South Carolina
Department of Transportation

U.S. Department
of Transportation

Federal Highway Administration

CLEMSON UNIVERSITY

PROJECT SUMMARY

Report No. FHWA-SC-08-05

September 2008

South Carolina
Department of Transportation
P. O. Box 191
Columbia, SC 29202-0191

FREQUENCY AND TIME DISTRIBUTION OF RAINFALL IN SOUTH CAROLINA

Nadim M. Aziz[1] and Abdul A. Khan[2]

Overview

Since rainfall is an integral component in the hydrologic cycle, engineers must be able to quantify rainfall in order to design structures dealing with the collection, conveyance, and storage of rainfall runoff. This report deals with the study of rainfall characteristics and patterns in South Carolina. The analysis involved the assessment of rainfall patterns in the state with special attention to rainfall along the coastal area, the development of new rainfall IDF curves, and the development of new rainfall distribution patterns. The study also involved installing 19 rainfall gauging stations in key areas in the state, collecting the rainfall data at these sites, and developing a website to monitor rainfall at these sites.

Background

In the last fifty years, new rainfall frequency analysis techniques have been developed. Furthermore, several state government agencies are beginning to make use of these new techniques to update their intensity-duration-frequency (IDF) relationships. It has been suggested that IDF curves be updated every 20 years. IDF relationships for South Carolina were last updated in 1988. Updating these relationships every 20 years not only increases the record length of the data set used, allowing for more accurate prediction of larger return periods, but also allows new rainfall gauging stations to be included in the analysis.

[1] Professor, Department of Civil Engineering, Clemson University, Clemson, SC 29634
[2] Assistant Professor of Civil Engineering, Clemson University, Clemson, SC 29634

Currently, Soil Conservation Service (SCS) Type II and III curves are used for rainfall distributions in South Carolina. These curves were developed by the SCS and were specified to be for storms that lasted 24-hours. Since these curves are dimensionless, it is a common practice to scale these curves to represent storm events with durations other than 24 hours. This scaling assumes that events of any duration have the same time-distribution pattern. However, the validity of this assumption is questionable, and it is widely believed that short and long duration events behave differently. Standard events generated from the SCS hyetographs are characterized by a very intense period of rainfall halfway through the event.

Observations of changes in the rainfall pattern along coastal South Carolina have been reported. A significant increase in precipitation may render some of the hydraulic structures inappropriate. A review of the historical annual precipitation at gauges located near the coast may identify changes, if any. In addition, the installation of rainfall gauging stations at key locations will allow monitoring rainfall patterns to identify significant changes.

Results

Depth-duration-frequency curves and isopluvial maps for South Carolina were developed using the available rainfall data. A total of 17 durations ranging from 15 minutes to 120 hours for return periods of 2, 10, 25, 50, and 100 years were analyzed. The new intensity-duration-frequency curves were found to be slightly lower than the existing curves developed in 1986. The difference can be attributed to the removal of outliers in the present study and the existence of the post 1986 drought conditions. The spatial interpolation of the rainfall intensity from the depth-duration-frequency curves yielded accurate intensity-duration-frequency curves and could be used to develop these curves at ungauged sites in the study area.

Further, dimensionless design rainfall patterns for South Carolina were developed based on actual rainfall events as an alternative to the presently used SCS curves that are based on rainfall bursts. Two distinct non-dimensional rainfall patterns, one for short durations of rainfall and the other for long durations, were identified. Though the general patterns for South Carolina were similar to rainfall patterns generated for other states in recent studies, they were markedly different when compared to the SCS curves currently used in the State

Rainfall patterns along the coast of South Carolina were also studied to determine if there is a historical trend of increasing or decreasing rainfall. Several decades of existing data did not provide a conclusive result. At some locations, the total annual rainfall amounts increased then decreased while at other sites no discernable change could be ascertained. The installation of 19 rainfall gauges as part of this project will provide a mechanism to closely monitor the situation along the coast.

For further information, contact Mr. Terry L. Swygert at SCDOT: 803.737.6652; swygertTL@scdot.org