7.13 Neck Curvature (relief) and Fret Height

The stronger a string is plucked, the more easily it can bounce onto the frets (those other than the fingered fret, Chapter 7.12.2) – the exact position of these "other" frets is therefore a decisive factor in the sound. On the unstressed guitar neck, all frets will have the same height; however, the string tension bends the neck and changes the distances between the frets and the string. According to the manufacturers, a slightly concave neck curvature is ideal; **Fender** recommends 0.25 mm clear width at the 8th fret, with the E_2-string pressed down simultaneously onto the 1st and last frets. **Lemme** allows for 0.3 – 0,5 mm, and **Gibson** proposes a different procedure: press down the string on the 12th fret and measure the clear width at the 7th fret – it should not read more than 0.4 mm. **Ovation**, on the other hand, reckons that the E_2-string should be pressed down at the 1st and the 13th fret, and the clear width at the 5th fret should read 0.13 – 0.38 mm. All these procedures merely allow the global neck curvature (also called neck relief) to be measured – the individual fret height cannot be checked this way. The latter is, however, of course just as important: if the 9th fret protrudes as little as 0.1 mm, the string fretted at the 8th fret does not sound right.

The neck relief depends on the solidity of the neck and the load forces acting on it: the string pull, and the counteractive force exerted by the truss rod. As the simplest model for an analytical description of a concave neck shape, mathematics offers us the 2nd-order parabola (**Fig. 7.148**). For the graphs, the height of the first and the last frets was defined as equal; on the left, three different neck curvatures are shown. However, a 2nd-order parabola can only serve to realize even (axially symmetric) functions – a scenario that cannot generally be expected for a guitar neck with a tapering cross-section. Help is on the way in the form of a 3rd-order parabola (right-hand graph); it can represent skewed curvatures, as well. To which extent a guitar neck shows a skewed curvature depends on the progression of the cross-section of the neck, and on the truss-rod. The progression of the cross-section therefore does not only influence how the neck "feels" but also how and where the strings bounce onto the frets.

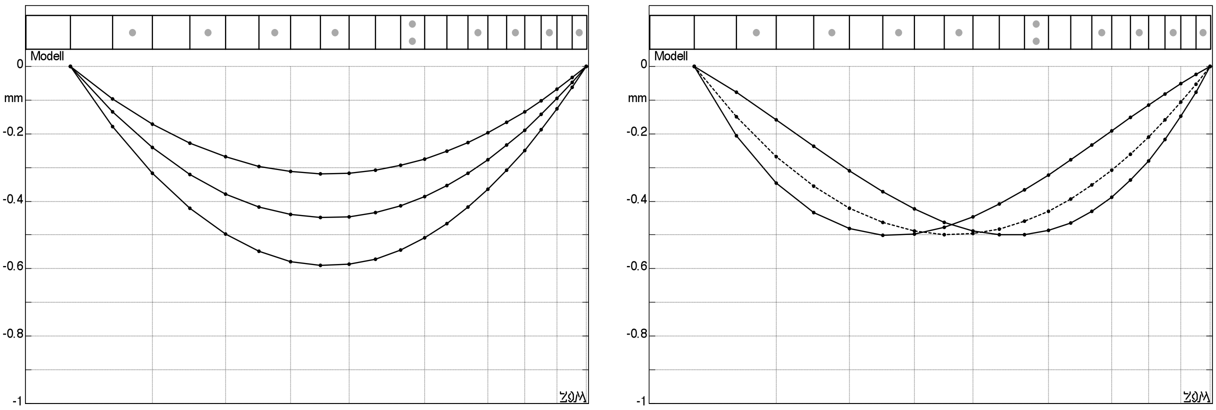

Fig. 7.148: Neck relief; 2nd-order parabola (left), 3rd-order parabola (right).

The graph as shown in Fig. 7.148 offers a good view of the neck curvature, but the relation to the string is still missing. If the latter is not fingered, it is supported by nut and bridge. The curvature is adjusted via the truss rod, and the so-called "**action**" (the distance between neck and string) is adjusted via the bridge height. As a benchmark, we find the general recommendation to adjust the action to about 1.5 – 2.5 mm at the last fret. This distance is difficult to measure with a ruler; it is more conducive to use a set of drills with a 1/10-mm-gradation between them. The drill-shank is pushed between string and last fret, and a check which drill fits just shy of lifting the string reveals the action.

