Questions Regarding Adaptation of the “**WEAK-POST, W-BEAM GUARDRAIL ATTACHED TO CULVERT”** (Reference MwRSF Report TRP-03-277-14)

Cast-in-Place Culverts

We are working towards adopting the referenced weak post system for attachment to culverts as part of the overall MGS implementation in Illinois. However, we find that the recommended attachments do not cover many common cases, based on designs for common in our “Culvert Manual.” (<http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Manuals-Guides-&-Handbooks/Highways/Bridges/Design/Culvert%20Manual.pdf> .) Two main conflicts are noted:

* The total vertical mounting height from the top of headwall to the inside top span of the culvert is less than 17 inches for low-fill culverts with spans of 8 feet or less. It appears that each of the weak post attachments requires about 17 inches for this mounting face in order to fit the socket assemblies and to allow 4 inches from the center of the bottom anchor bolt to the edge of the concrete structure.
* The IDOT Culvert Manual shows a 6 inch radius detail along the upstream top edge of the culvert opening. This further reduces the height of the flat face for mounting the weak post socket assemblies.

For the first issue, here is a tabulation of typical low-fill (about 2 feet) design values for the height of headwall and thickness of top slabs compared to the needed 17 inch vertical face:

12 in

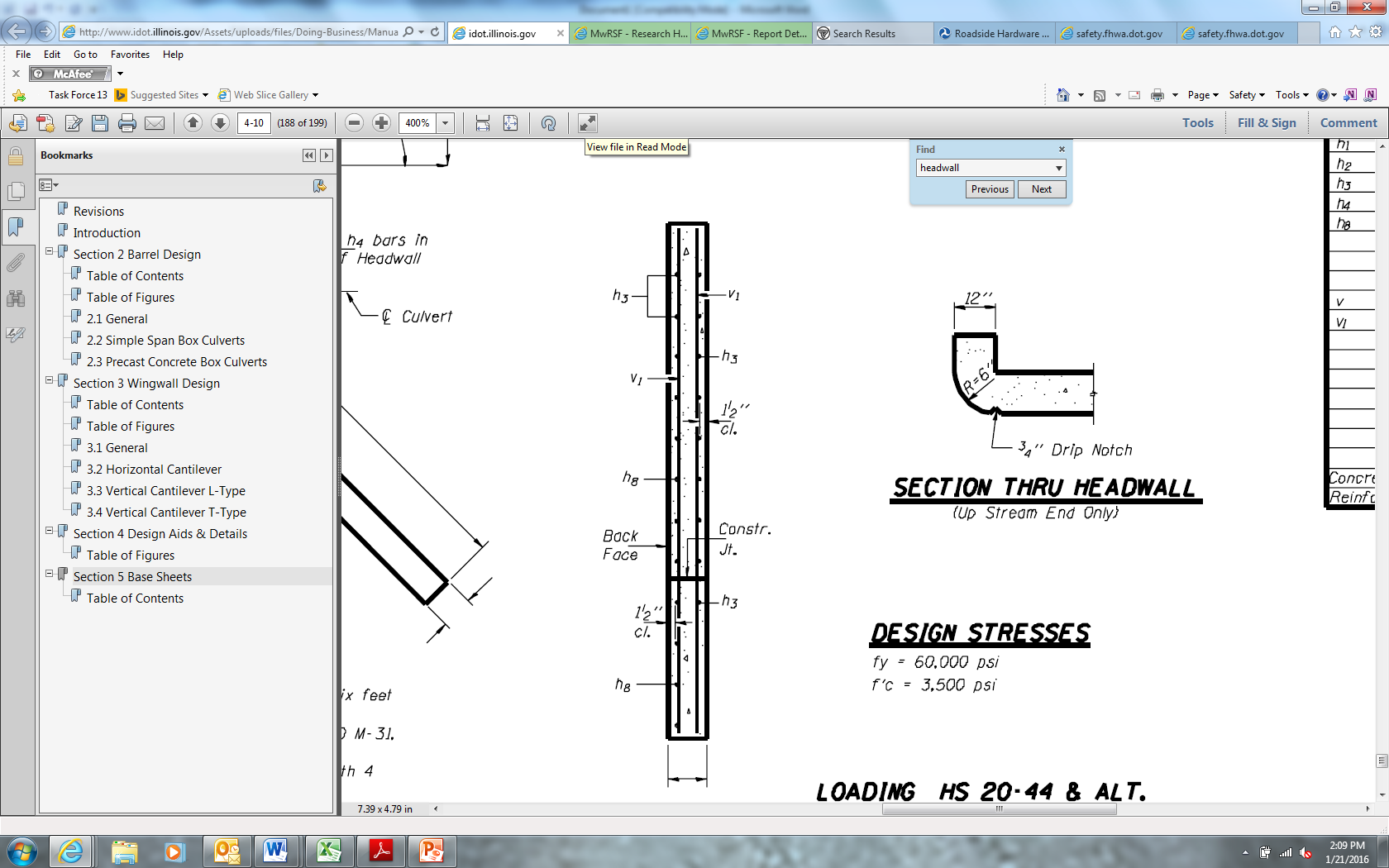
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Culvert Top Slab and Headwall

