How Much is Too Much?

by Wes Bender

On a recent birthday, I got a tee shirt with a fly fishing scene on the back and the slogan, “Too Much of a Good Thing is Still a Good Thing.” I know that holds true for fly fishing, actually for all forms of fishing for that matter, and probably applies to quite a few other things in life, but it doesn’t really apply to powder factors or the amount of explosive that you load. A short case history might better explain my point.

Back in 1984, I got a call from the contractor’s project manager on a large hydroelectric project in the central Sierras. He wanted me to come investigate a situation that had developed. The owner’s inspectors were concerned about the quality of the tunnel ribs (walls). They were complaining that they were experiencing “druminess” when they tapped some areas in the ribs with their rock hammers. In their opinion, the contractor’s blasters were over-shooting the rock. They were concerned that chunks might fall out later when the tunnel was carrying water. They were threatening to shut things down if the contractor didn’t correct the situation.

I made a visit to the project site and met with the contractor’s engineers. They provided me with the tunnel blast designs that they had developed. I then went underground and witnessed the drilling and loading of a couple of rounds. I also checked into the “druminess” that was the source of the complaint.

The tunnel round design was a bit heavy. It called for 84 1-3/4” holes (not counting the four unloaded 3” burn relief holes) for an 18 ft wide horseshoe tunnel. When loaded with 1-1/2” water gel cartridges in the production holes and a combination of 1-1/2” water gel cartridges and 3/4” pre-split cartridges in the perimeter holes, the design powder factor was close to 6.5 lbs. per cubic yard. (Now before any of you surface blasters get too excited, tunnel rounds will naturally carry a higher powder factor than surface blasts because you are having to fracture and shift rock from a face that is perpendicular to the axis of the holes. It takes more powder to do this than when the holes are breaking to a parallel free face.)

The area of the face was approximately 290 square feet. Smaller tunnels with a corresponding smaller free face area will take higher powder factors and vice versa. From past experience in Sierra granite, I would have expected that the rock could probably have been adequately blasted at a powder factor not exceeding 4 to 4-1/2 lbs. per cubic yard. Compounding the problem was that the drillers were adding a few extra holes to each round. There could be several reasons for this. A couple of the tunnel hands had recently been involved in a tunnel project using water gels where they had a considerable amount of trouble with misfired holes. This had been attributed to detonating charges that increased the density of cartridges in adjacent holes, desensitizing them. Of course, increasing the number of holes would probably exacerbate the problem rather than correcting it.

Another possibility is that some miners are worried more about failing to pull a round properly than they are about blasting it too hard (philosophizing that, “If a Little is Good, More Must be Better and Too Much is Just Right.”) While I sympathize with their concerns, one sometimes has to pay attention to the quality of the rock that you are leaving behind.

After comparing all the information that I had gathered and reviewing the magazine records to verify that my calculated powder factors matched their consumption numbers, I met with project management people to discuss my findings and to provide recommendations. My first was to have better field supervision of what was being accomplished at the face. The second was to reduce the powder factor in steps. This could be accomplished by reducing the hole count slightly. I further recommended that they attempt to reduce the "druminess" by reducing the column density in the outer production holes (those nearest the perimeter holes). The perimeter holes had been loaded with one primer cartridge and one cartridge of 1-1/2" water gel, followed by 3 cartridges of pre-split powder, and finished with two more cartridges of water gel. I recommended that they reduce this to one primer cartridge, followed by pre-split powder to the collar, stemming the collar if necessary. I also reiterated that I felt the tunnel rounds could eventually be successfully shot with a total powder factor of 4-1/2 to 5 lbs. per cubic yard.

I further expressed the opinion that the "druminess" that had been experienced may not have been from over-shooting the rounds. When rock that has been under compression for eons has a void suddenly opened within it, the rock tends to expand somewhat into the void. This is referred to as elastic rebound and can be quite violent in some situations. Several articles have been written about "rockbursts" in Canada and other locations.

After presenting my findings, comments and recommendations, they asked me if I could stay over one more night. They were having a meeting the next morning with the owner's management people and they wanted me to present my findings to them also. I indicated I was quite willing to do so, as long as they understood that I would be presenting exactly the same items even though some were a bit critical of the contractor's methods. They had no problem with this and indicated that I would be given a time slot early in the meeting.

……*then things took a very interesting turn.....*

Because I had not counted on staying the extra day, I had a little time to kill, so I called up a contractor from Redding who was doing some highway work in the local area and asked if he and his wife could join me for dinner. They were free for the evening and said they would be pleased to do so.

Nearby was a restaurant that served good food at reasonable prices. It was frequented by all the contractors, peddlers, consultants, etc. when they were in town. I met Bill and his wife there and we sat down in the dining room and ordered an adult beverage. Shortly after we were served our salads, a group of gentlemen came in and were seated fairly close to us. I recognized several of them as being some of the management people with the owner of the hydroelectric project. With them was a fairly distinguished-looking gentleman who seemed to be the center of attention.

As the evening wore on, this gentleman expounded on tunnel blasting, tunnel round design and similar things that led me to believe he might be some sort of consultant to the group. As he continued with his dissertation, much of what he was saying was sounding 'way too familiar to me and I came to the realization that I had read the same textbook. Apparently (as I confirmed the next day at the meeting), this gentleman was a professor at a well known west coast university and had been brought in to, in his words, "set this contractor straight".

I really didn't think it was right for me to hear all of what he had to say, but then it was really hard not to, considering the proximity. He was quite firm in his belief that "there wasn't a tunnel that couldn't be blasted with 4 lbs. or less per cubic yard." He was very much enjoying being the center of attention and, when we left, he was still holding forth. Some of his comments led me to believe that, while he had his theory down pat, he sure didn't have much field experience, at least in the blasting of tunnels in Sierra granite.

When I got back to the motel, rather than going straight to bed, I spent a little time going over my notes, rearranging them into a more logical sequence and doing a little "massaging" to better refute some of the statements to which I had been exposed earlier in the evening.

At the meeting the next morning, as the contractor was given the floor first, I was introduced to the personnel in attendance. All of the owner's people who had been at the restaurant the night before were there, in addition to their consultant, but none of them appeared to recognize me. I proceeded with my presentation, first outlining what I had done to verify everything about the blasting program. I then went into the matter of powder factor and what I proposed be done about it. I carefully laid out examples of blasting tunnels in similar rock. I paid particular attention to gradually bringing the powder factor down to 5 lbs. per cubic yard, and then lower if conditions allowed. I further addressed the theory of elastic rebound and its possible contribution to the perception of excessive druminess. Along the way, I tried to refute, and in a few cases reinforce, the points that I expected their consultant to make. It was apparent by the look on his face that his moment of fame had occurred the night before and would probably not be repeated at this meeting today. He didn't have much to contribute when it was his turn and, in a way, I felt a little sorry for him.

I never did tell the contractor about my experience of the prior evening at dinner. The only one who knew about it at the time was my Redding friend and his wife, who both found the situation hilarious. What I had overheard didn't have any impact on my findings or suggestions, only the manner in which they were presented.

The moral of the story: Too much of a good thing isn't necessarily still a good thing when it comes to powder factors in blasting ….. (or, for that matter, expounding on something when you aren't sure who might be listening or what they might do with it later).