Exploring API 650 Tank Calculations

2025-04-22

```r
knitr::opts_chunk$set(echo = TRUE)
```

Introduction

These problems help to illustrate the use of API 650 calculations. They were implemented in R, a statistical software package, but can be implemented in excel or any other programming language. The Appendix provides information related to how to read the code chucks embedded in this document as well as runtime information on the R program. If you have had any coding experience the math and formulas are written in a simplified way to facilitate understanding the relatively simple calculations involved. If you have no coding experience whatsoever it may be useful for understanding to review the Appendix so that you may read and understand the code chunks herein.

Problem 1 API 650 Shell Thickness Calculation

You are building a new tank per API 650 that will have a diameter of 49 ft and a height of 48 ft and want to know what the bottom course thickness must be. The shell will have six 8 ft high courses. You decide that corrosion allowance is not needed and that the material will be A36. You will design the tank for storage of liquid that has specific gravity of 0.75 based on the full shell height of 48 feet. What is the required thickness of the bottom shell course?

Allowable stress determination

Determining the shell course thickness involves determination of 3 different possible thicknesses based on these three constraints:

1. The product design stress
2. The hydrostatic test stress, and
3. The minimum mechanical thickness specified by API 650.

Each of these constraints on thickness is illustrated in the problems below. We start by listing the basic tank inputs needed for the calculations.

```r
D <- 49 #diameter ft
H <- 48 #height ft
G <- 0.75 #specific gravity (dimensionless)
CA <- 0 #corrosion allowance, in
Y <- 36000 #yield strength psi API 650 Table 5.2b
TS <- 58000 #tensile strength psi API 650 Table 5.2b
```

Product design allowable stress

It is important that the product load on the tank shell is within acceptable levels which produce acceptable stresses. This is also true for the hydrostatic test that is required for newly constructed tanks. The allowable stresses are different for these two cases.

First, we start by determining the allowable product design stresses per API 650 Table 5.2b for the particular steel that we will be using (i.e. ASTM A36 plate). In this problem we are going to use the process for determining allowable stress to see how this table is made.

The product design allowable stress is the minimum of 2/3 yield or 2/5 tensile whichever is less according to API 650 5.6.2.

While we are at it we determine the hydrostatic test allowable stress as it will also be needed. The hydrostatic test stress is 3/4 yield or 3/7 of tensile whichever is less according to API 650 5.6.2.

```
2*Y/3 #2/3 yield for product stress
```

```
## [1] 24000
```

```
2*TS/5 #2/5 tensile for product stress
```

```
## [1] 23200
```

```
Sd <- min(2*Y/3,2*TS/5) #min of 2 values above
Sd
```

```
## [1] 23200
```

```
3*Y/4 #3/4 of yield for hydro stress
```

```
## [1] 27000
```

```
3*TS/7 #3/7 of tensile for hydro stress
```

```
## [1] 24857.14
```

```
St <- min(3*Y/4,3*TS/7 ) #min of 2 values above
St
```

```
## [1] 24857.14
```

Summarizing, the allowable stresses we have:

$$S_d = 23200$$

$$S_t = 24900$$

Note that S_t has been rounded up and that is the value used in API 650 Table 5.2b.

Hoop stress thickness based on product stress

We now use the 1 ft formula in API 650 5.6.3.2 to determine the required shell thickness for the bottom course based on the product design allowable stress.

```
td <- 2.6*D*(H-1)*G/Sd + CA #so called "one foot formula"
td #required thickness based on allowable product design stress, inch
```

```
## [1] 0.1935711
```

Hoop stress thickness required by hydrostatic testing

We next determine the thickness required for the hydrostatic test. This is required because the density of water may be higher than that of the stored product given by the formula in API 650 5.6.3.2. For this calculation we need the hydrostatic test stresses St which are different than the product design allowable stresses Sd. Note in the formula below there is no G since the specific gravity is assumed to be 1.0 and there is no need to show the multiplier since anything multiplied by 1 is the thing. Also, corrosion allowance CA is not included since API 650 is based on use of new plate which should be within 1/100th of an inch of the specified thickness.

```
tt <- 2.6*D*(H-1)/St
tt #required hydrostatic test stress thickness based on allowable hydrostatic stress, inch
```

```
## [1] 0.2408885
```