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| --- | --- | --- | --- | --- | --- |
| **Typical Culvert Dimensions and Compatibility with Weak Post Guardrail Sockets** | | | | | |
| Span (ft) | Fill (ft) | T (in) | H (in) | T+H | Socket will Fit? |
| 6 | 2 | 7 | 6 | 13 | No |
| 7 | 2 | 7.5 | 7 | 14.5 | No |
| 8 | 2 | 8 | 8 | 16 | No |
| 9 | 2 | 8.5 | 9 | 17.5 | Yes |
| 10 | 2 | 9 | 9 | 18 | Yes |
| 11 | 2 | 9.5 | 9 | 18.5 | Yes |
| 12 | 2 | 10.5 | 9 | 19.5 | Yes |

Here is an example of the radius detail used on the inlet end of cast-in-place culverts:



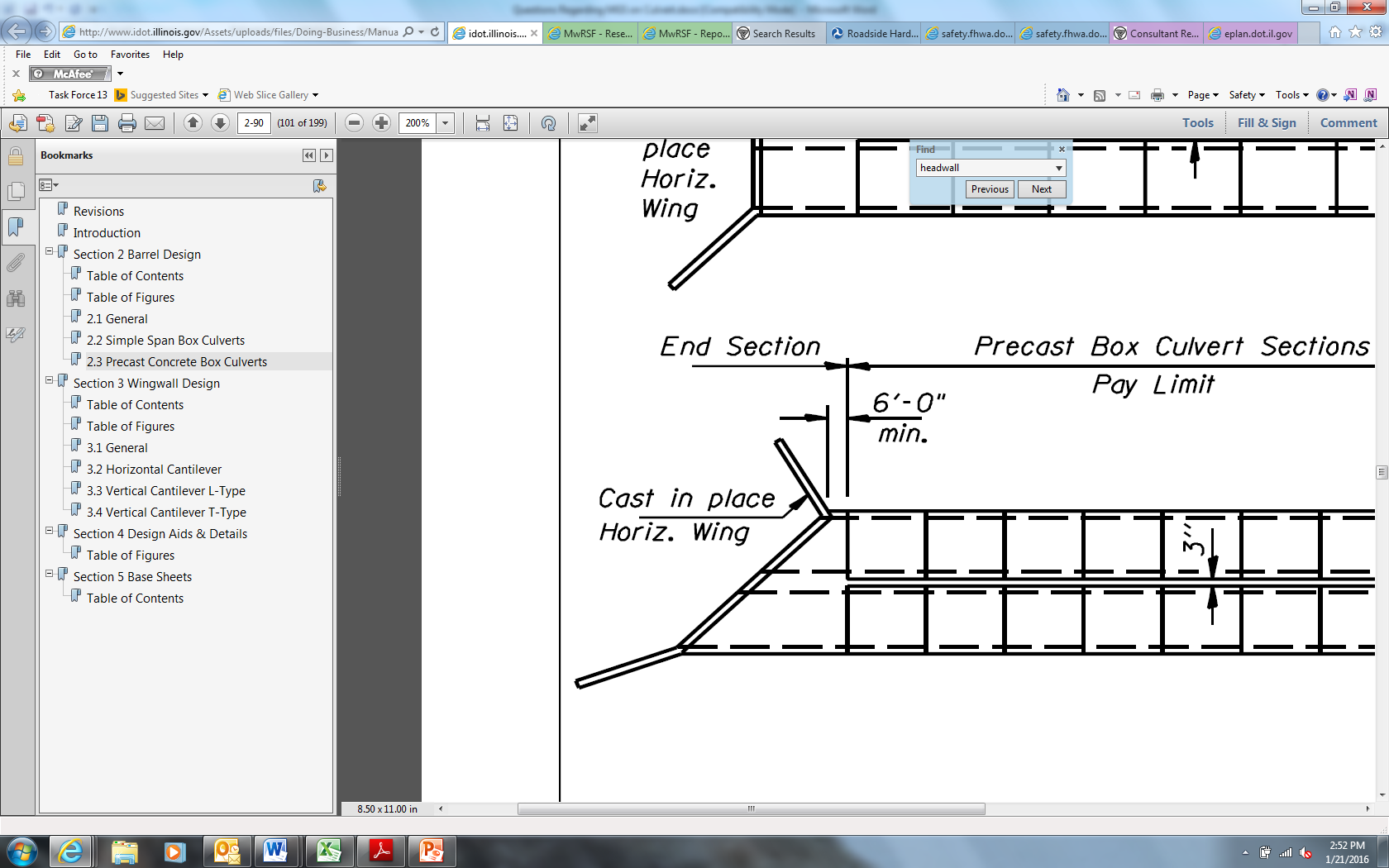
Precast Culverts

Precast culverts for low-fill application have slightly greater top slab thicknesses than the cast-in-place versions, but the difference is small for the cases most in question. For spans of 9 feet or less, the top slab thickness is just 1 inch thicker at most.

