

CLAIMS

1. A computer-implemented method of characterizing an operating performance of first and second tubular members that are connectable to one another by a threaded pin connector and a threaded box connector defined respectively thereon, the method comprising:

receiving by a computer, a virtual model of the first and second tubular members connected to one another by the threaded pin connector and the threaded box connector;

applying by the computer at least one first simulated force to the virtual model, the at least one first simulated force sufficient to induce a simulated plastic deformation in at least one of the first and second tubular members of the virtual model;

relieving by the computer the at least one first simulated force from the virtual model such that a portion of a geometry of the virtual model is rearranged by the plastic deformation;

applying by the computer at least one second simulated force to the virtual model;
and

identifying by the computer at least one peak stress in the virtual model induced by the at least one second simulated force.

2. The computer-implemented method of claim 1, wherein the computer has a non-transitory computer memory with a computer code stored thereon, the computer code being operable to determine a stress and strain distribution in the virtual model corresponding to simulated forces applied thereto.

3. The computer-implemented method of claim 1, wherein the step of identifying the at least one peak stress includes identifying a peak stress at an uppermost engaged thread of the pin connector.

4. The computer-implemented method of claim 1, wherein the step of identifying the at least one peak stress includes identifying a peak stress at one or more of the following selected locations: a thread on the threaded pin connector; a thread on the threaded box connector; a weld defined between the threaded pin connector and a pipe portion of the first

tubular member; and a weld defined between the threaded box connector and a pipe portion of the second tubular member.

5. The computer implemented method of claim 4, further comprising the step of determining at least one capacity of a threaded connection, and wherein the at least one capacity includes at least one of a tensile elastic capacity and a compressive elastic capacity.

6. The computer-implemented method of claim 5, wherein the step of applying at least one first simulated force to the virtual model includes repeatedly applying a peak load to the virtual model, wherein the peak load represents a percentage of the at least one capacity.

7. The computer implemented method of claim 6, wherein the at least one second simulated force includes a plurality of second forces, and wherein the plurality of second forces define a predetermined sequence of load steps wherein each load step represents a factor of the peak load.

8. The computer implemented method of claim 7, wherein the sequence of load steps includes a load step representing a factor of zero times the peak load, a load step representing a factor of one times the peak load, and at least one load step representing an intermediate factor of the peak load, wherein the intermediate factor is between zero and one.

9. The computer implemented method of claim 8, further comprising, for each load step, determining a peak alternating stress within the threaded connection and a pipe alternating stress within a pipe portion of the first tubular member.

10. The computer implemented method of claim 9, further comprising the step of generating a report including a graphical diagram including a plot of a curve representing the peak stresses versus the simulated forces applied at each of the load steps.

11. The computer implemented method of claim 10, further comprising the step of determining a stress amplification factor defined by a slope of the curve over a selected range of the simulated forces applied.

12. The computer implemented method of claim 11, further comprising determining a generally linear range of the curve, and a generally non-linear range of the curve, and wherein the selected range of the simulated forces applied includes one of the generally linear range of the curve and a combination of both the linear and non-linear ranges of the curve.

13. The computer implemented method of claim 10, further comprising the step of performing an elastic analysis on the virtual model, wherein the elastic analysis includes the steps of:

applying a sequence of simulated loads to the virtual model equal to the plurality of second forces;

determining a simulated stress distribution in the virtual model for each of the sequence of simulated loads assuming a hypothetical fully elastic response to simulated loads;

determining a peak stress at the one or more selected locations for each of the sequence of simulated loads; and

plotting an elastic curve on the graphical diagram wherein the elastic curve represents the peak stresses determined in the elastic analysis versus the simulated forces applied at each of the load steps.

14. The computer implemented method of claim 13, wherein the report further includes a tabular diagram including each of the load steps and the peak stresses determined at each of the respective load steps.

15. A computer-implemented method of characterizing an operating performance of first and second tubular members that are connectable to one another by a threaded pin connector and a threaded box connector defined respectively thereon to form a threaded connection, the method comprising the steps of:

receiving by a computer a virtual model of the first and second tubular members connected to one another by the threaded pin connector and the threaded box connector;

performing by the computer a structural capacity analysis on the virtual model to determine an elastic capacity of the virtual model;

performing by the computer an elastic analysis on the virtual model, the elastic analysis including:

applying a sequence of load steps to the virtual model wherein each load step of the sequence of load steps represents a factor of the elastic capacity;

determining a simulated stress distribution in the virtual model for each load step of the sequence of load steps assuming a hypothetical fully elastic response to simulated loads; and

determining a peak stress at one or more selected locations within the threaded connection for each load step of the sequence of load steps; and

performing by the computer an elastic-plastic analysis on the virtual model, the elastic-plastic analysis including:

applying at least one first simulated force to the virtual model, the at least one first simulated force sufficient to induce a simulated plastic deformation in at least one of the first and second tubular members of the virtual model;

relieving the at least one first simulated force from the virtual model such that a portion of a geometry of the virtual model is rearranged by the simulated plastic deformation;

applying a sequence of simulated second forces to the virtual model wherein the sequence of second forces corresponds to the sequence of load steps of the elastic analysis; and

identifying a peak stress in the rearranged virtual model at each of the one or more selected locations induced by each of simulated second force of the sequence of second simulated forces.

16. The computer-implemented method of claim 15, wherein the step of performing a structural capacity analysis on the virtual model includes the steps of:

applying an incremental sequence of simulated loads to the virtual model;

analyzing a stress distribution of the virtual model corresponding to each simulated load of the incremental sequence until a predetermined criteria is observed; and

defining the elastic capacity as the simulated load that induced the predetermined criteria.

17. The computer-implemented method of claim 16, wherein the predetermined criteria includes an average stress observed in the virtual model is greater than a yield strength of the virtual model.

18. The computer-implemented method of claim 15, further comprising the step of performing at least one partial-capacity elastic-plastic analysis on the virtual model, the at least one partial-capacity elastic-plastic analysis including:

applying the at least one first simulated force to the virtual model;

relieving the at least one first simulated force from the virtual model;

applying a sequence of simulated third forces to the virtual model wherein the sequence of third forces corresponds to a predetermined percentage of the sequence of load steps of the elastic analysis; and

identifying a peak stress in the rearranged virtual model at each of the one or more selected locations induced by each of the simulated third forces of the sequence of third simulated forces.

19. The computer-implemented method of claim 18, wherein the at least one partial-capacity elastic-plastic analysis includes a plurality of partial-capacity elastic-plastic analyses wherein the predetermined percentages for each respective partial-capacity elastic-plastic analysis includes 20%, 25%, 50% and 75% of the sequence of load steps of the elastic analysis.

20. The computer-implemented method of claim 19, further comprising the step of generating a report including a graphical diagram including a plot of a curve representing the peak stresses versus the simulated forces applied at each of the load steps for each of the elastic analysis, elastic-plastic analysis and each partial-capacity elastic-plastic analysis.

21. The computer-implemented method of claim 20, further comprising determining a stress amplification factor defined by a slope of the curve for the elastic analysis over a selected range of the simulated forces applied, and wherein the report further includes the stress amplification factor.