The Poor-Man's Warpless Pressure Case

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Vertical seismometers have exhibited considerable sensitivity to air buoyancy variations arising from atmospheric pressure and density fluctuations. This has required that they be surrounded by a pressure case in order to keep the atmosphere-induced noise at an acceptable level. It was realized early on that any microscopic flexing of the bottoms of such pressure cases must not be allowed to influence the stable mechanical connection between the instrument and the earth beneath.

Three solutions to the case-flexure problem seem to be in common use:

In relatively permanent installations the instrument can rest directly on a plate solidly bonded to the top of a massive concrete pier with a bottomless pressure cover sealed over it.

Testing STS-1 Verticals

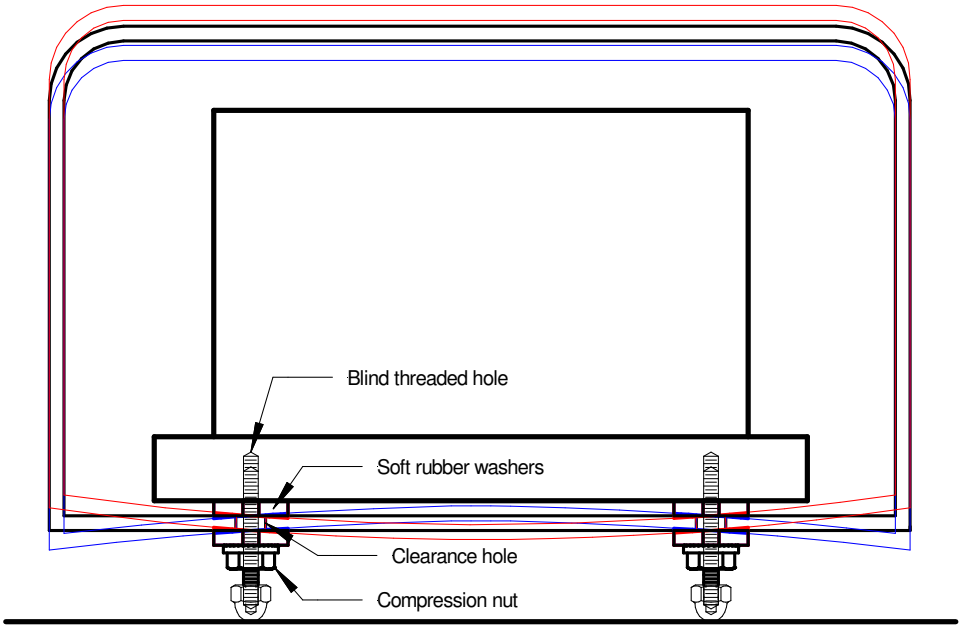
For more portability, a very stiff bottom plate can be used to support the seismometer, again with a pressure cover sealed over it. This plate must be extremely rigid in order to resist any tendency to flex as the atmospheric pressure changes. In the past, for their pressure isolation systems, the FBV instruments most often had employed granite plates, several inches thick.

Lennartz commercial pressure cover

In 1991 in cooperation with ASL, Erhard Wielandt helped perfect the "Warpless" seismometer base plate design, which was more compact and much lighter than a granite slab. It was allowed to flex under pressure changes instead of resisting flexing by brute strength, but it was designed to not significantly transmit the resulting distortions to the seismometer which rested on it. http://bnordgren.org/seismo/WarplessBase.pdf This beautiful but complex and expensive design has frequently been used in high-quality vertical seismometer installations. It was incorporated into the mounting for the vertical component of the Metrozet M2166-VBB STS-1 replacement, in their PBB-200S and a number of others.

Having tired of lifting heavy granite slabs and pressure cases, Dave Nelson was looking for a smaller, lighter alternative design, which would use the general principle of Wielandt's base, but which could be used by amateurs. First incorporated in his experimental Napa sensor and now in the upgraded Yuma2, this case design has proven itself capable of reducing atmospheric pressure effects to an insignificant level.