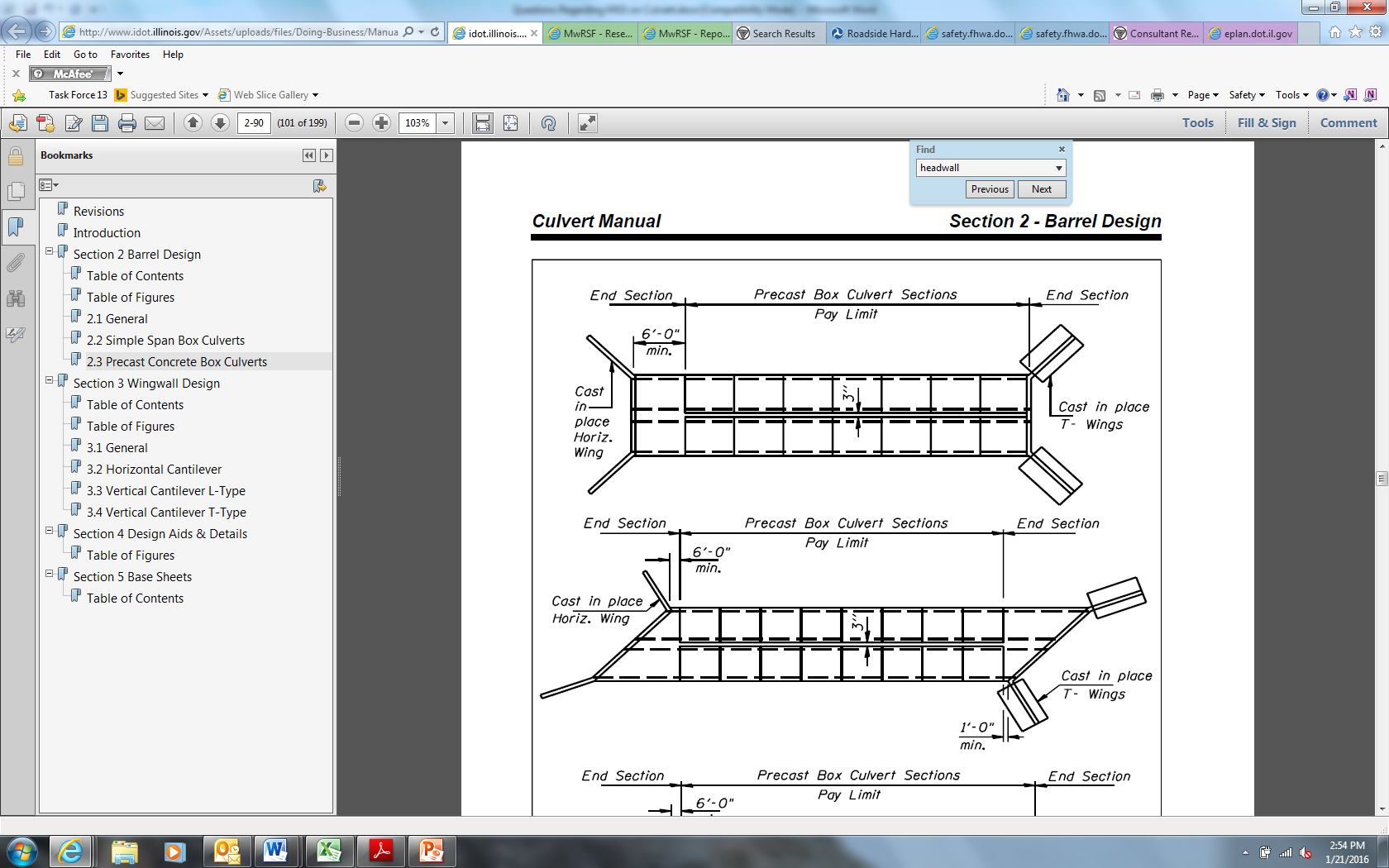
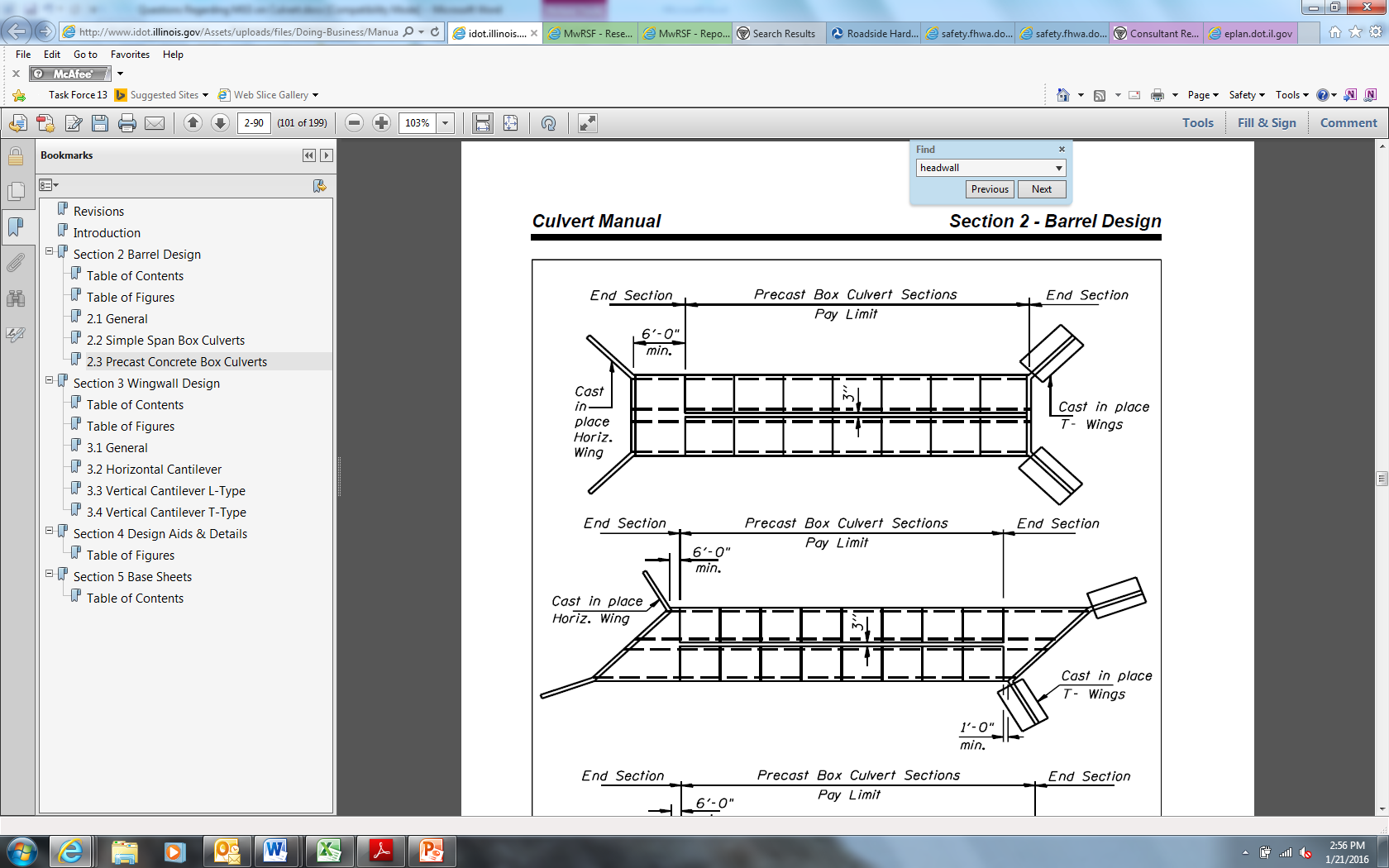
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| --- | --- | --- |
| **Span (ft)** | **Cast-in-Place Top Slab, T (in)** | **Precast (AASHTO M273, <2 ft Cover), T (in)** |
| 6 | 7 | 8 |
| 7 | 7.5 | 8 |
| 8 | 8 | 8 |
| 9 | 8.5 | 9 |
| 10 | 9 | 10 |
| 11 | 9.5 | 11 |
| 12 | 10.5 | 12 |