API 650 requires that the greater of t_d o t_t be the minimum required shell course thickness. Restating the above calculations we have:

```
td #product design thickness
```

```
## [1] 0.1935711
```

```
tt #hydrostatic test thickness
```

```
## [1] 0.2408885
```

In this case, the hydrostatic test stress thickness governs since it is thicker. However, we are not yet done. API 650 requires that regardless of the thickness required to contain the hoop stresses from product or from water (i.e. hydrostatic testing) we must have a minimum thickness for the tank shell based on diameter given in API 650 5.6.1.

Minimum shell thicknesses by diameter API 650 5.6.1

This code block provide the minimum thickness which depends on diameter. See API 650 5.6.1.2.

```
 if (D < 50 ) { #for tanks under 50 ft the min shell thickness is 3/16 in.
  tmin <- 3/16
} else if (D >= 50 & D < 120) { #for tanks from 50 and less than  120 ft diameter, the min thickness is
  tmin <- 1/4
} else if (D>= 120 & D <= 200) { #for tanks from 120 ft  and  less than 200 ft diameter, the min thickn
  tmin <- 5/16
} else {     #for tanks greater than 200 ft diameter the minimum thicness shall be 3/8 inch.
  tmin <- 3/8
}
tmin #minimum required thickness based on tank diameter
```

```
## [1] 0.1875
```

However, Note 4 of API 650 5.6.1.2 states that for tanks less than 50 ft but greater than 10.5 ft the first course thickness shall not be less than 1/4 in. overriding the code block above for our 49 ft diameter tank.

Because the tank is less than 50 ft diameter, we must have a minimum shell thickness of 0.1875 in (3/16 in) for Courses 2 and greater but 1/4 in. for the first course. We now need to take the 3 thickness values we computed above and find the greatest of $(t_d, t_t, tmin)$. Note how the governing thickness for this tank was the minimum required thickness per API 650 5.6.1.1.

```r
max(td, tt,0.25) #required minimum thickness
```

```
## [1] 0.25
```

Problem 1a

Suppose the original 49 ft diameter tank were to store a liquid with a specific gravity of 1.1. What would the required Course 1 thickness be.

Here we can simply repeat the calculation for the thickness based on the product design allowable stress since it is the only thickness that would be affected.

```r
Sd #allowable design stress
```

```
## [1] 23200
```

```r
St #allowable hydrostatic test stress
```

```
## [1] 24857.14
```

```r
D <- 49
G <- 1.1
td <- 2.6*D*(H-1)*G/Sd + CA #so called "one foot formula"
td #required thickness based on allowable product design stress, inch
```

```
## [1] 0.2839043
```

```r
tt <- 2.6*D*(H-1)/St
tt #required thickness based on hydrostatic test stress
```

```
## [1] 0.2408885
```

The thickness based on the hydrostatic test stress remains $t_t = 0.2408885$. The minimum thickness for tanks less than 50 ft diameter remains at $t_{min} = 1/4$ for Course 1. Therefore, the product design stress governs due to the high specific gravity and $t_{reqd} = max(1/4, 0.24088, 0.2839043) = 0.2839043$ in.

Problem 1b

Let's repeat the calculations for the 49 ft diameter tank, and product specific gravity of 1.0. We have a yard full of 5/16 inch plate that we intend to use for this tank. Can we use this material to construct the tank and will we end up with some corrosion allowance?

```
D <- 49
G <- 1.0
CA <- 0 #we start by assuming zero corrosion allowance to find the minimum required thicknesses
td <- 2.6*D*(H-1)*G/Sd + CA #so called "one foot formula"
tt <- 2.6*D*(H-1)/St
td #required thickness based on allowable product design stress, inch
```

```
## [1] 0.2580948
```

```
tt #required thickness based on allowable hydrostatic test stress, in
```

```
## [1] 0.2408885
```

Since the tank is 49 ft diameter we know the minimum thickess required by API 650 Table 5.6.1 is 0.25 in. The difference between 5/16 in and the required minimum thickness due to product stres is the corrosion allowance, in this case. The corrosion allowance being the difference between 5/16 inch and the greater of the required product and hydrostatic test thicknesses.

```
5/16-max(tt,td)
```

```
## [1] 0.05440517
```

The corrosion allowance is 0.0544. And we can use the extra 5/16 plate we have to construct the tank.