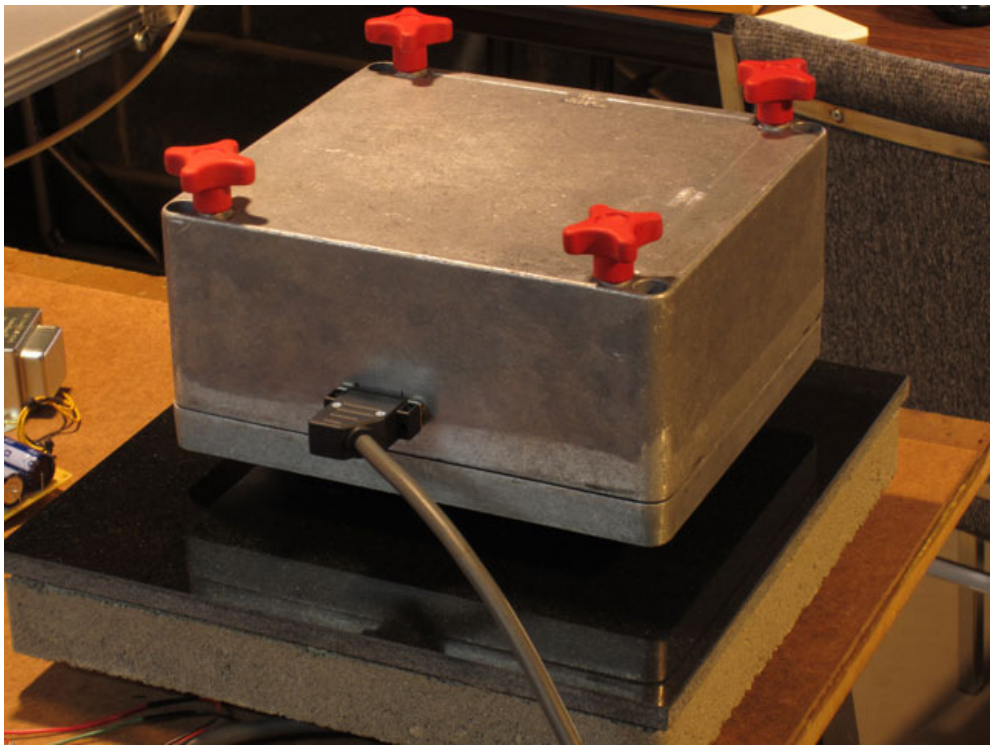
The figure below shows how it responds to a greatly exaggerated illustration of pressure-induced case distortion. In this design the seismometer is built or rests on a thick metal plate which contains blind holes into which are threaded the three adjustable support legs. The sealed pressure case walls may be relatively thin, though they must still be thick enough in proportion to the case volume to adequately attenuate outside pressure variations. The Yuma2 case is now built from a commercial waterproof box made by Hammond Manufacturing.



Principle of operation

On each leg, a pair of thick washers made from soft rubber such as silicone, provide the mechanical isolation from the forces resulting from the case's flexing. The top washer, clamped between the metal base plate and the case ensures the pressure seal, while another similar washer is clamped against the underside of the pressure case by a serrated, flanged nut. This only needs gentle tightening in order to provide an excellent seal, and it has proven adequate to resist long term air leakage in an evacuated case trial. The friction of the nuts against the rubber washers is adequate to prevent their rotating when the legs are turned as the instrument is leveled, while generous clearance holes in the case prevent any metal-to-metal contact between it and the legs.

As the case flexes the rubber washers absorb any small motions, preventing them from significantly distorting the internal mounting plate or the adjustment legs. Although not yet tried, it might be helpful to add very small rubber O-rings inside the clearance holes which surround the adjustment legs, to insure that they can't contact the case.



A Yuma2 in its case