Headwall configurations for precast culverts may vary from cast-in-place designs.

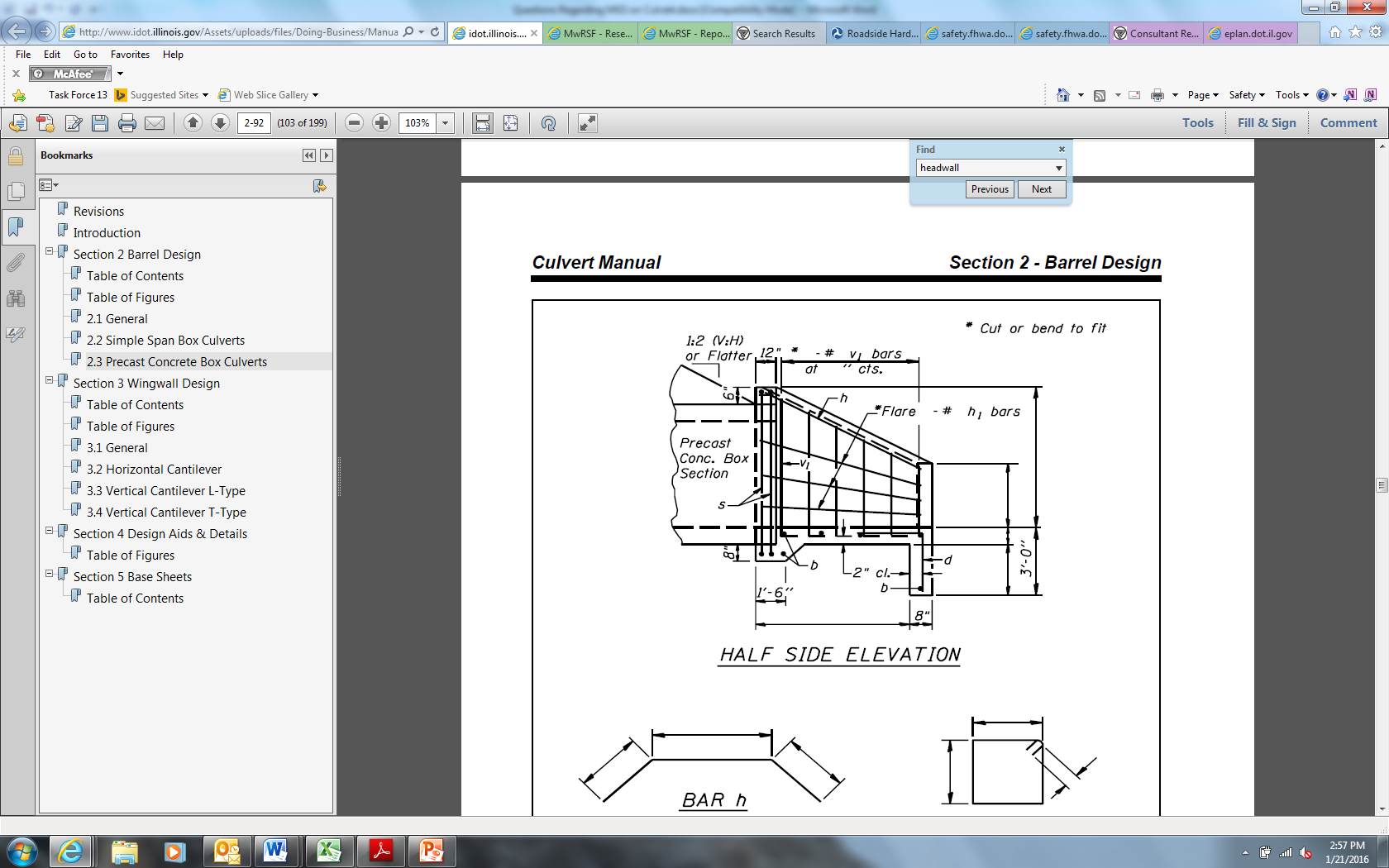
In some cases, precast culverts use cast-in-place wingwalls. If horizontal cantilever wingwalls are used, then at least 6 feet of the barrel must be poured with the wings. In this case, the fitment questions for the precast culvert are similar to those for cast-in-place culverts.