Problem 1c Returning to the conditions of Problem 1, what is the required thickness for Course 2 (second course above the base). In this case, according to API 650 5.6.1.3 "The calculated stress for each shell course shall not be greater than the stress permitted for the particular material used for the course". This means that the tank height for the purpose of the calculations will be $H = 48 - 8 = 40$ ft. We can use our one foot formula equation (API 65.6.3.2) as follows.

```
H <- 40 #height ft (note we use the height of liquid to the bottom of the Course 2)
D <- 49 #diameter ft
G <- 0.75
CA <- 0
td <- 2.6*D*(H-1)*G/Sd + CA
tt <- 2.6*D*(H-1)/St
td # required thickness based on product design stress
```

```
## [1] 0.1606228
```

```
tt # required thickness based on hydrostatic test stress
```

```
## [1] 0.1998862
```

For course 2 the three plate thicknesses are:

- product 0.1606228
- hydrotest 0.1998862
- min 0.1875 (3/16)

The required thickness of the 2nd course is 0.1998862 in so that indicates that the hydrostatic test thickness governs.

Problem 1d

Determine the course thickness for the 3rd, 4th, 5th and 6th courses for the tank in Problem 1. In the next code block we will compute the required product thickness and hydrotest thickness for all courses at once.

```
D <- 49 #diameter ft
G <- 0.75
CA <- 0
Y <- 36000 #yield strength API 650 Table 5.2b
TS <- 58000 #tensile strength API 650 Table 5.2b
H <- c(48,40,32,24,16,8) #heights of liquid to bottom of courses 3,4,5,6
td <- 2.6*D*(H-1)*G/Sd + CA #product design thickness
tt <- 2.6*D*(H-1)/St #hydrostatic test thickness
tmin <- c(0.25,0.1875,0.1875,0.1875,0.1875,0.1875) #API 650 5.6.1.1
biggest <- pmax(td,tt,tmin)
cbind("product"=round(td,4),"hydro"=round(tt,4),"min"=round(tmin,4),"governing"=round(biggest,4))
```

```
##      product  hydro    min governing
## [1,]  0.1936 0.2409 0.2500    0.2500
## [2,]  0.1606 0.1999 0.1875    0.1999
## [3,]  0.1277 0.1589 0.1875    0.1875
## [4,]  0.0947 0.1179 0.1875    0.1875
## [5,]  0.0618 0.0769 0.1875    0.1875
## [6,]  0.0288 0.0359 0.1875    0.1875
```

We see that the governing thickness for Course 1 is the requirement of Note 4 of API 650 5.6.1.1. For Course 2 the hydrostatic test stress governs. Course 3 and above are governed by the minimum required plate thicknesses per API 650 API 650 5.6.1.1.

Problem 2 API 650 Shell Thickness Calculation

See if you can do this problem on your own. We have a 150 ft diameter by 48 ft tall tank to be constructed of A573 Grade 58 to API 650. A corrosion allowance of 1/16 in is specified. The product specific gravity is 0.9. Determine the allowable product design and hydrostatic test stresses (you may look them up in API 650). Here are the inputs. Note that we have 6 values for H for the 6 courses.

```
G <- 0.9
D <- 150 #diameter ft
H <- c(48,40,32,24,16,8) #depth liquid to bottom of each course
Sd <- 21300 #allowable product design stress from API 650 TAble 5.2b
St <- 24000 #allowable hydrostatic test stress from API 650 TAble 5.2b
CA <- 1/16 #corrosion allowance in
```