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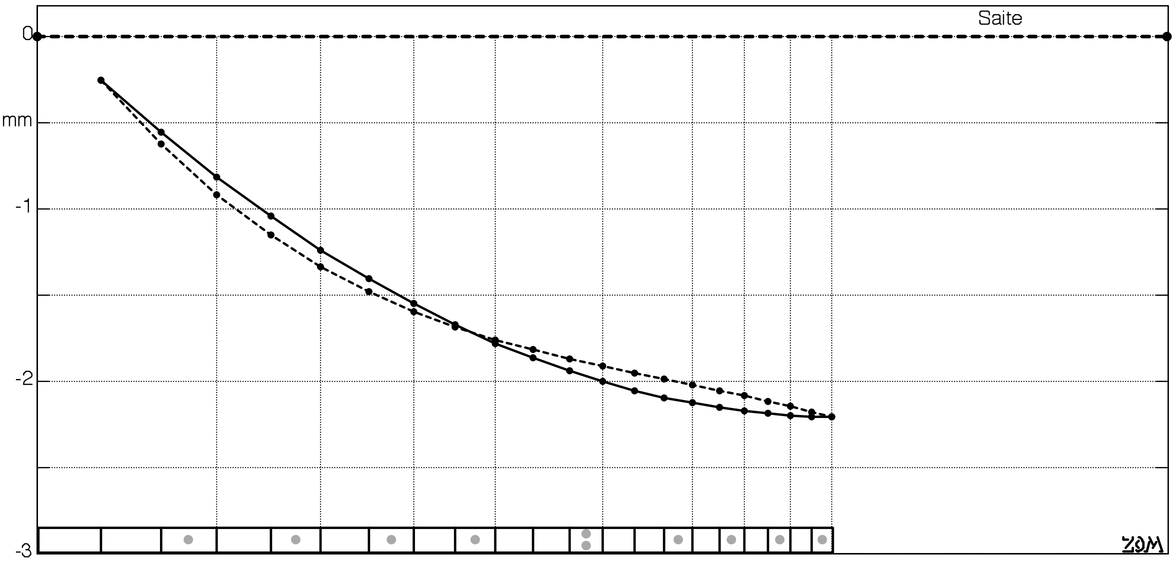

Fig. 7.149: Two different fret heights relative to the string ("Saite");
2nd-order parabola (——) / 3rd-order parabola (----).

Fig. 7.149 shows two differently curved necks and the string above them (dotted line). The width of the graph corresponds to the scale (about 65 cm) i.e. it covers a multiple of the height of the graph: the curvature therefore is strongly exaggerated. There is no "optimum" neck relief, but we frequently read that a convex curvature is not conducive, and too strong a concave one is not, either. Theoretical essays about the optimum neck relief most often assume sinusoidal string movements (often even with a fret-independent displacement-amplitude), and fail to consider the (in fact rather complicated) real shape of the string-oscillation. Generally, sections of shallow incline tend to be unfavorable, and therefore each of the (established) neck-profiles includes advantageous and disadvantageous sections. In the end, the choice is a matter of taste.

Contrary to the global neck curvature, the **differential fret-height** has to satisfy objective criteria: the height of each fret needs to precision-fit within a few hundredths of a millimeter relative to a regression curve (representing the average curve)! This precision can, however, not be achieved if the frets are simply hammered into the neck – further dressing (sanding) of the frets is mandatory. On the following pages, measurements are depicted that were taken on a measurement table using a dial gauge. Control measurements with a straightedge showed a measurement error of about 1/100th of a mm – accurate enough for such measurements.

All measurements were taken between the D-string and the G-string with the guitar laid on the measurement table; the guitar body was (horizontally) pressed down onto the table. The neck was not supported. The electric guitars were strung with a 009 – 046 string set (Ernie Ball) and tuned to 440 Hz (regular tuning). The setup for the acoustic guitars included a 012-string-set and also regular tuning. The graphs need to be seen as showing a randomly picked sample; they are not necessarily typical for the respective type of guitar. Still, we can obtain from this reference values about common curvatures and errors in the individual frets.

The **USA-Standard-Stratocaster** had been played little; it still featured the original frets. The small warping at the 7th fret is found between the E-and the A-string, as well – it is therefore not due to wear. The four graphs represent four adjustments of the truss-rod. The **Yamaha** was brand new.

The neck of the **Jazzmaster** (built in 1962) had been re-fretted once (ca. 1969); the guitar had been rarely played afterwards. The **truss-rod** was slackened, and with the 009 – 046 string-set, no sizeable neck-curvature could be adjusted. When the guitar was built, a 012-string-set was still standard. Note should be taken of the position of the apex: it was not found in the middle of the neck (like in the other Fender necks) but around the 6th fret.

The **Squier Super-Sonic** is worn; its fretboard would need a dressing. The **100-Euro-Squier** is new and shows that an acceptable neck can be realized at very low cost (the loathsome machine-heads being a different matter).

