From Green to Greener

BY MARTIN ANDERSON

The structural steel supply chain is efficiently sustainable—and there are ways to make it even more so.

AS BUILDING DESIGNERS STRIVE TO MINIMIZE THEIR ENVIRONMENTAL IMPACT and optimize their project designs, attention naturally turns to the material supply chains for those projects. So, can your steel supply chain be optimized?

Generally speaking, the modern U.S. structural steel supply chain can be outlined as follows:

Scrap ➜ Mill ➜ Service Center ➜ Fabricator

There are, of course, exceptions to this chain, but this sequence is true for most U.S. structural steel projects. Occasionally, well-meaning project teams may attempt to reduce environmental impact by stipulating, for example, that the scrap metal that goes into "their" steel must come from the project's immediate area or region.

In almost every case, such requirements actually result in a significantly increased environmental impact for the project. Why? Because the existing steel supply chain is highly tuned and efficient, and attempting to change it without careful consideration of the consequences will create more problems than solutions.

Scrap Yards

Scrap metal tends to be bulky and difficult to handle until it can be shredded or compressed. This means that metal recyclers tend to draw from their local area in order to minimize the shipping of unprocessed materials. A significant portion (60% to 70%) of scrap metal for structural steels comes from junked cars, which require processing before they can be shredded; mercury switches have to be removed, oils and other fluids drained for separate recycling, airbags removed, and so on. Even once shredded, scrap metal is not equally valuable and different customers have different requirements, so the scrapped metals must be sorted and separated accordingly.

All metal has value, and identifying and extracting that value as rapidly as possible drives recycler profitability.

Steel Mills

Steel mills operate most efficiently when they are producing at a constant rate, as this lets the operators tune their equipment to run at an optimal duty cycle. Anything that interrupts the process creates additional wear and tear on the system, and incurs large startup expenses—e.g., motors typically use far more energy when starting than when running, so the longer you can keep one running the cheaper that operation becomes.

An additional consequence is that mills tend to prefer ready access to their raw materials, which in U.S. wide-flange production is mostly scrap metal. The majority of the scrap metal they use comes from within a few hundred miles of the mill; sourcing the scrap from farther away increases cost and increases shipping variability.

This same logic applies to essentially all aspects of mill operation. For example, electric-arc furnaces need extremely robust cooling systems to keep equipment operational, but filtering and cleaning intake water can be extremely expensive and exposes the cooling system to unpredictable water quality and supply. To avoid this, mills use closed-loop water systems, so they only need to replace water that has escaped the system by evaporation. So it can be said that steel production uses almost no wastewater.

Similarly, energy is expensive, so mills have made great progress in stabilizing and reducing their energy use. Stabilizing power consumption at the mill in turn makes life easier for the electric utilities that supply the mill, helping them rely more on "base load" power stations (which are typically more efficient than the on-demand alternatives for the same reasons that a continuously operating mill is more efficient than one that starts and stops all the time).

Reducing electrical usage has the side effect of also reducing CO_2 output, since the major source for mill "emissions" is actually the utility company that supplies the electricity to the mill. U.S. structural mills reduced their carbon emissions by 47% between 1990 and 2005; they're on track for an additional 10% reduction in energy usage by 2012.

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Service Centers

Since mills are highly motivated to run continuously for greatest efficiency, and construction markets are highly variable, there needs to be a "shock absorber" in the system. This is one of the roles played by service centers. They buy large quantities of steel from the mills on an ongoing basis, and then store it for sale to fabricators as needed. Service centers can also enable more efficient use of steel by cutting it to required lengths.

Here's an example: Let's assume a standard 40-ft beam. If one fabricator needs a 25-ft piece and another needs a 15-ft piece, the service center can simply cut one beam into both pieces without either fabricator having to coordinate with one another. The alternative would be for each fabricator to buy a 40-ft section, cut the piece to the length they need, and keep the remainder on hand in case they need that particular length someday (potentially wasting it).

Service centers enable fabricators to buy only what they need, as they need it. So rather than purchasing all of the steel for a given project at the same time and storing it at their own facility, the fabricator can take delivery as the project progresses, making their own storage space available for staged delivery of finished material to the site, rather than simple stockpiles.

A further "hidden" benefit of service centers is geometric; large, single-storage yards are more efficient in terms of area vs. perimeter than many smaller storage areas, so one service center can store more material than many fabricators, using less space to do so. This also means fewer cranes, fewer forklifts, more efficient handling, and subsequently lower fuel consumption.

