller to interrogate each of the plurality of sensors at intervals having a frequency of one Hertz.

16. The method of claim 11, further comprising the steps of:

fastening each container of the subset of the one or more containers to a fixed point on the container ship by the turnbuckle member of one of the one or more restraint members; and

attaching each of the plurality of sensors to the shackle or fork member of the turnbuckle member of one of the one or more restraint members.

17. The method of claim 16, wherein attaching each of the plurality of sensors to the shackle or fork member of the turnbuckle member of one of the one or more restraint members comprises attaching ones of the plurality of sensors to restraint members securing the subset of the one or more containers restrainedly secured to the container ship.

18. The method of claim 16 or 17, wherein attaching each of the plurality of sensors to the shackle or fork member of the turnbuckle member of one of the one or more restraint members comprises attaching ones of the plurality of sensors to restraint

members securing ones of the one or more containers positioned on one of an outermost row with reference to a container ship longitudinal centerline, the containers on the container ship being stacked in longitudinally-oriented rows, and/or positioned in a row having a highest stack weight among the plurality of containers on the container ship.