The Gibson **Les Paul** still has its original frets and (hopefully) a long life ahead. The **ES-335** (built in 1968) received a new fret-job sometime and was played little afterwards.

The **Duesenberg** Starplayer TV is new; its frets were dressed on a CNC-sander. They are perfect.

The Gretsch **Tennessean** (built around 1964) has seen a lot of action; it shares its fate with the above Jazzmaster of similar vintage: the truss-rod is fully slackened (lower curve). The guitar has presumable been re-fretted at some point – that job was done with poor quality.

The **Ovation Viper** EA-68 already stood out in Fig. 7.7; it does not ignite much enthusiasm regarding the height of the (practically untouched) frets, either. The **SMT**, on the other hand, had received a makeover by the distributor of Ovation, and is perfect within the framework of the type-specific neck-shape. This guitar is not likely to be played very often on the highest frets.

The **Collings** is of Texan nobility and under no circumstance wants to be confused with a Collins. It (the Collings) is perfect – as is its price.

More than double the cost of the Collings (and still almost brand new) is the blue Personal-**Taylor**, with its 13th fret marching to a different drummer (no wonder given the number). So what – you won't want to press down 12 strings up there anyway. In Fig. 7.7, this was the landmark guitar.

The almost new **Martin D-45V** affords itself a swerve at the 16th fret – that is certainly not the result of excessive use. At the given price, something like that should not occur … but it doesn't really get in the way, either.

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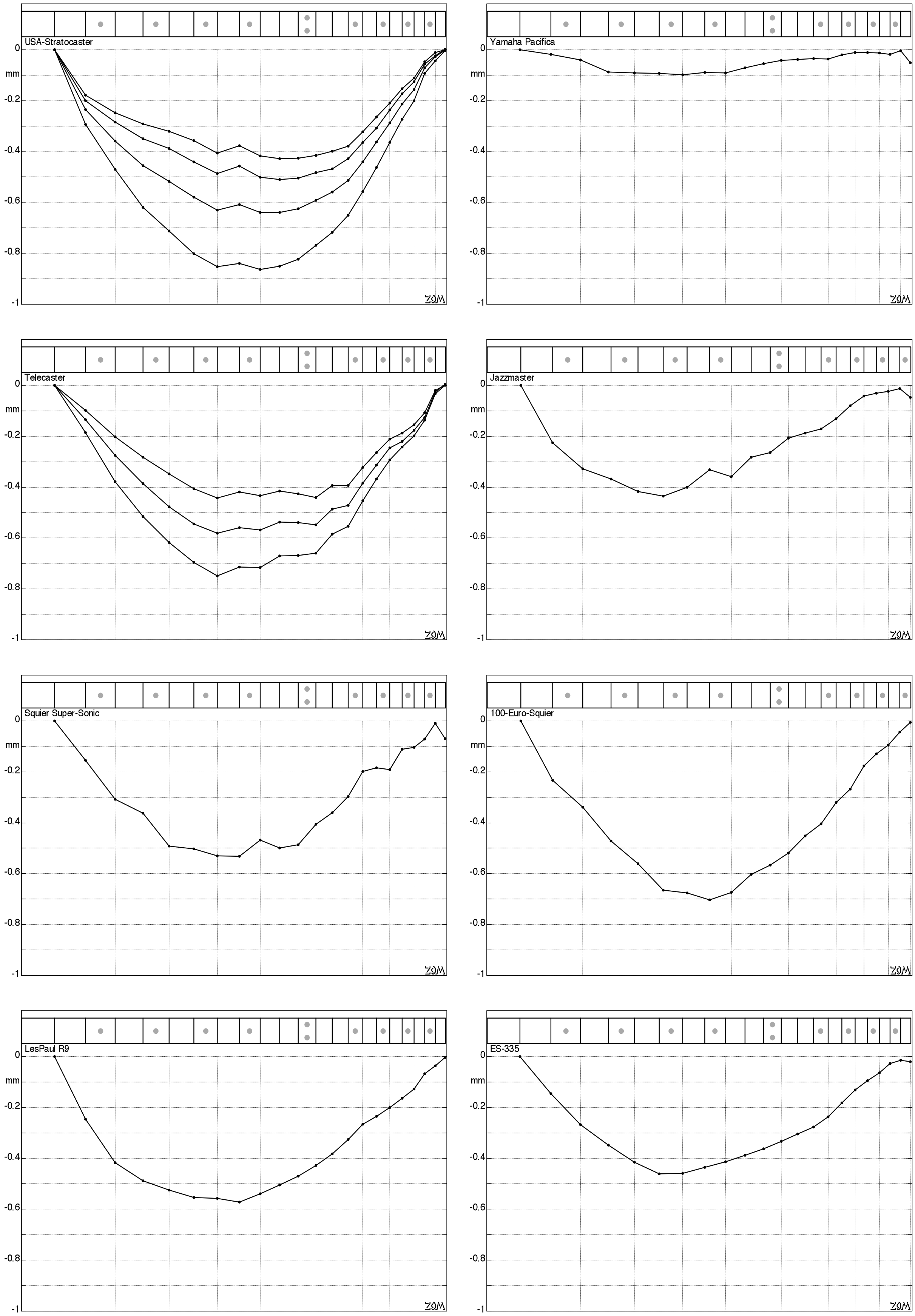

