Calculation of Attenuation Parameters of Tripods made of Different Material

1. Problem Definition

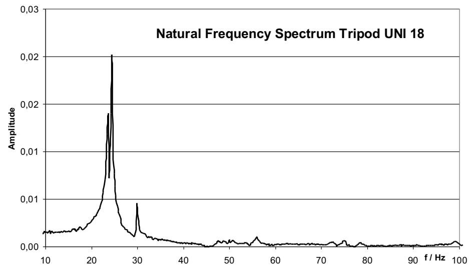
Several earlier tests and analyses have proved the advantages of wooden tripods.
This test series is to analyse whether certain materials are suitable to further optimise tripods for astronomic use. 5 tripods have been tested (2 wood, 1 wood/carbon fibre, 1 aluminium, 1 steel tube). The steel and aluminium pripods are widely used brand tripods, the wooden tripods are products of **Berlebach** Stativtechnik W. Fleischer, Mulda. All tripods are of about the same hight. The aim of the test series was to identify the attenuation parametres, especially the attenuation constant ∂ and the resonance frequency of the tripods.

2. Test Setup

The tripods have been placed uniformly on a concrete floor, the stands extracted to one third of the maximum length and loaded with 70% of their working load. Vibration was stimulated using a pulse hammer Endeveco 2302-5 with soft plastic dome according to the frequency range to be measured and a max. power of approx. 120 N. This high value has been chosen due to the large mass of the mounting, it is normally only created when accidently bumping into a tripod. The displacement was measured using a triangulation laser optoNCDT 1800-50.

3. Test Procedure

For digital processing of the analog time signals, a sampling rate of 370 Hz and 2048 time values were used. 4 separate measurements were carried out and averaged afterwards.
This transfer function was analysed by means of modal analysis. The results of the modal analysis are described as decay constant and corresponding natural frequency.

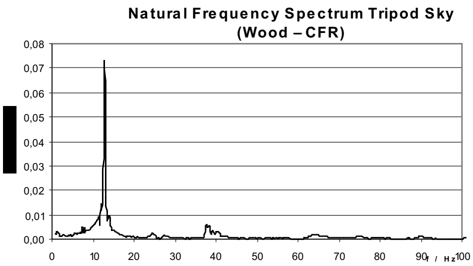


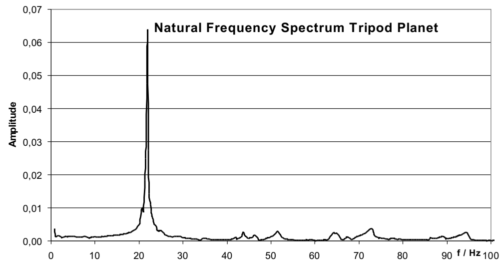
4. Results and Analysis

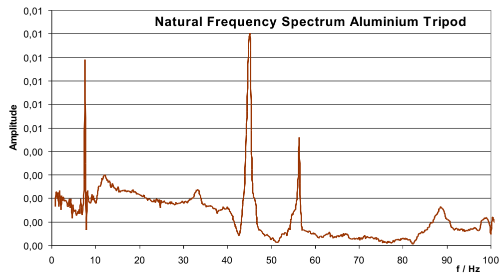
4.1 Natural Frequencies and their Meaning

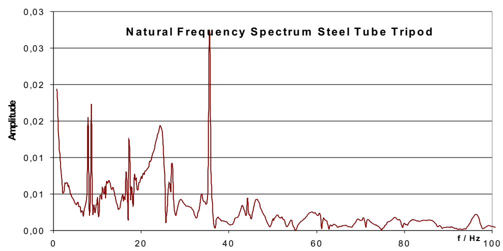
After measuring the corresponding natural frequencies it is clear that for the tripods Planet (wood) and Sky (wood - CFK) only one discreet frequency, for UNI 18 a close pair of frequencies and for the metal tripods at least three resonance frequencies determine the vibration settlement.
The resonance frequencies are displayed in the curve as distinct peaks.
These resonance frequencies indicate how a tripod is prone to resonances. The more resonance frequencies a tripod has, the higher is the danger of resonance feedback making observation impossible by causing vibrations in the whole system.
Here also the frequency (the rotation speed) of motors attached to the mounting must be taken into account. If these frequencies and the resonance frequencies of the tripod are almost identical, the tripod must be replaced.
Further more the tripod is more prone to vibrate in itself at certain wind speeds.

Occurance of several resonance frequencies (higher modal density) does also prolong the attenuation of the tripod. This is illustrated in the decay curves.