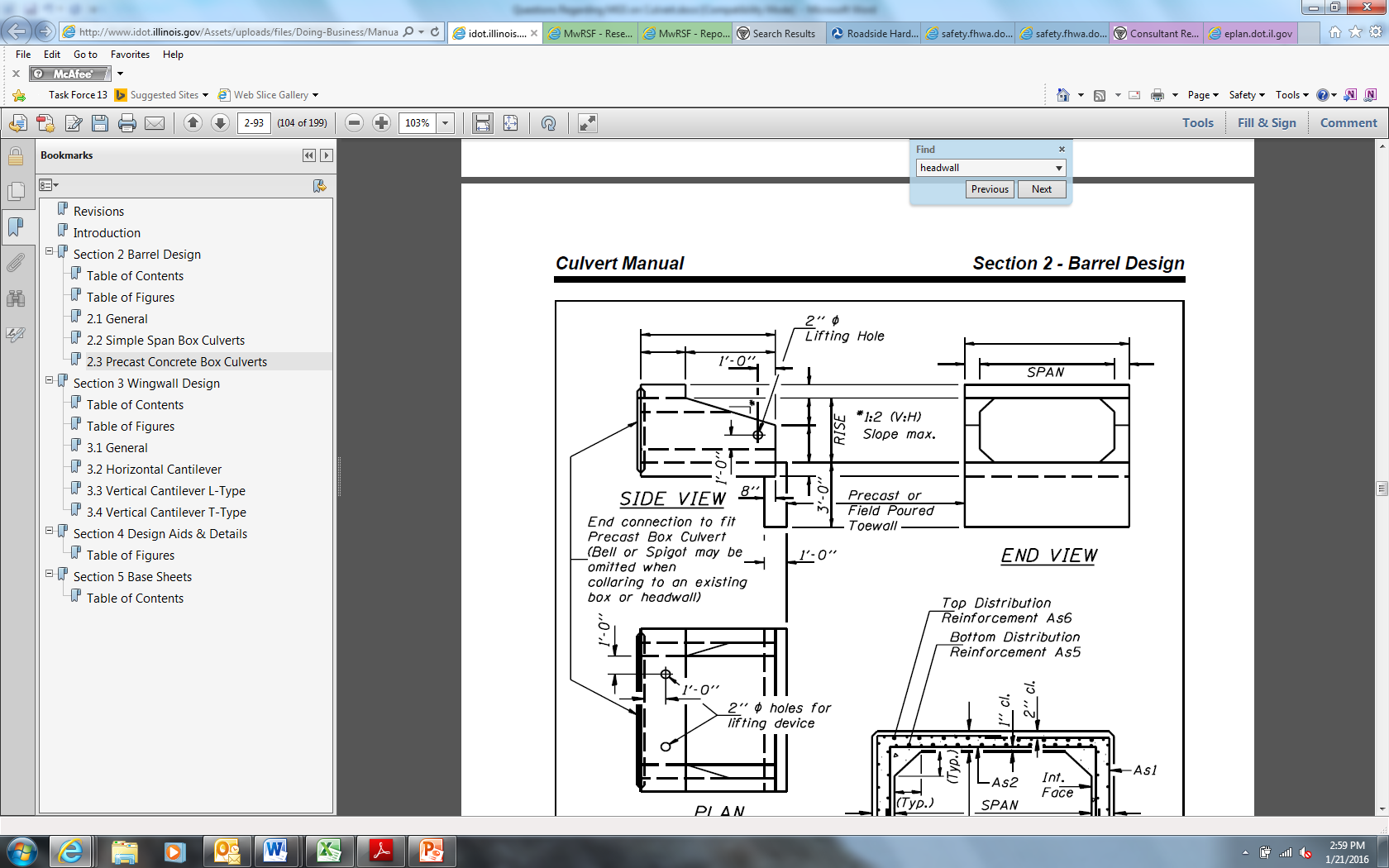
If wings with spread footings are used, then the headwall is part of the band of reinforced concrete cast around or spliced into the precast culvert. Depending on the skew, a part of the barrel may be cast with the headwall. Headwall dimensions would be similar to those for cast-in-place work.

If wingwalls with an apron are used, then the headwall is a part of the band of reinforced concrete cast around the precast culvert. Depending on the skew, a part of the barrel may be cast with the headwall. Headwall dimensions would be similar to those for cast-in-place work.



Precast end sections are sometimes used. These are little more than truncated barrel sections and have no headwall, so these would require a different approach.



For any new culvert construction, consideration could be given to detailing to accommodate the weak post sockets.

However, many more existing culverts could be upgraded if we could adapt the socket system to match the headwall and top slab dimensions. Many of these would be according to or very similar to what is shown in the IDOT Culvert Manual.

Questions

Without compromising MASH compatibility with the MGS, and without introducing a stiffness transition between the MGS and the socketed weak post system:

* How can the weak post socket system be modified to fit our common cases where the thickness of the top slab plus the height of the headwall (T+H) is as little as 13 inches?
* If this is not feasible, how can the required T+H dimension be reduced, and by how much?
* How can the weak post socket system be adapted to our rounded top slab detail? For the as-designed T+H value of 17 inches? For some reduced T+H values as noted above?
* For precast culverts, when the headwall is part of the band or collar joining the wings and barrel, what concerns or constraints arise?
* Are there constraints on how close bolt holes could be placed to the barrel/headwall horizontal joint when the headwall is part of the band or collar joining the wings and precast barrel.