Fabricators

A major benefit of fabricators is that they do their work off-site, under controlled conditions. This means that only the materials necessary for the structure are actually shipped to the site; beams don't need to be trimmed on-site, holes needn't be drilled on-site, extra items aren't sent "just in case," and so on. Thus, nobody has to pay to truck materials that won't be used (trimmed ends and spare beams may not seem like much at first, but they add up quickly), and the gas needed to move them won't be burned.

Compare this to typical residential wood framing, where basically all pieces are custom-built on-site; scraps of wood cannot be reclaimed efficiently, and thus the overall level of construction waste is considerably higher.

Making Mistakes

Some projects, in an effort to meet arbitrary goals for "local materials," will attempt to require that the steel in their building come from scrap metal from their area. Simply put, this well-intended approach would create staggering waste at every level of the production chain.

Think about it for a moment: You'd be shipping a junked car from City A to City B to be processed. That entire trip is a waste, because there was already perfectly usable scrap metal in City B. Then the scrap from City A would have to be kept separate from all other scrap, which is still more waste, because it wouldn't allow efficient use of the scrap storage yard (which is predicated on maximum density of similar materials). Then, that "local" scrap would have to be shipped to the mill separately, creating yet another inefficient use of transport, since it likely wouldn't constitute a full shipment.

Once the mill received the scrap, they'd have to keep it separate again. Then, once they were ready to use it, they'd have to melt only that scrap, by itself, separate from everything else. In most cases, that wouldn't be a full load for the furnace, and worse, the mill would need to fire up the furnace separately for each type of structural member being used in the project, resulting in many small loads, erratic power consumption, and a lot of time spent changing out rolling equipment. The cost in time, money, and resources would be gigantic; even the local electrical utility would be affected and forced to waste effort due to the erratic power consumption pattern.

Even once the steel had been formed into structural members, the waste wouldn't be over yet! Those rolled steel members would have to be handled separately from all others—probably sent to a service center on their own truck rather than a fuel-efficient railcar or barge. The service center would need to keep them separate so that the fabricator could also keep them separate, and any extras would be unusable, because other projects wouldn't be able to use them as they weren't made with "their" scrap.

In the end, trying to use only local materials will have increased the project timeline, multiplied costs several-fold, and wasted extra fuel, increased wear-and-tear on equipment, and generally produced far more waste. The total impact on the environment would probably be a full order of magnitude greater, if not more.

Making Meaningful Improvements

The foregoing does not mean, however, that there aren't productive green steps to be taken. It simply means that designers must be careful to avoid creating inefficiencies by mandating requirements that seem on their face to be green, but which end up generating greater environmental impacts and fail to provide the desired benefits.

There are still things you can do that will have beneficial ripple effects throughout your supply chain. A few steps to consider:

- Recycle all ferrous scrap, from whatever the source. Throwing away any type of metal is the same as throwing away money.
- Enable just-in-time deliveries from your fabricator by developing a logical construction sequence and then sticking to it. This involves coordination with other trades, so the fabricator and erector can't do it by themselves, and the sooner it's hammered out the better.
- When specifying structural steel, make sure you're using the most common grades from Table 2-3 in the AISC 13th Edition *Steel Construction Manual*. For plates and bars, use Table 2-4; for various structural fasteners, use Table 2-5.
- Use readily available materials. For information on structural steel material availability, see **www.aisc.org/availability**.
- Be aware of the job specifications and their implications, and don't use products or parts that aren't necessary. For example, if your steel is going to be enclosed in the building envelope, there's no reason to require a coat of shop primer. It's unnecessary and therefore a waste of time, money, and resources.
- Always look for opportunities to develop efficiencies of scale through repetitive design. Designing many identical or similar items allows for considerable construction efficiency.
- Minimize post-bid changes; work that's already been done will need to be done again, wasting time, effort, money, and materials.
- Be sure connection forces are shown on the structural drawings; leaving them

out will result in wasteful connections that are stronger than they really need to be. Don't specify slip-critical connections unless they're actually needed. Don't say "weld all around" or specify complete joint penetration groove welds unless they're genuinely called for. Arbitrary catch-all requirements waste time, money, and reduce sustainability by demanding the use of materials that aren't truly required.

In the end, the most effective improvement that can be made is to help ensure that an efficient system can continue to run efficiently. MSC

For a related article on achieving savings via smart detailing and design, see "Save More Money" in the March 2008 issue.