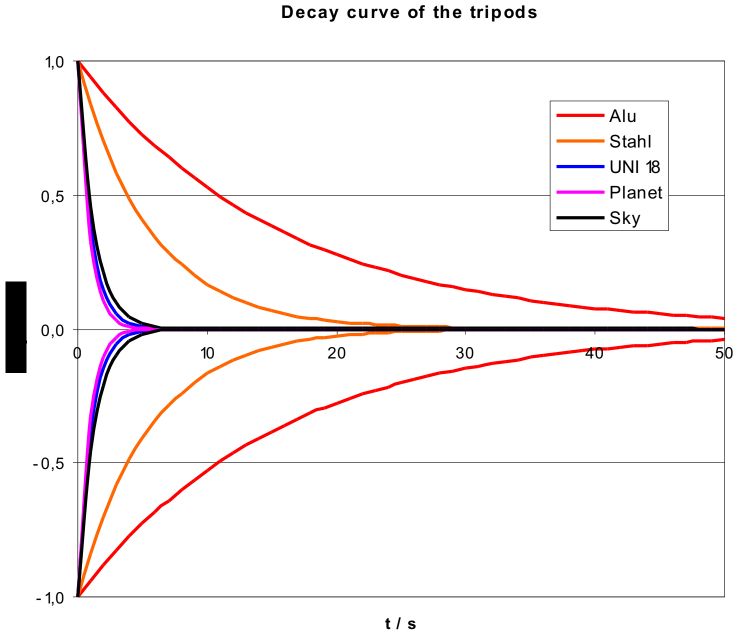




4.2 Decay Curves

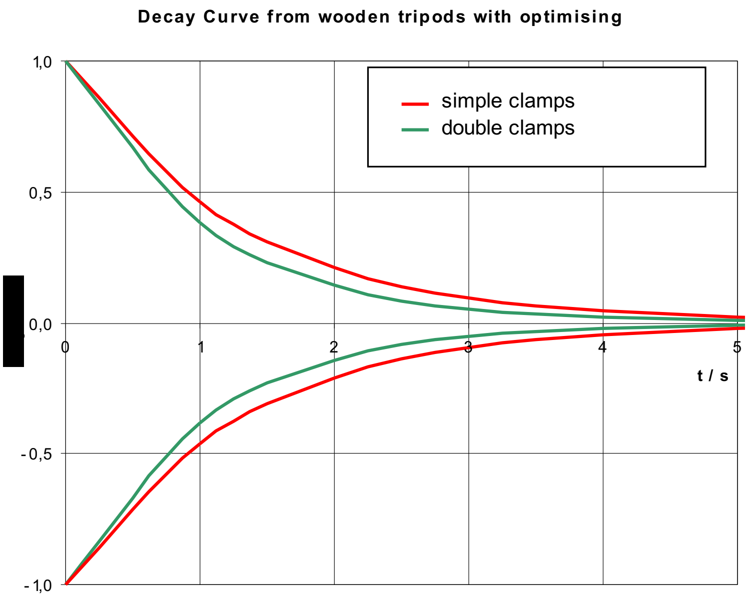
The following diagram illustrates the result stated in the previous tests: Wooden tripods can attenuate vibrations much better than tripods of other material. The faster the amplitude is running out to zero, the quicker the tripod is steady again. The relatively long periods of time are caused by the high excitation energy of 120 N. In practice, these periods are shorter.

The decay constants as attenuation measure are for wooden tripods about four times higher than for the metal tripods analysed. This causes the vibrations to calm down four times quicker at the tripod. The steeper curve for wooden tripods indicates that after 1 second the vibration intensity is reduced by 65% already, while for metal tripods, the reduction is only 10%.



4.3 Optimising Tripods

The connection between the extracable elements and the parts statically mounted to the head is the weak spot of every tripod. Mostly, only one point is clamped to the tripod and the connection allows only small movements. For higher safety and stability, sometimes double clamps are mounted to tripods. The diagram displayed on the right illustrates that better attentuation characteristics can be accomplished by using double clamps at tripods. Since clamping in several spots causes a longer parallel pressure of the segments resulting in a much tighter connection, vibrations in the connection are very limited. Even if the improvement is visible only in a small range, for higher focal lengths this leads to a steadier image.



5. Summary

Displacement measurements were carried out in pulse-excited tripods. After analysing the first decisive natural vibration form using signal analysis, the modal attenuations of the various constructions could be compared. The test results prove previous experiences that metal provides smaller attentuations than wood and wooden materials. From a vibration point of view, a wooden tripod is more suitable than a metal tripod

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Dresden , 06.04.2009