Fig. 7.150a: Fret-heights of various guitars.

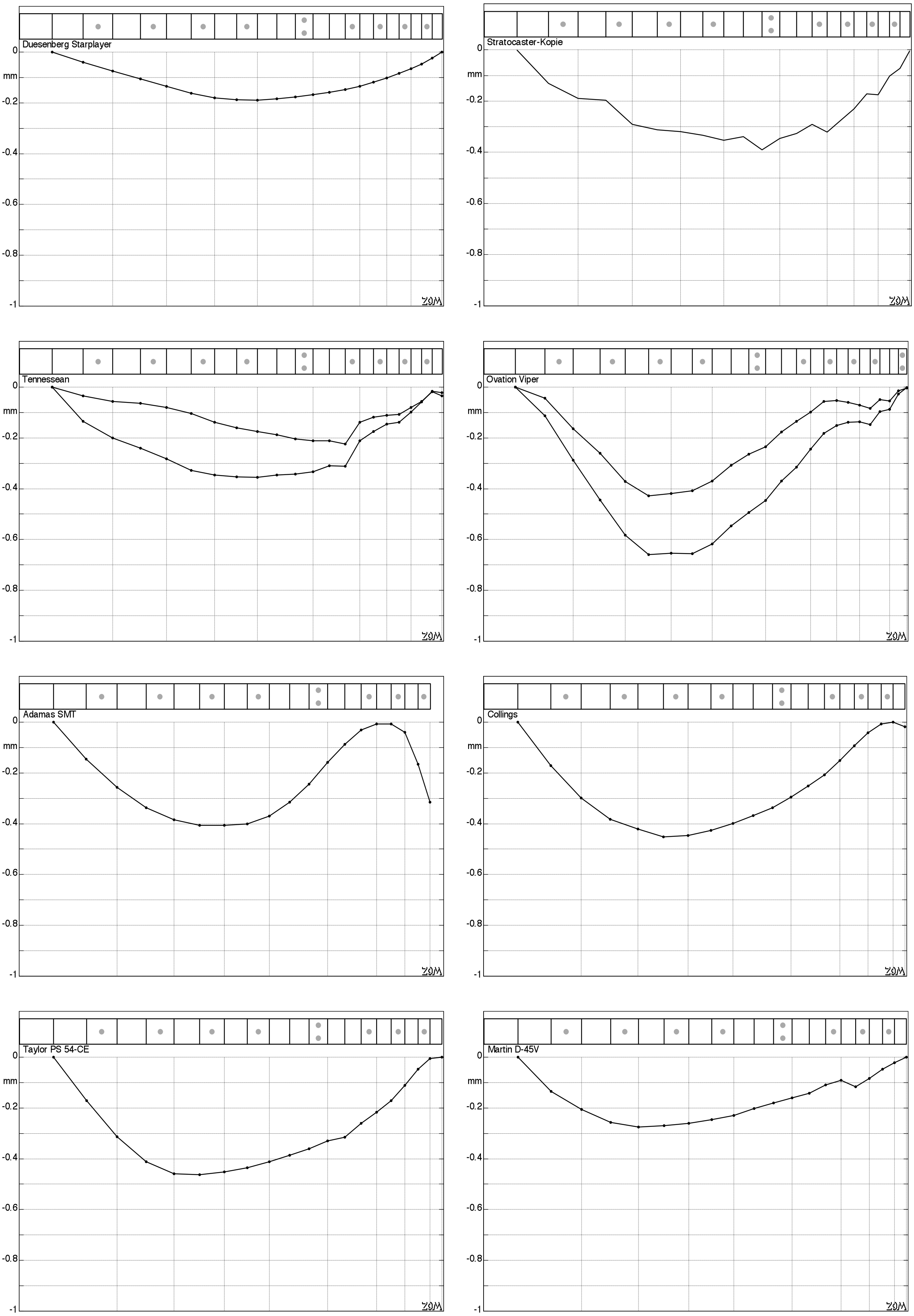

Fig. 7.150b: Fret-heights of various guitars.