The minimum thickness is based on diameter.

```
 if (D < 50 ) { #for tanks under 50 ft the min shell thickness is 3/16 in.
  tmin <- 3/16
} else if (D >= 50 & D < 120) { #for tanks from 50 and less than  120 ft diameter, the min thickness is
  tmin <- 1/4
} else if (D>= 120 & D <= 200) { #for tanks from 120 ft  and  less than 200 ft diameter, the min thickn
  tmin <- 5/16
} else {     #for tanks greater than 200 ft diameter the minimum thicness shall be 3/8 inch.
```

```r
  tmin <- 3/8
}
tmin #minimum required thickness based on tank diameter
```

```
## [1] 0.3125
```

```r
td <- 2.6*D*(H-1)*G/Sd + CA
tt <- 2.6*D*(H-1)/St
tmin <- rep(5/16,6)
biggest <- pmax(td,tt,tmin)

cbind("product"=round(td,4),"hydro"=round(tt,4),"min"=tmin,"governing"=round(biggest,4))
```

```
##      product  hydro    min governing
## [1,]  0.8370 0.7638 0.3125    0.8370
## [2,]  0.7052 0.6338 0.3125    0.7052
## [3,]  0.5733 0.5038 0.3125    0.5733
## [4,]  0.4415 0.3738 0.3125    0.4415
## [5,]  0.3097 0.2438 0.3125    0.3125
## [6,]  0.1779 0.1138 0.3125    0.3125
```

Note that Course 1 through 4 are governed by the product design thickness and courses 5 and 6 by the the minimum thickness requirement for plate based on diameter. This shows that in most cases the top course or courses will generally be governed by the minimum plate thicknesses per API 650 5.6.1.1 because the hydrostatic pressure is lowest there.

Problem 2a

Compute the required thickness for the top course for this tank based on the product allowable design stress without corrosion allowance.

```r
G <- 0.9
D <- 150 #diameter ft
H <- 8 #depth liquid to bottom of top course
Sd <- 21300 #allowable product design stress from API 650 TAble 5.2b
CA <- 0 #corrosion allowance in
td <- 2.6*D*(H-1)*G/Sd + CA
td #required top course thickness based on product stress alone.
```

```
## [1] 0.1153521
```

As mentioned this shows that even for a moderate sized tank only slightly over 1/10 in is required to contain the hoop stresses but for this tank API requires that the thickness of every course be at least 5/16 (0.3125) in thick or slightly less than three times thicker.

Problem 3 API 650 Small Tanks

Describing tanks as small here is simply to consider tanks in the 20 to 30 foot diameter range. Compute the required thicknesses for all courses for a 25 ft diameter tank that has a design liquid level of 40 ft with five 8 ft courses, specific gravity $G = 0.9$, and product allowable stress of 21300 psi and hydrostatic allowable stress of 24000 psi and no corrosion allowance. State what governs the thickness (product stress, hydrostatic stress, or API 650 5.6.1.1 plate minimum thicknesses).

```r
D <- 25 #diameter ft
G <- 0.9
CA <- 0
Sd <- 21300 #product allowable stress
TS <- 24000 #hydrotest allowable stress
H <- c(40,32,24,16,8) #heights of liquid to bottom of courses 3,4,5,6
td <- 2.6*D*(H-1)*G/Sd + CA #product design thickness
tt <- 2.6*D*(H-1)/St #hydrostatic test thickness
tmin <- c(0.25,0.1875,0.1875,0.1875,0.1875) #API 650 5.6.1.1
biggest <- pmax(td,tt,tmin)
cbind("product"=round(td,4),"hydro"=round(tt,4),"min"=round(tmin,4),"governing"=round(biggest,4))
```

```
##      product  hydro    min governing
## [1,]  0.1071 0.1056 0.2500    0.2500
## [2,]  0.0851 0.0840 0.1875    0.1875
## [3,]  0.0632 0.0623 0.1875    0.1875
## [4,]  0.0412 0.0406 0.1875    0.1875
## [5,]  0.0192 0.0190 0.1875    0.1875
```

Note that the greatest thickness for any course required for either product or hydrotest thickness is only 0.1056 in. All course thicknesses are governed by the minimum mechanical plate thicknesses defined by API 650 5.6.1.1. We can say in general that for small tanks the minimum plate thickness required by API 650 govern the shell course thicknesses. Why is this a good thing?

