Understanding Lens Diffraction

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http://www.luminous-landscape.com/tutorials/understanding-series/u-diffraction.shtml

This is not a comprehensive treatise on the subject of lens diffraction effects.
Rather, it's purpose is to bring to the attention of photographers who may not be aware
of the issue that there is no free lunch when it comes to achieving greater depth of field though stopping down.

Every photographer wants both maximum resolution and maximum depth of field. But unfortunately these two demands can be mutually exclusive. As you stop down the aperture on a lens the light passing through tends to diffract, reducing sharpness, though DOF is increased. The reason for this is that the edges of the diaphragm blades in the lens tend to disperse the light. At larger apertures this diffracted light is only a small percentage of the total amount of light hitting the sensor or film, but as the aperture is stopped down the amount of diffracted light becomes a larger percentage of the total amount of light being recorded.

This is why it's important to test each lens in your arsenal for the point at which they are visibly affected by diffraction. After recently purchasing four ultra-high performance Rodenstock medium format lenses for use with a 39 Megapixel Phase One P45 back, I was curious to see whether Rodenstock's claim that these lenses were diffraction limited would hold true. Since diffraction cannot be completely eliminated, the finest lens is one that produces an image whose quality is limited only by diffraction. A lens such as this is said to be "diffraction limited". And with a diffraction limited lens, wide apertures demand higher resolution before the diffraction limit is reached.

The frames below were taken at every available aperture with a 180mm f/5.6 Rodenstock APO Sironar HR lens. The lens was stopped down one stop at a time, and the shutter speed opened up accordingly to maintain exposure. These 100% crops of the full frame have not been processed in any way, with no sharpening having been applied. These are screen grabs are from the Focus Utility in Capture One raw conversion software.

These were taken with a Phase One P45 39 Megapixel back on a Linhof 679cs camera. A very heavy tripod was used, there was no wind, cable release (of course) and every other measure possible to ensure that the only effect being seen is diffraction.

Study pictures on Page 2

For a slightly more advanced explanation of Diffraction go to this site Diffraction

CONCLUSION

It doesn't take an experienced eye to see how f/5.6 has a small but visible edge. f/8 is very close, but f/11, though still usable, is starting to deteriorate. After that resolution declines rapidly. I regard f/32 and f/45 as unusable.
Optical theory says that a perfect lens will be perfect wide open, and that diffraction will start to take its toll as the lens is stopped down. Some of the very best 35mm lenses show this. I'm thinking of the Canon 300mm f/2.8L IS, which measures as well wide open as stopped down one or two stops. There may be others. But most lenses need to be stopped down to improve some of their other optical characteristics, and so like most things in life there are compromises to be made.

With this lens at least, and by inference others in Rodenstock's HR line which are claimed by the company to be similarly diffraction limited, we have a lens that is possibly about as good as the current state of the lens designer's and maker's art can produce.

If you would like a more detailed (Highly Advanced) description of the relationship of diffraction to photography you might want to read the following page. And if you'd like the math, this page will also be found to be of interest.


f/ 5.6


f/ 8


f/ 11


f/ 22


f/ 32


f/ 45