

API Specification 2C Kingpost/ Pedestal Design and Fatigue Considerations

Since 1983, API Specification 2C requires the use of conservative allowable stresses for **kingpost** or **pedestal** design. The intent has is to ensure operating stresses, with respect to safe working load, are such that the API default 25,000 cycle design criteria will be automatically met without further consideration.

API Specification 2C—Allowable Kingpost/Pedestals Stress

To implement this specification, API **kingposts** and **pedestals** have additional factors of increase of 1.33 and 1.5 added to the **safe working load (SWL)**. This factored load is then used in conjunction with AISC allowable stresses. The nominal AISC allowable bending stress for round tubes is $0.66 * F_y$. This equates to a factor of safety of 1.5. When the factors of increase are applied, the resulting factor of safety relative to safe working load is approximately $(1.33 * 1.5 * 1.5) = 3.0$ with respect to yield. The allowable stress is approximately 33% of yield.

API Specification 2C—Fatigue

The API default of 25,000 cycles is referenced in both API Specification 2C (cranes) and API RP 2A (structures). The assumed load used in conjunction with the specified 25,000 cycles is specified to be **safe working load (SWL)** modified by a factor of increase of 1.33. ($SWL * 1.33$). If we take the 33% of yield referenced above and multiply by 1.33, we have an approximate stress of 44% of yield to be used for the fatigue analysis. $(.33 * 1.33) = .4389$

API RP 2A tells us that, for purposes of this fatigue analysis, the **boom** is considered stationary with respect to rotation and the applied load ($SWL * 1.33$) will be applied and released with out moving the **boom** (no stress reversal). (*Note: The API factors of increase are only applied to the **safe working load (SWL)** and not to the self-weight of the **boom**.*)

For example, assume a material with a yield strength of 50,000 psi. The self-weight of the boom is zero. (This is the worst possible assumption as the 1.33 factor is then applied to the total load.)

The maximum fatigue stress is then 22,000 psi. $(50,000 * 44\%)$. This is approximately the same number as $(50,000/1.33/1.5/1.5) * 1.33 = 22,000$ psi. Assuming zero self-weight, our maximum fatigue stress range is 22,000 psi.

(Note: Assuming the zero self-weight is presented strictly for illustrative purposes. In an actual fatigue analysis, when self-weight is deducted, the stress range will decrease. For a typical crane, with the appropriate self-weight

deducted, a stress range between 10,000 and 17,000 psi is common.)

API Specification 2C states the fatigue analysis can be done in accordance with either AISC Appendix K or the Fatigue Curves from API RP 2A.

AISC appendix K is for allowable fatigue cycles with respect to maximum stress range and connection details. If we assume a stress category of “C” and a loading condition of 1 (20,000 to 100,000 cycles), appendix K gives an allowable stress range of 35,000 psi. The 22,000 psi stress range is more than adequate for these conditions.

API RP 2A X and X’s curves provide fatigue design life for a given stress range. Using the formulas for each, the maximum stress range permitted to meet the fatigue requirements for the example load condition at 25,000 cycles can be found for each curve.

The maximum stress range for the X curve design life = 39,400 psi

The maximum stress range for the X’s curve design life = 36,700 psi (*Note: X’s is the more conservative curve.*)

As before, the 22,000 psi stress range is more than adequate for these conditions.

Conclusion

It is virtually impossible for any **kingpost** or **pedestal** constructed from 50,000 psi material to fail to comply with the fatigue requirements or API 2C and API RP 2A when conforming to the API 2C allowable stresses.

Additional Comments

To equate the API 25,000 cycle at 133% overload condition to meaningful loads, API Specification 2C, Sixth Edition Table B.5.4 provides a table of equivalent fatigue cycles.

The table below lists the minimum API equivalent design fatigue cycles from this table, based on percent of **safe working load (SWL)** under the column named **Equivalent Minimum Design Fatigue Cycles for API X’s Fatigue Curve**.

The next column, **Equivalent Fatigue Cycles: Maximum Possible Kingpost/Pedestal Stress Range API X’s Fatigue Curve** lists the API **kingpost** and **pedestal** cycle life based on the maximum mathematically possible fatigue stress range (where self-weight = 0) corresponding to the percentage of **SWL**.

Load, % of SWL	Equivalent Minimum Design Fatigue Cycles for API X's Fatigue Curve		Equivalent Fatigue Cycles: Maximum Possible Kingpost/ Pedestal Stress Range- API X's Fatigue Curve	
	Cycles	Stress Range	Cycles	Stress Range
133	25,000	36,700 psi	171,000	22,000 psi
75	213,000	20,700 psi	1,471,000	12,375 psi
50	970,000	13,800 psi	6,703,000	8,250 psi
25	13,000,000	6,900 psi	89,571,000	4,125 psi