Problem 4 API 653 Shell Course Thickness

We will rework Problem 1 (i.e. determine first course thickness) with the exception that it is an in-service tank meaning that we are applying the rules of API 653. Also assume that the tank will *not* be hydrostatically tested so that only the allowable product design stresses are required for computing the required shell course thickness. The tank was built to API 650 and we refer to API 653 Table 4.2—Joint Efficiencies for Welded Joints which shows this tank to have a joint efficiency of 1.0. API 653 4.3.3.1 has rules for determining the minimum acceptable thickness for an entire shell course.

$$t_{min} = \frac{2.6(H-1)DG}{SE}$$

Since the "1" in the one-foot method is meant to show that using the full depth of the hydrostatic head is overly conservative due to the restraint on expansion at the bottom of the course it is included just as it is in API 650. However, when looking a a local thin spot we omit the 1 and the equation becomes

$$t_{min} = \frac{2.6HDG}{SE}.$$

There is a floor on thickness of 0.1 in regardless of the computed value of t_{min}.

Another important fact about the use of API 653 is that the allowable stresses are not only based on material but they are higher for a given material as compared to API 650. For example, in Problem 1 we found the A36 allowable stress to be 23200 but in API 653 the allowable stress is either 24900 or 27400 depending on which course we are considering. For API 653 the allowable stress consists of 2 different sets of allowable stress based on the shell course being considered.

API 653 Table 4.1 has allowable product and hydrostatic test stresses. For example, Table 4.1 lists the A36 allowable stresses for Courses 1 and 2 at 24900 and for Courses 3 plus at 27400. Similarly the hydrostatic test stresses are for Courses 1 and 2 27400 and for courses 3 and above 30100.

As before we state the various known inputs. We will consider the first course only.

```
E <- 1.0 #joint efficiency
D <- 49 #diameter ft
H <- 48 #height ft
G <- 0.75
CA <- 0
S12 <- 24900 #allowable stress A36 for courses 1 and 2. See Table 4.1
S3 <- 27400 #allowable stress A36 for courses 3 and above.
```

Problem 4a

Consider that uniform corrosion has reduced the first shell course from 0.2409 to 0.20 in thick on average. Is the first course fit for continued service?

Because of the higher allowable stresses it is possible that the tank is fit for continued service under API 653. To determine this we use the formula.

```
treqd <- 2.6*D*(H-1)*G/(S12*E)
treqd # required thickness
```

```
## [1] 0.1803554
```

Note that since this thickness is greater than 0.1 inch minimum required thickness (API 653 4.3.3.1) and the corroded thickness is 0.2 in which is greater than the minimum required thickness, this course is acceptable and is suitable for service. Also, note that the requirements for minimum plate thickness API 650 Table 5.6.1.2 do not apply. Remember that once the tank is constructed API 650 is not applicable to the existing tank for the purpose of determining required shell course thicknesses.

Problem 4b

Assume that further research shows that the joint efficiency is actually $E = 0.7$ and not $E = 1.0$. Recompute the required thicknesses for all shell courses.

```
E <- 0.7
treqd <- 2.6*D*(H-1)*G/(S12*E)
treqd # required thickness
```

```
## [1] 0.2576506
```

Based on these results the shell course is not suitable for service as the required thickness is greater than the current corroded thickness of 0.2 in. One option is to lower the liquid level to reduce the product and hydrotest stresses.

Problem 4c

Assuming the following data and determine the required shell course thicknesses.

```r
E <- 1.0 #joint efficiency
D <- 49 #diameter ft
H <- c(48,40,32,24,16,8) #height ft
S <- c(24900,24900,27400,27400,27400,27400) #allowable stress A36 for courses.
G <- 0.75
CA <- 0
treqd <- 2.6*D*(H-1)*G/E/S
treqd #required shell course thicknesses
```

```
## [1] 0.18035542 0.14965663 0.10810401 0.08020620 0.05230839 0.02441058
```

To illustrate we will do a "hand calculation" on courses 2 and 3.

For Course 2

```r
t_c2 <- 2.6*49*(40-1)*0.75/1.0/24900
t_c2 #2nd shell course required thickness for product
```

```
## [1] 0.1496566
```

For Course 3

```r
t_c3 <- 2.6*49*(32-1)*0.75/1.0/27400
t_c3 #3rd shell course required thickness for product
```

```
## [1] 0.108104
```

Problem 5

API 653 Figure 4.1 shows a substantial large corroded area that is treated differently than sparse or widely scatted pits. This is the controlling thickness for the shell course thickness which has thinned areas from corrosion. The inspector is required to determine t_2 which is the least thickness in the corroded area exclusive of pits. Without considering pits it represents the maximum of thinning from corrosion generally in an area of corrosion. The length L is the averaging length for the corrosion area and requires inspector judgement to find this minimum average thickness over a maximum distance of 40 inches as shown by the Figure. The value of the averaging length is computed by $L = 3.7\sqrt{Dt_2}$ which is limited to 40 inches. Diameter D is in feet, t_2 in inches, and L in inches. Careful reading of the language is required to understand the averaging length L.

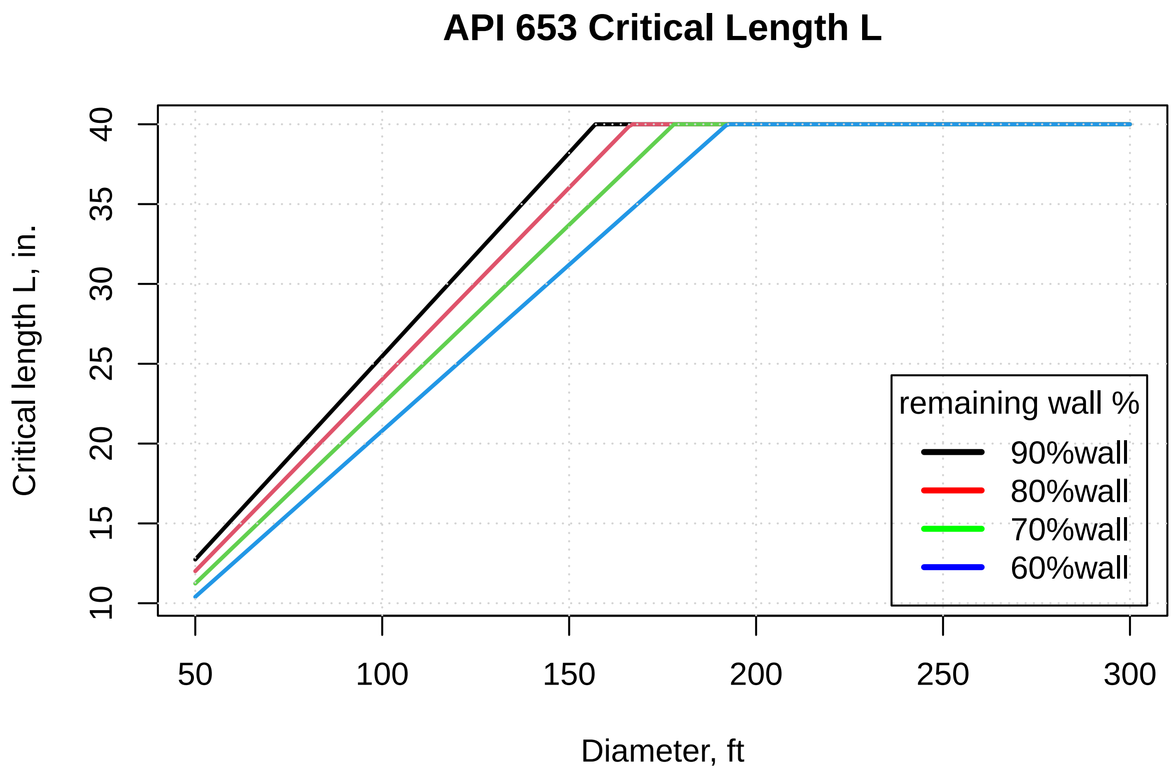
Determine what the critical averaging length L is for the tank in Problem 2 where the Course 1 thickness was 0.837 in. and the value of $t_2 = 0.67$. Recall the diameter was 150 ft.

```r
D <- 150
t2 <- 0.67
L <- 3.7*sqrt(D*t2)
L #averaging length
```

```
## [1] 37.09238
```

In general if we consider a wide range of diameters and remaining wall thicknesses represented by t_2 ranging from 60 to 90 percent remaining wall we see in the plot below that when the diameter exceeds roughly 150 ft then the maximum value for L occurs which is 40 inches. In this example we have used the design product stress thickness for new tanks for illustration purposes.

```
D <- seq(from=50,to=300,by=1)
G <- 1.0
H <- 48
Sd <- 23200
td <- 2.6*D*(H-1)*G/Sd
td90 <- 0.9*td
td80 <- 0.8*td
td70 <- 0.7*td
td60 <- 0.6*td
L90 <- 3.7*sqrt(D*td90)
L80 <- 3.7*sqrt(D*td80)
L70 <- 3.7*sqrt(D*td70)
L60 <- 3.7*sqrt(D*td60)
L <- c(L90,L80,L70,L60)
L[L>40]<-40
M1 <- matrix(c(D,td),ncol=2)
M2 <- matrix(data=L,ncol=4)
dimnames(M1) <- list(NULL,c("D","td"))
dimnames(M2) <- list(NULL,c("L90","L80","L70","L60"))
legendnames <- c("90%wall","80%wall","70%wall","60%wall")
matplot(M1[,1],M2,type='l',lwd=2,lty=1,xlab="Diameter, ft",ylab="Critical length L, in.")
title("API 653 Critical Length L")
grid()
legend("bottomright",inset=0.02,legend=legendnames,lty=c(1,1,1,1),lwd=c(3,3,3,3),col=c("black","red","g
```



Appendices

Appendix 1

This document was produced with R Markdown. We will show how to read the code chunk used above in this appendix.

```
1   const <- 0.00256; #const
2   Kz <- 1.04 #Kz
3   Kd <- 0.95 #Kd
4   G <- 0.85 #G
5   Cf <- 0.6 #Cf
6   factor10 <- 0.6 #load factor ASCE7-05
7   V10 <- 155 #wind velocity
8   p10 <- const*Kz*Kd*V10^2 #wind pressure
9   p10 #wind pressure before adjustment for gust factor and drag coefficient on cylinder
10  p10adj <- p10*G*Cf*factor10 #adjusted wind pressure for G and Cf
11  round(p10adj,2) #wind pressure in API 650 for 120 mph
```

Lines 1 - 7 assign values to variables that are created by the symbol <- which is equivalent to = in other languages.

Line8 multiplies the variables const, Kz, Kd, with the square of V10.

Line 9 prints the value of the variable p10.

Line 10 is another arithmetic operation similar to line 8.

Line 11 rounds the value of p10adj to 2 decimal places.

p05 <- const*Kz*Kd*V05^2 #wind pressure means that the variable p05 is assigned to be the product of constant, Kz, Kd, and V05 squared which is typical in other languages.

R Session Information

More information can be found about R Markdown by searching the internet.

```r
sessionInfo()
```

```
## R version 4.4.3 (2025-02-28 ucrt)
## Platform: x86_64-w64-mingw32/x64
## Running under: Windows 11 x64 (build 26100)
##
## Matrix products: default
##
##
## locale:
## [1] LC_COLLATE=English_United States.utf8
## [2] LC_CTYPE=English_United States.utf8
## [3] LC_MONETARY=English_United States.utf8
## [4] LC_NUMERIC=C
## [5] LC_TIME=English_United States.utf8
##
## time zone: America/Los_Angeles
## tzcode source: internal
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## loaded via a namespace (and not attached):
##  [1] compiler_4.4.3    fastmap_1.2.0     cli_3.6.4         tools_4.4.3
##  [5] htmltools_0.5.8.1 yaml_2.3.10       rmarkdown_2.29    knitr_1.50
##  [9] xfun_0.52         digest_0.6.37     rlang_1.1.6       evaluate_1.0.3
```